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Fish and macroinvertebrate assemblages of the upper Ord River catchment

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Executive summary

The upper Ord River catchment was identified as data deficient for fish species distributional data by the Northern Australian Fish Fauna project (NAFF) and the Heritage Division (Department of the Environment, Water, Heritage and the Arts (DEWHA)) via their Australian Natural Heritage Assessment Tool (ANHAT). The Environmental Institute of the Supervising Scientist (***eriss***) and University of Western Australia (UWA) had been conducting biodiversity assessments in the region and were in a position to expand their current work to encompass the whole of the upper catchment and thereby add to the records in the upper Ord River catchment for the respective organisations. Argyle Diamonds operates in the upper Ord River catchment and recognised that aquatic biodiversity information, particularly macroinvertebrates, in their region will have benefits to mine site management. To this end, funding was provided by Argyle Diamonds, ANHAT and the NAFF project in mid 2007 to sample a broad array of sites to provide data and preserved samples for the upper Ord River Catchment.

The current project aimed to access and sample fish and macroinvertebrate assemblages from a diversity of rivers, creeklines, springs and pools encompassing the upper Ord Catchment, south of the Ord River Dam (ORD), over a two week period in June 2007. The intention was to collect as comprehensive a taxa list as possible for each site in the time available. Fish were identified to species level in the field and confirmed by samples returned to the ***eriss*** laboratory. Macroinvertebrate samples were preserved in the field and returned to the laboratory for identification to family level, with the exception of the family Leptophlebiidae which was identified to species level.

Over the sampling period 22 sites were sampled, encompassing 18 sites for fish and 14 for macroinvertebrates from riffle habitats. A further seven sites sampled for fish during earlier studies have also been incorporated to increase the spatial distribution of sites.

In total, 24 fish species were collected from the upper Ord river catchment. The survey has a) provided new records for *Syncomistes trigonicus* and *S. rastellus* in the Ord River system, b) provided a range extension, to above the ORD, for most non-catadromous species, c) confirmed the absence of catadromous species from upstream of the Kununurra Diversion Dam (KDD) and ORD (excluding farm-released barramundi that are known to occur in Lake Argyle), d) provided records of juvenile *Glossogobius giuris* at many sites above these major barriers, suggesting this is not an obligate amphidromous species, and e) identified taxonomic issues within the *Syncomistes* genus.

Specimens of all fish species collected were provided to the NAFF project to assist with taxonomic resolution of several species (morphometric and genetic) across northern Australia. Specimens have also been submitted to the Museum and Art Gallery of the Northern Territory.

In total, 47 families of macroinvertebrates were recorded from the upper Ord River catchments. All taxa are commonly and frequently encountered in north western Australia. Further taxonomic resolution of the mayfly family Leptophlebiidae has identified a range extension for *Tillyardophlebia dostinei* and the possible intolerance of *Austrophlebioides* sp AV10 to waters of high concentrations of naturally-occurring ions (expressed as elevated electrical conductivity). Observations of freshwater shrimp, *Macrobrachium* spp collected by the back pack electrofisher have identified an absence of *M. rosenbergii* from sites above the ORD. Given this species requires an estuarine larval stage, this suggests that the ORD prevents the movement of this species into the upper Ord River, as also identified for catadromous fish species.

Acknowledgments

The authors are extremely grateful to Argyle Diamonds, the Department of the Environment, Water, Heritage and the Arts (DEWHA) – Heritage Division, and the Northern Australian Fish Fauna project (NAFF) for funding this survey. We would also like to thank the WA Department of Water (DoW) in Kununurra for providing a fully equipped 4wd vehicle (including fuel) suitable for the terrain. We are extremely grateful to all the land owners who permitted us to access and sample various sites across the upper catchment. A special thanks to Katrina Nissen for invaluable field assistance and local knowledge, and a special thanks to Helen Larson for assisting with fish identifications, especially gobies and *Syncomistes* spp. This work was conducted under a General Exemption from the *Fish Resources Management Act 1994* that allows the collection of fish for scientific purposes, issued by the Director of Fisheries Research, WA Department of Fisheries (1 July 2005 – 30 June 2007) and a Special Permit (No 2006–2007/S17/1617) under section 17 of the *Northern Territory Fisheries Act 1995*, issued by the Director of Fisheries or Delegate, NT Department of Regional Development, Primary Industry, Fisheries and Resources.

Fish and macroinvertebrate assemblages of the upper Ord River catchment

D Buckle, A Storey, C Humphrey & L Chandler

1 Introduction

1.1 Background to study

The upper Ord River catchment was identified as data deficient for fish species distributional data by the Northern Australian Fish Fauna (NAFF) project and the Heritage Division of the Department of the Environment, Water, Heritage and the Arts (DEWHA) via its Australian Natural Heritage Assessment Tool (ANHAT). The Environmental Institute of the Supervising Scientist (***eriss***) and the University of Western Australia (UWA) had been conducting biodiversity assessments in the region and were in a position to expand their current work to encompass the whole of the upper catchment and thereby add to the records in the upper Ord River catchment for the respective organisations. To this end, funding was provided by Argyle Diamonds, ANHAT and the NAFF project in mid 2007 to sample a broad array of sites to provide data and preserved samples for the upper Ord River catchment.

NAFF is a three year project being conducted by the Australian Centre for Tropical Freshwater Research (ACTFR) at James Cook University and the Australian Rivers Institute at Griffith University (ARIGU). The project is NHT funded and entitled 'A comprehensive analysis of the freshwater fish fauna of Northern Australia and their key management needs'. The project has the following objectives:

1 Collation and summary of the distribution of freshwater fishes based on existing known information into a single database. This will create an invaluable dataset that can be interrogated for many purposes to improve knowledge and management decisions.

2 Identifying gaps in the known distribution of northern Australian freshwater fishes and then undertaking field sampling to fill these gaps.

3 Undertake surveys to identify the existence and location of new fish species.

4 Engaging scientists, environmental managers and the broader community on habitat and management issues related to freshwater fishes, including development of a dedicated website hosting a 'one-stop-shop' of information on freshwater fish of northern Australia.

The ANHAT is used to assess places for the National Heritage List by comparing their natural heritage values. The assessment is based on the largest fauna and flora specimen/observation database in Australia and provides a robust comparison of patterns of species richness and endemism for a broad range of taxonomic groups. ANHAT holds and analyses information on recorded locations of thousands of Australian species to help identify places which best represent what is unique about Australia's natural environment. The system is also used to generate lists of species recorded in an area, or show areas of Australia where the biodiversity has been poorly surveyed, such as in the upper Ord River.

Argyle Diamonds operates in the upper Ord River catchment and recognised that aquatic biodiversity information in its region will have benefits to mine site management and as a result has part-funded this project to include macroinvertebrates within riffle habitats at sites sampled for fish. This included a regional understanding of the distribution of species within the family Leptophebiidae.

The current project aimed to access and sample fish and macroinvertebrate assemblages from a diversity of rivers, creeklines, springs and pools encompassing the upper Ord River catchments over a two week period in June 2007. Sampling was conducted in an east to west direction, with all sites accessed by 4x4 and on foot. The intention was to collect as comprehensive a species/taxa list as possible for each site in the time available. This report summarises the findings from the June 2007 field surveys and includes additional information from previous fish surveys conducted in March 2006 and April/May 2007.

1.2 Study area

The Ord River is situated in the East Kimberley region of Western Australia and extends into north-western Northern Territory (Figure 1). The Ord river is 650 km in length and drains into the Cambridge Gulf near Wyndham. Two dams, The Ord River Dam (ORD, established 1972) and the downstream Kununurra Diversion Dam (KDD, established 1963) regulate water flow to the lower Ord River. The KDD provides a hydraulic head to feed water to irrigated farmland on the floodplain. The upstream ORD provides water to the KDD to maintain the hydraulic head, especially in the dry season, as well as generating hydro-electric power for Argyle Diamond Mine and townsites of Kununurra and Wyndham (WA Department of Water 2006).

The upper Ord River is defined as the area above the ORD and has a catchment of approximately 45 300 km^2 (Braimbridge & Malseed 2007). The major tributaries to the upper Ord are the Panton, Elvire, Nicholson, Negri and Wilson/Bow. The KDD and ORD form major barriers for these rivers and restrict the distribution of catadromous, anadromous and amphidromous fish, and crustaceans with marine stages (ie *Macrobrachium rosenbergii*), in the upper Ord River. Prior to impoundment, fish such as barramundi (*Lates calcarifer*), ox-eye herring (*Megalops cyprinoides*), bull shark (*Carcharhinus leucas*), pony fish (*Leiognathus equulus*), mullet (*Liza alata*), tailed sole (*Aseraggodes klunzingeri*), golden grunter (*Nibea squamosa*), freshwater sawfish (*Pristis microdon*), freshwater whipray (*Himantura chaophraya*), and spotted scat (*Scatophagus argus*) would have travelled further upstream, but are now limited by the dams to about one-quarter of the catchment (Storey & Trayler 2007). The Dunham River is the only major tributary to the Ord River that is not regulated, joining the main river downstream of the KDD and the ORD.

The Ord River catchment has a semi-arid to arid monsoonal climate which results in highly variable seasonally flowing streams. The dry season is warm and lasts from May to October while the wet season is hot lasting November to April (Braimbridge & Malseed 2007). During the wet season most of the rainfall is the result of localised thunderstorms which results in large variations in average monthly rainfall (Payne et al 2004) and highly variable river flows. Widespread rainfall events are usually associated with monsoonal lows and tropical cyclones (Water and Rivers Commission 2001, Braimbridge & Malseed 2007). Rainfall decreases in a southerly direction from ~ 780 mm at Kununurra to ~ 550 mm at Halls Creek.

The geology of the upper Ord River is complex and varies throughout. Stream and river structure, and ultimately instream habitat, varies greatly depending upon the geology. The region has had a number of earth movements since 1790–1920 million years before present. The associated upheavals formed metamorphic and igneous (intrusions and extrusive) rocks

that have eroded over millions of years to form sedimentary rocks (Tyler 1996). One of the subsequent earth movements, around 550 million years ago, formed the Halls Creek Fault system which roughly demarcates the major geologic features in the upper Ord River catchment. The fault passes just east of Halls Creek and directly under Lake Argyle. West of the fault is primarily the Lamboo Complex and forms a rugged landscape with high and steep strike ridges and hogbacks with narrow valleys with sandy alluvium. To the East, is a lower relief landscape formed on Cambrian sedimentary rocks and Antrium Volcanics. The landscape includes cuestas, hogbacks and wide plains with steep sided but generally shallow valleys (Wasson et al 2002).

The landscape to the east of Halls creek fault was prime grazing country and since European settlement in the 1880's cattle numbers expanded rapidly. By the 1930s over grazing, compounded by fire, resulted in large areas of degraded and eroded land. The erosion was identified in 1940 but remedial action was only initiated when sediment load estimates threatened the long term storage capacity of the proposed KDD and ORD Dams (Payne et al 2004). Payne et al (2004) document a highly degraded landscape at the commencement of the Ord River Regeneration Project in 1960 and a dramatic recovery over 44 years. Whilst the area has undoubtedly made a remarkable recovery, Wasson et al (2002) suggested the remedial action had little effect on the sediment loads to Lake Argyle because the project did not target the gully and channel erosion, the main source of sediment.

2 Methods

2.1 Sampling sites

Sampling was conducted in June 2007. Sites were selected based on accessibility and to provide a broad spatial coverage in the upper Ord River catchment. In total twenty-two sites were sampled, comprising 18 sites sampled for fish and 14 sites sampled for macroinvertebrates (Table 1, Figure 1). These include one site on the Dunham River catchment (confluence downstream from Ord River Dam) and one site on the Chamberlain River (Site 22 Teronis Gorge), the latter two sites were opportunistically sampled, the former joining the Ord downstream of the impoundments, and the latter a headwater site in the adjacent Chamberlain/Pentecost catchment.

A further seven sites located on Limestone and Flying Fox creeks (three and four sites respectively) have been sampled more intensively for fish on previous surveys in the upper Ord River catchment as part of work conducted for Argyle Diamonds (Table 2). These sites were sampled in March 2006 and again in April/May 2007. Data from both years have been included to provide a more comprehensive species list at each site. These additional sites have been included as they increase the spatial distribution of sites in the upper Ord. Sampling of these sites was locally intensive but employed the same sampling techniques as those used in the current upper Ord River survey, outlined below.

2.2 Fish sampling

Freshwater fish were surveyed using qualitative methodologies that aimed to maximise the number of species captured from each site. The main technique used was backpack electrofishing (Smith-Root model LR24) supported by seine netting, multipanel gillnets, handline and visual observations. The methods used varied depending upon the conditions at each site. Small streams were often sampled effectively by electrofishing, larger rivers required use of a boat and a combination of all methods.

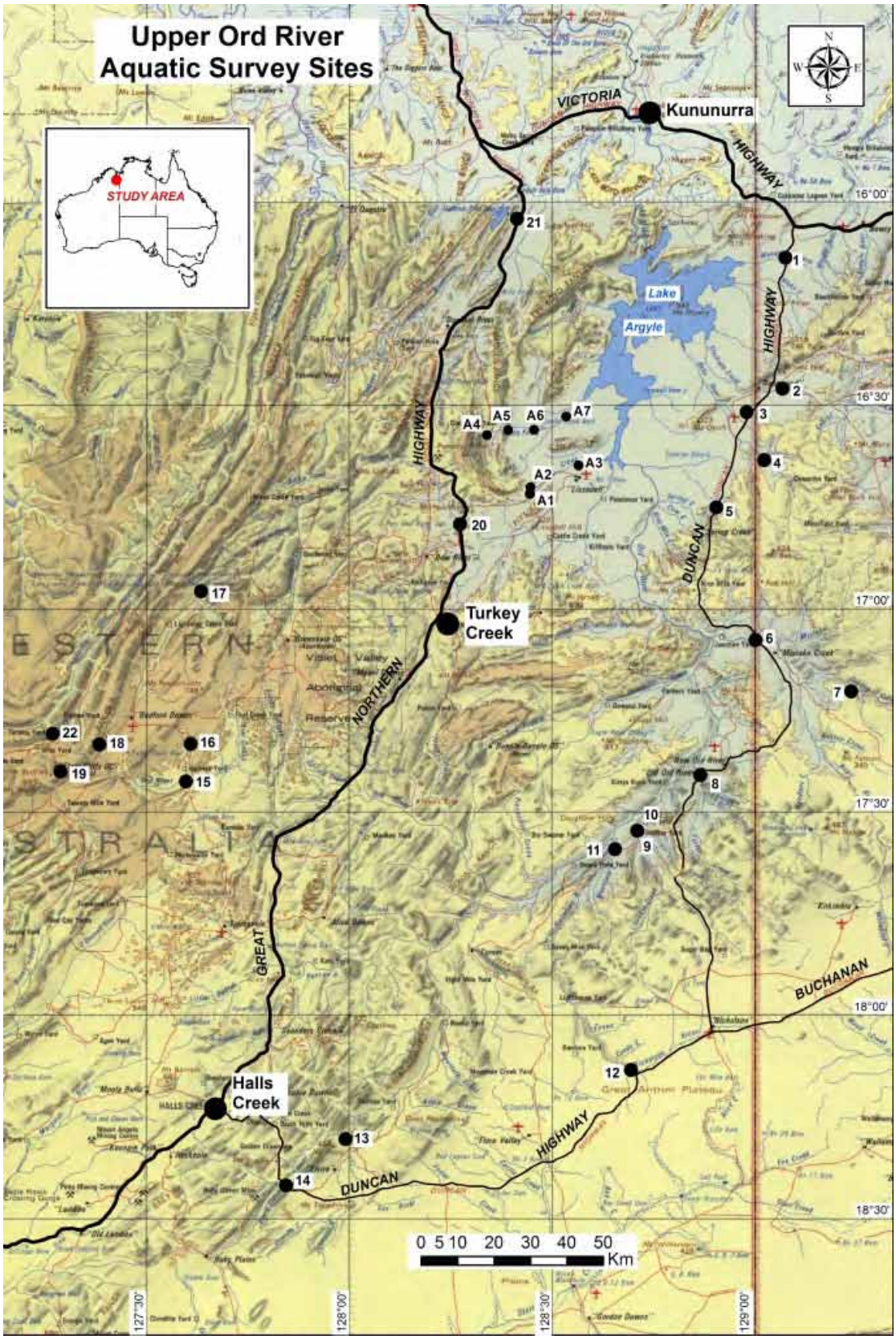


Figure 1 Location of sampling sites in the upper Ord River Catchment. Numbers 1–22 were sampled in June 2007, sites with a prefix 'A' were sampled during earlier surveys.

Table 1 Sites sampled during the upper Ord River aquatic survey, June 2007. Indicating fish and macroinvertebrates sampling sites (coordinates derived using map datum WGS84).

Catchment	Site name	Site code	Date	Latitude	Longitude	Fish	Inverts
Ord Matilda	Ck	1	8/06/07	16º08.228’	129º04.498’	Y	
Ord Stockade	Ck	2	9/06/07	16º27.593’	129º04.080’	Y	
Ord	4 Mile Ck	3	9/06/07	16º30.984’	128º58.884’		Y
Ord Behn	R	4	9/06/07	16º38.094’	129º01.438’	Y	
Ord Johnn	y Cake Ck	5	10/06/07	16º45.083’	128º54.314’		Y
Ord Negri	R	6	11/06/07	17º04.667’	129º00.120’	Y	Y
Ord Stirling	Spring	7	12/06/07	17º12.190’	129º14.301’	Y	Y
Ord Forr	est Ck	8	12/06/07	17º24.029’	128º52.060’	Y	Y
Ord Linnekar	Ck	9	13/06/07	17º32.856’	128º42.661’	Y	Y
Ord Brook	Ck	10	13/06/07	17º32.857’	128º42.741’		Y
Ord Nicholson	R	11	13/06/07	17º35.535’	128º39.398’	Y	Y
Ord	Nicholson R – Mirella Gorge	12	14/06/07	18º08.076’	128º41.669’	Y	
Ord	Elvire R (gorge)	13	15/06/07	18º17.599’	127º58.737’	Y	
Ord	Palm Spring Ck	14	15/06/07	18º25.202’	127º50.709’		Y
Ord Ord	River Gorge	15	16/06/07	17º25.528’	127º35.909’	Y	
Ord Crossland	Spring	16	16/06/07	17º19.954’	127º36.571’	Y	Y
Ord	Wilson R (fig tree hole)	17	16/06/07	16º57.551’	127º38.152’	Y	
Ord	Mt King Bore Ck	18	17/06/07	17º20.057’	127º23.126’	Y	Y
Ord	Upper Ord – Elgee Spring Ck	19	17/06/07	17º24.082’	127º17.266’	Y	Y
Ord Bow	R	20	19/06/07	16º47.475’	128º16.434’	Y	Y
Ord /Dunham	Arthur Ck	21	19/06/07	16º02.485’	128º24.897’	Y	Y
Chamberland	Teronis Ck (gorge)	22	18/06/07	17º18.417’	127º16.202’	Y	

Y = Sampled

Table 2 Sites sampled for fish communities in March 2006 and April/May 2007, as part of a separate project (coordinates derived using map datum WGS84)

Catchment	Site name	Site code	Date	Latitude	Longitude
Ord	Limestone Ck – upstream	A1	10/3/06 & 27/4/07	16°43.015’	128°26.854’
Ord	Limestone Ck – mid	A2	15/3/06 & 1/5/07	16°42.078’	128°26.924’
Ord	Limestone Ck – downstream	A3	11/3/06 & 30/4/07	16°38.819’	128°33.958’
Ord	Flying Fox Ck – upper gorge	A4	13/3/06 & 28/4/07	16°34.345’	128°20.435’
Ord	Flying Fox Ck – lower gorge	A5	13/3/06 & 26/4/07	16°33.529’	128°23.632’
Ord	Flying Fox Ck – mid	A6	12/3/06 & 2/5/07	16°33.435’	128°27.439’
Ord	Flying Fox Ck – downstream	A7	12/3/06 & 2/5/07	16°31.609’	128°32.174’

Nets used during surveying included: (i) 10 m length seine, approximately 1.8 m drop with 10 mm diamond mesh (stretched); (ii) 5 m seine, approximately 1.8 m drop with 6 mm diamond mesh; (iii) 35 m multi-panel gill nets (panels ranging from 2.5 to 15 cm stretched mesh size); and (iv) 25 m multi-panel gill nets (light weight mesh ranging from 2.5 to 15 cm stretched mesh size).

Backpack electrofishing and seine netting are active sampling techniques that target specific habitats and have proven effective for small-bodied species in Kimberley waterways. By contrast, the gill net is a passive fishing technique that relies on fish moving into the nets (or being scared into the nets using dinghy and motor) and becoming entangled, and is only effective in deeper pools. Electrofishing was performed in an upstream direction, shocking in all meso-habitats with the intention of recovering as many species as possible over a standard reach, with shocking restricted to approximately 45 minutes active sampling per site. Visual counts were used to further supplement catch data where species were observed but not taken by either method.

Fish caught were identified to species and their fork length recorded before being released back into the river. Nets were checked frequently to avoid fish deaths. Specimens that could not be identified to species were preserved for laboratory examination. Additionally up to 30 specimens of each species, across all sites, were collected and preserved in 10% Formalin as well as 100% ethanol. After identification specimens were provided to the NAFF project for further morphometric and genetic investigation. The existence of rare, restricted or endemic species was determined by cross-referencing taxa lists for each site with the IUCN 2004 Red List of Threatened Species and with the CALM Wildlife Conservation (current threatened and priority fauna ranking, 5 February 2009).

2.3 Macroinvertebrate sampling

Macroinvertebrate samples were collected using standard national sampling protocols (WA AusRivas protocol – Halse et al 2002): A sweep sample was taken from riffle zones dominated by pebble and gravel substrates using a dip net (250 μm mesh). The equivalent of 10 m (x 0.3 m) riffle habitat was collected. After collection, the samples were preserved in 70% ethanol. The whole samples were later sorted in the laboratory to determine the presence/absence of macroinvertebrate families. Macroinvertebrates were identified to family level using current available keys and voucher specimens held by ***eriss***. Members of the mayfly family Leptophlebiidae were identified to species level using current available keys and the identifications confirmed by Dr Faye Christidis (James Cook University).

Samples are stored at ***eriss*** in 70% ethanol.

2.4 Habitat assessment

The aim of this survey was to obtain a comprehensive list of fish species and collect macroinvertebrate samples. To ensure a broad spatial selection of sites only a reduced selection of habitat variables were collected.

A list of all the major physico-chemical and habitat variables measured during the surveying is provided in Table 3 and further outlined below.

Geo-references (latitude and longitude) for each site were measured using a hand held GPS (WGS 84).

2.4.1 Water physico-chemistry

The basic suite of in situ water chemistry variables was measured using a Hydrolab minisonde multiparameter water quality meter at each site. The unit was fully serived and calibrated before sampling commenced and re calibrated every third day during. Surface water quality measurements were taken approximately 30 cm below the water surface in an area representative of the sample site.

Surface water velocity and discharge were estimated at flowing sites. Measurements were made in well defined riffle areas where cross-sectional areas could be measures easily. Velocity was estimated by using a 50 ml water sample bottle, half filled with water, and timed (replicated three times) over a known length. Discharge (L/sec) was estimated by using the average surface water velocity (m sec^{-1}) and the measured cross section area.

2.4.2 Habitat description

Habitat parameters were recorded separately for fish and macroinvertebrates. Macroinvertebrate habitat descriptions are specific to the riffle zone sampled, whilst fish habitat was generalised over the different habitats within the area sampled – which could be up to a reach of 1000 m and include pool, riffles, glides, runs and backwaters.

Widths and distance measures were mostly estimated by eye and occasionally calibrated by a 25 m tape measure or guided by the proportional coverage of the 25 m and 35 m multi panel gill nets. Depth measures were made using a lead weighted 25 m measuring tape.

Percentage (%) estimates were made visually.

Habitat for fish sampled at sites 1 to 22

Habitat variables relating to fish collected at sites 1 to 22 were based on the comprehensive protocol developed by *NAFF* (Kennard et al 2007) (Table 3). Where time permitted, replicate habitat variables were taken then averaged to represent the sampling site. At small creeks, or when sampling was limited by time, an overall site estimate was made. Due to the electrofisher being the dominant sampling method, habitat data may be biased towards these sampling areas. In large deep pools it was very difficult – or impossible to judge substrate and submerged structure using the 'rapid' habitat assessment techniques.

Habitat for fish sampled at sites A1 to A7

Habitat variables relating to fish collected at sites A1 to A7 are outlined in Table 3 and include the same variables as those collected for macroinvertebrates. However the values recorded are not habitat specific, instead they include all habitats sampled for fish across the entire sample site. Note the classification of mineral substrate differs slightly from those used at sites 1 to 22.

Measurement of logs and branches were made by counting the number of logs and branches in the sample area. The structure of logs and branches was given a numeric code based on complexity of habitat created (score of 1–3). A branch is classified as having a diameter < 10 cm.

1 = Simple (single branch or log).

2 = Medium (mix of branches and logs – moderate mix of sizes – ie old fallen tree smaller branches fallen off).

3 = Complex (complex mix of branch and log sizes – bundled together – creating habitat for numerous fish sizes – ie large fallen tree with all fine branches).

Habitat for macroinvertebrate communities

Habitat variables relating to macroinvertebrate communities were assessed according to the WA AusRivers protocol (Halse et al 2002) and the variables are described in Table 3. Habitat variables recorded for macroinvertebrates are specific to the 10 m riffle zone from which the sample was collected.

Table 3 Physico-chemical and habitat variables measured during field surveying for fish and macroinvertebrates in the upper Ord River catchment

General site information	**Fish from sites 1 to 22**
Water chemistry variables pH Aquatic Temperature (°C) Conductivity (µS cm^{-1}) Dissolved oxygen (% saturation & mg L^{-1}) Turbidity (NTU) *Other measured variables* Surface water discharge estimate (L sec^{-1}) Surface water velocity (m sec^{-1}) Wetted width (m) Site length (m)	*Habitat characteristics (%)* macrophytes Leaf litter Submerged marginal veg. (eg grasses, weeds) Submerged overhanging veg. (eg tree branches / leaves) Emergent veg (eg sedges, rushes) Root masses Undercut banks Large woody debris (>15 cm stem diameter) Small woody debris (<15 cm stem diameter) Filamentous algae Average water depth (m) Maximum water depth (m)
Macroinvertebrate sites 1 to 22 and fish sites A1 to A7	*Mineral substrate characteristics (%)* Bedrock Rock (> 128 mm) Cobbles (64 – 128 mm) Pebbles (16 – 64 mm) Gravel (2 – 16 mm) Sand (0.06 – 2 mm) Mud (<0.06 mm)
Mineral substrate characteristics (%) Bedrock Boulders (>256 mm) Cobbles (64 – 256 mm) Pebbles (16 – 64 mm) Gravel (4 – 16 mm) Sand (1 – 4 mm) Silt (<1mm) Clay Run	*Habitats types sampled (%)* Riffle Glide Pool Backwater
Breakdown of habitat surface area (%) Mineral substrate Emergent Macrophyte Submergent Macrophyte Floating Macrophyte Algae Cover Detritus Riparian veg draped in water Other	**Fish from Sites A1 to A7** # Logs and branches in sampling area Complexity of logs and branches score (1 = simple to 3 = complex)

3 Results and discussion

3.1 Fish

A total of 24 species of fish from 12 families were recorded during the upper Ord River fish surveys (Table 4). Within the fish fauna, the Teraponidae (grunters) were particularly well-represented (six species), while *Melanotaenia australis* (rainbowfish) and *Leiopotherapon unicolor* (spangled grunter) were the most widespread and abundant. *M. australis* was recorded at all 25 sites sampled and *L. unicolor* was recorded at 24 of the 25 sites. Other commonly recorded species were *Nematalosa erebi* (bony bream), *Glossogobius giuris* (flathead goby), *Amniataba percoides* (banded grunter), *Oxyeleotris selheimi* (giant gudgeon) and *Neosilurus pseudospinosus* (false spined catfish).

The greatest species richness (18 species) was recorded at Linnekar Ck and Flying Fox Creek – upper gorge (site 9 and A4 respectively, Table 4). Linnekar Creek being a larger creek with good diversity of habitat. Flying Fox Creek – upper gorge is located below a gorge system that provides deep permanent waterholes in near pristine condition, with shallow pools and riffle sections as well. Flying Fox Creek – upper gorge was one of two sites to record *Porochilus rendahli* (Rendahl's catfish), which was found amongst thick melaleuca root mats. This site was also only one of four sites from which *Syncomistes trigonicus* (long-nose grunter) was recorded and one of two sites (the other being just downstream; A5) that recorded all three species of *Syncomistes* (*S butleri, S rastellus* and *S trigonicus*). This is the first known co-occurrence of the three species of *Syncomistes* at the same location.

The lowest species richness was recorded in headwater streams and smaller tributaries, where natural conditions (small pools and shallow water, and seasonal flows) likely restricted larger fish species and those less determined to disperse. Mount King Bore Creek (site 18) recorded two species, *Melanotaenia australis* (rainbowfish) and *Mogurnda mogurnda* (purple spotted gudgeon). This creek was a very small spring feed creek, reportedly retaining water year round.

Glossogobius giuris (flathead goby) was collected at 20 of the 25 sites (Table 4) and ranged in size from 173 mm to 28 mm (Appendix 1 – Table 1A). This is the only, reportedly, amphidromus species collected. The abundance of juveniles located hundreds of kilometres from the Ord River estuary and above both the Ord River Dam and Kununurra Diversion Dam may suggest this species is maintaining a freshwater population.

This survey, combined with the data previously collected from Flying Fox Creek has provided a range extension for *S. trigonicus*, a Kimberley endemic, previously recorded from the Prince Regent, Roe, Mitchell, Lawley, Carson and Drysdale river systems (Allen et al 2002). This species was only collected at sites in close proximity to headwater gorges, which we presume is due to good quality permanent water. Prior to the construction of the Ord River Dam (ORD) the Ord River had extensive gorge habitat, some of which remains between the ORD and KDD, however flows are heavily regulated. It would be interesting to see if this species still occurs over this reach – or in lakes Kununurra or Argyle.

This survey provides the first record of *S. rastellus* from the upper Ord. It was originally recorded from the Drysdale River system where it was believed to be restricted to (Allen et al 2002, Allen et al 2006) but it has since been recorded from the Upper Victoria River systems (OZCAM). *S. rastellus* is listed as Lower Risk: near threatened in the 2004 IUCN Red List of Threatened Species, Red List category and criteria (LR/nt) and as Priority 2 (P2, taxa with few poorly known populations on conservation land) by the DEC list. This species being the most common *Syncomistes* sp in the upper Ord, being collected at 11 of 25 sites sampled for fish (Table 4).

Juvenile (<50 mm) specimens of *Syncomistes rastellus*, and *S. trigonicus* were difficult to distinguish using the current key by Vari and Hutchins (1978) due to morphometric variations. We have identified most as *S. rastellus* primarily due to a consistent juvenile colour pattern of 7–8 horizontal body stripes, as noted by Allen et al (2002) for this species. This taxonomic problem for juveniles is further confounded by the possible presence of *Syncomistes kimberleyensis* which was described from the Bow River (upper Ord) from only three juvenile specimens, the largest being 36 mm in standard length (Vari 1978). The description of *S. kimberleyensis* by Vari (1978) is very similar to juvenile specimens we identified as *S. rastellus*, the main difference being the shape of the lower jaw. *S. kimberleyensis* is distinguished as having a 'U' shaped lower jaw and 16 lower gill rakers on the lower arch, *S. rastellus* is described as having a 'V' shaped lower jaw and 19–21 gill

rakers on the lower arch (Vari & Hutchins 1978). Our specimens, identified as *S. rastellus*, suggest an ontogenetic shift in gill rakers on the lower arch and a less distinct lower jaw shape in juveniles (Figure 2). Interestingly an ontogenetic shift in the lower jaw shape has been observed in juvenile *S. trigonicus* collected from the Gibb and King rivers (pers comm Aaron Davis). Without information on adult *S. kimberleyensis*, combined with the problems identifying juvenile specimens of the three species, it is difficult to be certain of the identity of these juvenile *Syncomistes*. There appears to be a need for the *Syncomistes* genus to be revised to clarify these issues.

Fish specimens of all species have been collected and preserved in formalin and tissue samples in 100% ethanol from a range of fish species, in particular grunters. These samples will allow morphometric and genetic resolution of the status of these species across northern Australia. These samples have been provided to the NAFF project. Samples have also been submitted to the Museum and Art Gallery of the Northern Territory.

3.2 Macroinvertebrates

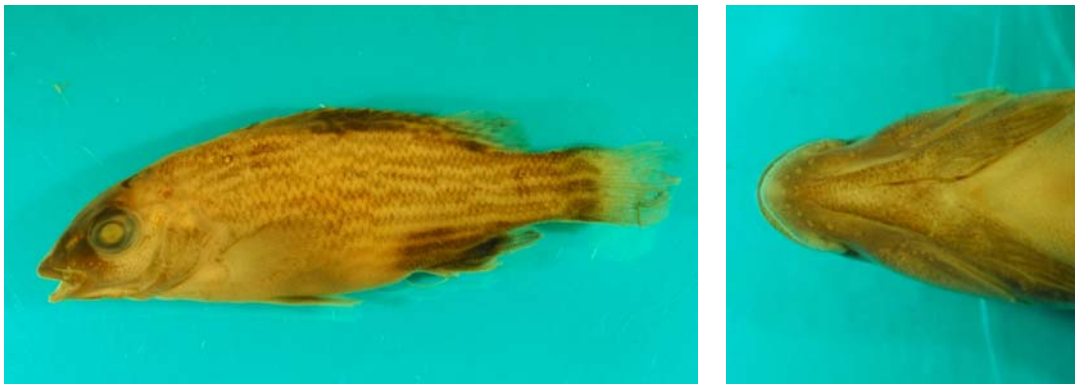
In total, 47 families of aquatic macroinvertebrates were recorded from the 14 sites (Table 4). All taxa recorded are common and frequently encountered in river systems and wetlands within northern Western Australia.

The dominant taxa (present at > 85% of sites, and generally in large numbers) included: Acarina (water mites); Baetidae and Caenidae (mayflies); the dipteran families, Chironomidae (non-biting midges), Ceratopogonidae (biting midges), Simuliidae (blackflies), and Tabanidae (march flies); and the trichopteran (caddis flies) families, Hydropsychidae and Philopotamidae.

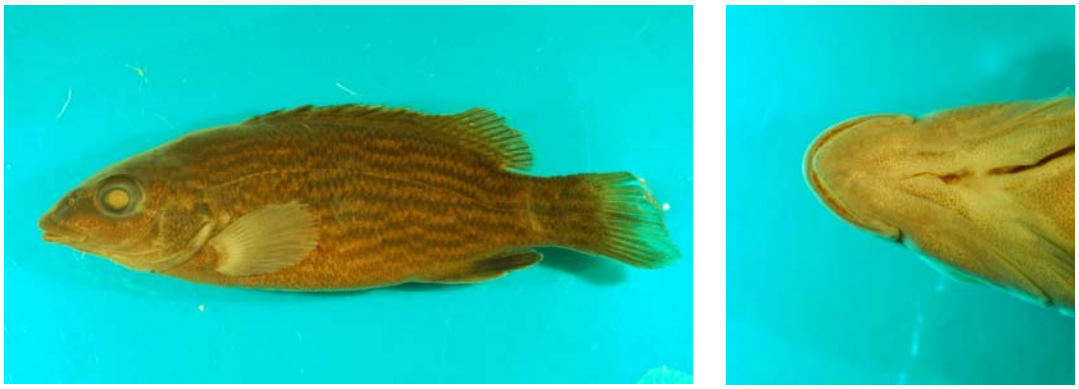
Taxa richness showed some variation between sites, with Arthur Creek (Site 21 – Table 5) recording the lowest. This would be due to lack of suitable mineral substrate in the riffles. The riffle areas were dominated by root mats (40%) with only 30% being mineral substrate (Table 10). The dominance of root mats is most likely due to the leaking diversion dam upstream which has resulted in permanent water flow over the riffle areas allowing riparian plants to establish their roots and smother mineral substrate.

Palaemonidae (freshwater prawns) were only collected at one macroinvertebrate site (Table 5) which is not unexpected as this taxa is not typically located in riffle habitats. However, species from this taxa was commonly collected when surveying fish with the backpack electrofisher. *M. bullatum* is a freshwater resident and was commonly collected at almost all sites in the upper Ord River. *Macrobrachium rosenbergii*, on the other hand, was only collected from Teronis Gorge (site 22) which is located on the headwaters of the adjacent Chamberlain River, a system that is not regulated by dams. *M. rosenbergii* requires brackish water for spawning and nursing up to postlarval stage (Chan 1998), thus its absence at sites above Argyle Dam suggests juvenile movement upstream is prevented by the dam wall. Whilst *M. rosenbergii* was not collected at Arthur Creek (site 21) on the Dunham River (the only other unregulated site) during this survey, it has been recorded at an adjacent site on the Dunham River and below the Kununurra Diversion Dam in previous studies (Andrew Storey unpublished data).

A. Specimen 32 mm standard length with 16 gill rakers on lower gill arch



B. Specimen 41 mm standard length with 16 gill rakers on the lower arch



C. Specimen 55 mm standard length with 19 gill rakers on the lower arch

D. Specimen 62 mm standard length with 18 gill rakers on the lower arch

Figure 2 Photographs of specimens identified as *Syncomistes rastellus*, depicting colour change in juveniles and less distinct V shaped lower jaw, information on gill rakers on lower arch are also included. Photographs taken by Caroline Camilleri (Supervising Scientist Division).

Table 4 Fish species and abundances captured from surveys in the upper Ord River catchment. Site codes are explained in Tables 1 & 2. Y = species captured, O = species recorded by visual observation, I = Anecdotal record from landowners.

Common name	Scientific name	Sites sampled during upper Ord Aquatic survey, June 2007																		Sites sampled March 2006 & April/May 2007							Total
		1	2	4	6	7	8	9	11	12	13	15	16	17	18	19	20	21	22	A1	A2	A3	A4	A5	A6	A7	
Glassfish	*Ambassis* sp *(A. mulleri)*		Y					O								Y	Y	Y			Y	Y	Y		Y		9
Giant glassfish	*Parambassis gulliveri*				Y															Y	Y			Y		Y	5
Mouth-almighty	*Glossamia aprion*																				Y						1
Blue catfish	*Neoarius graeffei*		Y		Y		Y		Y		Y	Y								Y	Y	Y			Y	Y	12
Midgley's catfish	*Neoarius midgleyi*								Y		Y	Y								Y			Y				5
Strawman, blackmast	*Craterocephalus stramineus*	Y		Y	Y		Y	Y	Y		Y						Y			Y	Y	Y			Y		12
Freshwater longtom	*Strongylura kreffti*	Y						O			I										Y	Y	Y				6
Boney bream	*Nematalosa erebi*	Y	Y	Y	Y		Y		Y	Y	Y	Y	Y	Y		Y	O			Y	Y	Y	Y	Y	Y		20
Northern trout gudgeon	*Mogurnda mogurnda*					Y							Y		Y	Y		Y					Y				6
Giant gudgeon	*Oxyeleotris selheimi*	Y	Y	Y	Y		Y		Y		Y		Y	Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	19
Sleepy cod	*Oxyeleotris lineolata*	Y	Y	Y	Y			Y	Y										Y								7
Flathead goby	*Glossogobius giuris*	Y	Y	Y	Y		Y	Y	Y		Y	Y	Y	Y			Y		Y	Y	Y	Y	Y	Y	Y	Y	20
Western rainbowfish	*Melanotaenia australis*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	25
Black catfish	*Neosilurus ater*							Y	Y												Y		Y	Y	Y		6
Hyrtl's catfish	*Neosilurus hyrtlii*	Y	Y		O		Y	Y		Y	Y			Y	Y			Y	Y		Y		Y	Y	Y	Y	18
False-spined catfish	*Neosilurus pseudospinosus*		Y	Y	Y	O	Y	Y	Y		Y	Y	Y			Y	Y			Y	Y	Y	Y	Y	Y	Y	19
Rendahl's catfish	*Porochilus rendahli*																	Y					Y				2
Banded grunter	*Amniataba percoides*	Y	Y	Y	Y		Y	Y	Y		Y	Y	Y	Y			Y		Y	Y	Y	Y	Y	Y	Y	Y	20
Jenkins grunter	*Hephaestus jenkinsi*		Y	Y	Y		Y	Y	Y		Y			Y		Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	18
Spangled grunter	*Leiopotherapon unicolor*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	24
Butlers grunter	*Syncomistes butleri*							Y			Y									Y			Y	Y	Y		6
Long-nose grunter	*Syncomistes trigonicus*											Y							Y				Y	Y			4
Drysdale grunter	*Syncomistes rastellus*				Y		Y				Y	Y		Y		Y							Y	Y	Y		Y	11
Spotted archerfish	*Toxotes chatareus*	Y		Y	Y		Y		Y		Y	Y		Y						Y	Y	Y	Y	Y	Y	Y	15
	Total	**11**	**12**	**11**	**15**	**4**	**8**	**18**	**14**	**4**	**16**	**11**	**9**	**10**	**2**	**9**	**11**	**7**	**10**	**14**	**17**	**12**	**18**	**17**	**17**	**13**	

Table 5 Systematic list of macroinvertebrate families collected during June 2007 study. Site codes are explained in Table 1. Taxa abbreviations: Ph, Phylum; Cl, Class; Or, Order.

Taxa		Site code													
Ph-Cl-Or	**Family**	**3**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**14**	**16**	**18**	**19**	**20**	**21**
CNIDARIA															
HYDROZOA	Hydridae										Y				
PLATYHELMINTHES															
TURBELLARIA	Turbellaria						Y	Y		Y	Y	Y	Y		
NEMATODA	Nematoda				Y	Y	Y					Y			
MOLLUSCA															
BIVALVIA	Corbiculidae									Y					
GASTROPODA	Lymnaeidae										Y		Y		
	Ancylidae	Y	Y								Y		Y		
	Planorbidae	Y	Y			Y					Y	Y		Y	
ANNELIDA															
OLIGOCHAETA					Y	Y			Y	Y	Y	Y			
CRUSTACEA															
Ostracoda		Y						Y		Y			Y		
Decapoda	Parathelphusidae		Y												
	Palaemonidae				Y										
ARACHNIDA															
Acarina	Hydracarina	Y	Y		Y	Y		Y	Y	Y			Y	Y	Y
COLLEMBOLA											Y				
INSECTA															
Ephemeroptera	Baetidae	Y	Y		Y	Y		Y	Y	Y	Y			Y	Y
	Caenidae	Y	Y		Y	Y		Y	Y	Y	Y		Y		Y
	Leptophlebiidae	Y			Y	Y		Y	Y	Y		Y	Y		
Zygoptera	Coenagrionidae		Y							Y			Y		
	Protoneuridae										Y				
	Zygoptera (imm/damaged)				Y										
Anisoptera	Gomphidae			Y		Y	Y								
	Libellulidae	Y	Y			Y	Y	Y	Y		Y	Y			Y
Hemiptera	Veliidae	Y	Y		Y						Y	Y	Y	Y	
	Gerridae		Y		Y									Y	
	Corixidae	Y									Y				
	Naucoridae									Y					
Neuroptera	Sisyridae									Y	Y				
Coleoptera	Dytiscidae	Y	Y		Y	Y		Y			Y	Y	Y	Y	
	Hydrophilidae	Y				Y	Y		Y	Y	Y	Y		Y	
	Hydrochidae							Y			Y	Y			
	Hydraenidae	Y	Y								Y		Y		
	Scirtidae				Y					Y		Y			
	Elmidae	Y		Y		Y	Y	Y	Y	Y	Y		Y		
Diptera	Culicidae	Y						Y		Y		Y	Y		
	Chironomidae	Y	Y		Y	Y		Y	Y	Y	Y		Y	Y	
	Ceratopogonidae	Y	Y			Y	Y	Y	Y	Y	Y		Y	Y	
	Simuliidae		Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	
	Tipulidae	Y		Y		Y	Y	Y		Y		Y	Y		
	Tabanidae	Y	Y	Y		Y	Y	Y	Y	Y	Y		Y	Y	
	Empididae									Y					
	Dolichopodidae	Y	Y	Y	Y		Y			Y	Y				
	?Muscidae										Y				
Trichoptera	Ecnomidae	Y		Y	Y			Y	Y	Y	Y		Y	Y	
	Hydropsychidae	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
	Hydroptilidae		Y	Y	Y		Y	Y	Y	Y	Y		Y	Y	
	Leptoceridae			Y			Y			Y		Y	Y	Y	
	Philapotamidae		Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	
Lepidoptera	Pyralidae		Y	Y	Y	Y	Y		Y	Y	Y			Y	
	Total Taxa	**19**	**24**	**16**	**23**	**18**	**22**	**21**	**17**	**23**	**35**	**24**	**21**	**21**	**9**

From the family Leptophlebiidae four species were identified with taxa unidentified being grouped into 'Leptophlebiidae sp (imm./damaged)' (Table 6). Taxa within this unidentified group are most likely to be one of the other species identified at each site, however they were missing diagnostic features or were immature specimens preventing a positive identification.

Of the identified species *Austrophlebioides* sp AV10 was generally the dominant and collected from 6 sites (Table 6). This species has a streamlined shape and relatively large teeth on the tarsal claws which make it suited to faster flowing environments. It was generally collected from larger rivers with faster flowing riffles (with the exception of site 7, Stirling Spring) and absent from smaller slow flowing rivers. Notably, higher abundances of *Austroplebioides* sp AV10 were recorded at sites 6 (72) and 20 (84), which had lower conductivities (459 µs/cm and 268 µs/cm respectively, Table 6), with the species generally absent or in low abundances at EC values >500 µs/cm. This suggests the species has an intolerance to the presence of high concentrations of naturally-occurring ions.

Thraulus sp AV1 was collected from three sites which were slower flowing. This species has small teeth on the tarsal claws, and large oval gills with elaborately fringed margins which increase the surface area (Dudgeon 1999) making them more adapted to low flow conditions with reduced oxygen available.

Manggabora wapitja was only collected from the Negri River (site 6) which was a larger river with faster flow. This species is widespread typically located in faster flowing streams due to its streamlined shape and larger teeth on the tarsal claws.

Tillyardophlebia dostinei was only collected from Mount King Bore Creek (site 18). The confirmed identity of *T. dostinei* indicates an extension of its range. It was previously only known from the type locality at Rockhole Mine Creek (South Alligator River) in Kakadu National Park, although it was believed to be more widely distributed (Dean and Suter 2004) and has subsequently been found in creeks and rivers in the vicinity of Rockhole Mine Creek, Moline Rockhole (Mary River, NT) and Flying Fox creek (upper Ord River, WA) (unpublished data), specimens collected from these sites are awaiting genetic determination.

Table 6 List of Leptophlebiidae species collected during June 2007 upper Ord River study with conductivity included. Site codes are explained in Table 1.

Taxa	**Site code**													
Species	**3**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**14**	**16**	**18**	**19**	**20**	**21**
Austrophlebioides sp *AV10*		72		1	4	1	1						84	
Manggabora wapitja			1											
Thraulus sp *AV1*		2	1							13				
Tillyardophlebia dostinei											15			
Leptophlebiidae sp (imm./damaged)		2	27	1						11				
Conductivity (µs/cm)	615	809	459	710	540		590.6	787	570	798	.8	744	14. 6	580.2	268	133

3.3 Water chemistry

Physico chemical parameters and flow varied considerably between sites (Table 7). Notably electrical conductivity varied greatly between neighbouring catchments, reflecting the complexity of the underlying geology. Limestone influenced creeks typically had more alkaline waters and were characterised by calcium concretions that welded the rocks together in riffle zones making macroinvertebrate sampling difficult, and reducing habitat diversity. These sites also tended to have higher electrical conductivity and were spring fed (ie Stirling Springs and Elgee Springs). Sites flowing from sandstone sub catchments typically had more acidic waters and tended to have lower conductivity (Mt King Bore Creek and Flying Fox gorge sites).

Turbidity varied considerably amongst sites (Table 7) with the highest turbidity recorded at Ord River Gorge (26.0 NTU), Wilson River at Fig tree hole (18.9 NTU) and Matilda Creek (13.4 NTU). Notably these sites were heavily impacted by cattle grazing at the sampling site or surrounding areas. Furthermore, surface water had ceased to flow at these sites. Low turbidity was associated with headwater streams and springs and streams that still maintained flow, presumably from groundwater sources which typically flow clearer.

Of note, most sites sampled within the historically highly degraded landscape (1960) which was rehabilitated over 44 years by the Ord River Regeneration Project (Payne et al 2004) recorded low turbidity during this survey (Johnny Cake, Negri, Forrest, Linnekar, and Brook creeks; 0.0, 2.8, 0.7, 0.4 and 0.6 NTU respectively). Two rivers, the Nicholson River and Elvire River (Gorge) sites within this area had slightly turbid waters (8.9 and 8.2 NTU respectively) and settled fine silts indicative of erosion (see site notes Appendix 2).

Dissolved oxygen and temperature also varied among sites. However these parameters are greatly influenced by the time of sampling. It was not possible to standardise the time of water chemistry measurements as sites were sampled opportunistically throughout the day as the sites were encountered.

3.4 Habitat conditions

Habitat variables are presented in Tables 8 – 10 and further site notes and photos in Appendix 2.

Habitat structure varied greatly between sites which is expected when sampling over a large spatial area, differing stream orders and from various geological influences. In this study, sites ranged from small permanent spring feed creeks (Mt King Bore Creek), to large permanent pools/rivers (Behn River, Elvire River Gorge) and seasonal pools/rivers (Matilda Creek).

It is quite evident from the site photos and habitat conditions that the Ord River Regeneration Project has allowed the restoration of stream habitat conditions in the project area. Sites such as Linnekar Creek (site 9), Negri River (site 6) and Nicholson River (site 11) were within the worst affected areas identified by Payne et al (2004), but recorded a good diversity of fish species in this study (18, 15 and 14 species respectively). Macroinvertebrate families were also well represented with 22, 16 and 17 respectively.

Table 7 Insitu physico chemical parameters and site characteristic for fish and macroinvertebrate sites sampled in the upper Ord River catchments in June 2007

Site code	Site	Time	Cond µs/cm	Turb NTU	pH	DO mg/l	DO %	TEMP °C	Discharge L sec	Velocity m sec	Wetted width m	Site length m
1	Matilda Ck	7:40	481.0	13.4	8.04	7.3	79.3	19.6	0.0	0.0	25.0	150
2	Stockade Ck	7:30	677.0	8.1	8.27	5.2	53.7	17.4	0.0	0.0	15.0	150
3	4 Mile Ck		615.0	10.7	5.09	6.4	NR	19.5	Trickle	Trickle	4.0	5
4	Behn River	16:00	676.2	7.6	7.63	8.6	96.7	21.1	0.0	0.0	40.0	800
5	Johnny cake Ck	12:00	809.0	0.0	6.65	7.8	89.6	22.1	2.0	NR	1.0	5
6	Negri R	8:30	459.0	2.8	4.95	9.4	98.5	17.6	448.6	1.5	40.0	250
7	Stirling Spring	10:30	710.0	0.0	6.70	7.6	82.5	19.1	6.0	0.1	5.0	150
8	Forr est Ck	13:30	540.0	0.7	5.44	9.7	108.0	20.6	1194.8	0.9	5.0	50
9	Linnekar Ck	8:00	590.6	0.4	8.20	8.3	86.8	17.5	277.0	1.0	12.0	150
10	Brook Ck	8:00	787.0	0.6	7.90	8.2	87.0	18.2	61.3	0.3	1.5	5
11	Nicholson R	14:45	570.0	8.9	6.00	8.8	100.0	21.8	178.3	0.3	20.0	600
12	Nicholson R - Mirella Gorge	12:20	452.0	9.7 5.60		8.4	89.0	18.9	Trickle	Trickle	50.0	250
13	Elvire R gorge	8:00	581.0	8.2	5.10	8.3	82.8	15.3	0.0	0.0	50.0	1000
14	Palm Spring Ck	12:00	789.8	1.6	5.41	8.1	88.9	20.1	5.0	0.2	1.2	5
15	Ord River Gorge	7:45	226.0	26.0	5.40	8.3	81.9	15.2	0.0	0.0	50.0	150
16	Crossland Springs	14:00	744.0	0.5	5.95	9.5	101.0	18.2	5.0	0.1	10.0	100
17	Wilson River (fig tree hole)	16:30	322.0	18.9	6.20	7.9	80.8	18.7	0.0	0.0	40.0	800
18	Mt King Bore Ck	12:00	14.6	2.6	5.78	8.7	94.9	19.7	5.0	0.2	2.0	50
19	Upper Ord - Elgee Spring Ck	14:10	580.2	1.4	6.30	7.2	75.2	17.8	3.0	0.2	3.0	50
20	Bow River	7:00	665.0	0.8	5.60	7.7	79.0	16.7	NR	0.2	40.0	150
21	Arthur Ck	8:00	268.0	4.5	6.70	6.6	73.0	20.8	1.4	0.4	4.0	80
22	Teronis ck (gorge)	12:00	133.0	1.4	5.30	4.9	54.8	20.9	2.5	NR	4.0	30
A1	Limestone Ck – upstream	10:30	1475.0	8.2	7.96	6.7	NR	24.4	NR	0.4	2.5	40
A2	Limestone Ck – mid	7:30	1470.0	2.5	8.15	6.3	NR	24.7	NR	0.6	10.0	100
A3	Limestone Ck – downstream	15:00	1436.0	1.9	8.19	8.8	NR	32.2	NR	0.5	12.0	100
A4	Flying Fox Ck – upper gorge	11:00	16.8	2.9	6.34	7.6	NR	26.3	NR	0.5	2.0	70
A5	Flying Fox Ck – lower gorge	12:30	191.3	3.3	7.17	5.8	NR	28.7	NR	0.3	3.0	60
A6	Flying Fox Ck – mid	10:30	163.9	4.3	7.45	7.1	NR	29.8	NR	0.8	8.0	80
A7	Flying Fox Ck – downstream	16:15	261.2	1.4	7.74	6.6	NR	31.6	NR	0.6	12.0	75

Table 8 Habitat structure at sites sampled for fish in the upper Ord River catchments in June 2007. Site codes are explained in Table 1.

	Site code																	
	1	**2**	**4**	**6**	**7**	**8**	**9**	**11**	**12**	**13**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Habitat characteristics (%)																		
Aquatic macrophytes	1	2 0		0	10	0	5	1	10	0 0		30	0 0		5	20	0	NR
Leaf litter	30 5		4	2 5 0			0 6		2	1	5	5	10	10	10	5	1	NR
Submerged marginal veg	0	0	<1	0	2	0	2	1	0	0	0	5	0	10	10	0	0	NR
Submerged overhanging veg	0	3 2		0	8	0	11	3	0	0 5		0	0 0		1	20	0	NR
Emergent veg.	0	0	<1	0 0 0			2 1		10 0		0	0	0	5 50		5	0	NR
Root masses	1	3	<1	1 2 0			2 1		0 10		5	1	5	10	10	5	0	NR
Undercut banks	1	1	2	2 1 0			3 5		2	1	0	5	5	2	2 0		0	NR
Large woody debris	1	2	0	3 3 0			3 3		3	1	5	1	5	5	5 0		0	NR
Small woody debris	1	1	<1	3 5 2			<1	3	1	5	5	1	5	10 5 5			0	NR
Filamentous algae	0	0	0	4 3		30	5 3		20 0		0	10	0	10 0		10	60	NR
Habitat characteristics (m)																		
Average water depth	1	0.7	0.8	0.8 0.5 0.3			0.6 1.3		2.3	1.3	2.5	0.8	1.1	0.45 0.8 0.6			0.4	NR
Maximum water depth	2	1.2	1.8	2.9 1.2 0.7			1.2 2.7		6.0	3.9	7.9	1.2	2.3	1.0	1.5 1.0		0.8	NR
Mineral substrate (%)																		
Bedrock	5	4	7	6	15	0	1 0		70 5		10	0	5	0 30		0	0	NR
Rock (>128 mm)	10	1	4	5	15	10	38	30	20	0	0	20	10	5	40	30	40	NR
Cobbles (64–128 mm)	5	5	10	40 27 40			37 30		5	10	0	30	10	50	10 30		15	NR
Pebbles (16–64 mm)	1	35	25	25 23 30			17 30		0	30	10	30	15	30	5	20	20	NR
Gravel (2–16 mm)	0	25 40		12	18	20 7		10	0	40 30		20	30 15		10	15	20	NR
Sand (0.06–2 mm)	0 30		10	10	2 0		0 0		0 10		50	0	30	0	5 5		5	NR
Mud (<0.06 mm)	79 0		4	2 0 0			0 0		5	5	0	0	0	0	0 0		0	NR
Habitat types (%)																		
Riffle	0	0	0	38 35 40			8	0	0	0	0	2	0	20	5	30	50	NR
Run	0	0	0	4	10 10		33 65		0	0	0	0	0	80	5	0	0	NR
Glide	0	0 0		0	0	20	33	0	0	0 0		0	0 0		0	0	0	NR
Pool	100	100	100	57 50 28			25 20		100	100	100	98	80	20	90 70		50	NR
Backwater	0 0		0	1	5	2	0	15	0 0		0	0	20	0 0		0	0	NR

Table 9 Habitat structure at sites sampled for fish during previous surveys in March 2006 and April/May 2007 from Limestone and Flying Fox creeks in the upper Ord River catchment. Site codes are explained in Table 2.

	Site code						
	A1	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**
Habitat characteristics (%)							
Mineral substrate	70 69		79	70 85 83			83
Emergent Macrophyte	15	20	1	30	0	0	1
Submergent Macrophyte	0 0		0	0 0 0			0
Floating Macrophyte	0 0		0	0 0 0			0
Algae Cover	10 1		5	90 0		5	2
Detritus	2 3		2	5 0 5			2
Riparian veg draped in water	5	5	1	0	5	1	2
Root mat	0 1		10	5 5 5			5
Undercut banks	0 0		0	0 0 0			0
Habitat characteristics							
# of logs/branches	5	1	1	2	8	1	2
Complexity of logs/branches	3 1		2	1 3 2			2
Average water depth (m)	0.8 0.35		0.23	0.38 0.4 0.45			0.25
Maximum water depth (m)	2.0	1.2	0.7	4	1.5	1.5	1
Mineral substrate (%)							
Bedrock	0 0		0	0 0		20	0
Boulders (>256 mm)	20	2	0	15 15 10			0
Cobbles (64–256 mm)	20 35		10	55 50 25			30
Pebbles (16–64 mm)	10 30		25	10 25 25			30
Gravel (4–16 mm)	30 10		30	15 10 10			25
Sand (1–4 mm)	20	20	35	5	0	10	15
Silt (<1 mm)	0 3		0	0 0 0			0
Clay	0 0		0	0 0 0			0

Table 10 Habitat results for macroinvertebrate sites sampled in the upper Ord River catchment, June 2007. Site codes are explained in Table 1.

	Site code													
	3	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**14**	**16**	**18**	**19**	**20**	**21**
Breakdown of habitat surface area (%)														
Mineral substrate	40	100	95	60	25 85 99			95	85	60	85 30		74 30	
Emergent macrophyte	10	0	0	0	0 0 0			0	5	5	0	20	0 0	
Submergent macrophyte	0	0	0	0	0 0 0			0	0	15	0 0		0 0	
Floating macrophyte	0	0	0	0	0 0 0			0	0	0	0 0		0 0	
Algae cover	0 0 5			40	75	5	1	0	100	0	5	15	25	10
Detritus	50	0	0	0	0 5 0			5	10	5	5	15	1	10
Riparian veg draped in water	0	0	0	0	0	5	0	0	0	15	5	20	0	10
Other (root mats)	0 0 0			0	0	0	0	0 0		0	0	0	0	40
Mineral substrate (%)														
Bedrock	0 0 0			0	0	0	40	0 0		0	0	50	25	0
Boulders (>256 mm)	2 5 5			10	1	0	0	15	0	20	5	20	25	0
Cobbles (64–256 mm)	10	70	40	40	30 20 15			40	5	35	40 20		5	10
Pebbles (16–64 mm)	20 10 45			20	30	60	30	35 60		35	30	5	5	5
Gravel (4–16 mm)	20	10	9	25	30	20	10	10	30	5	15	4	20	5
Sand (1–4 mm)	8 5 1			5	9	0	5	0 5		5	10	1	20	20
Silt (<1 mm)	40	0	0	0	0 0 0			0	0	0	0 0		0	10
Clay	0	0	0	0	0 0 0			0	0	0	0 0		0 0	

4 Conclusions

24 species of fish and 47 families of macroinvertebrates were collected from the upper Ord River catchment. Specimens of all the fish species have been provided to the NAFF project to assist with taxonomic resolution of various species (morphometric and genetic) across northern Australia. Whilst macroinvertebrate samples are preserved and stored at ***eriss***.

The survey has a) provided new records for *Syncomistes trigonicus* and *S. rastellus* in the Ord River system, b) provided a range extension, to above the ORD, for most other non-catadromous species, c) confirmed the absence of catadromous fish species from upstream of the KDD and ORD (excluding farm-released barramundi which are known to occur in Lake Argyle), and c) provided records of juvenile *Glossogobius giuris* at many sites above these major barriers, suggesting this is not an obligate amphidromous species.

There appear to be taxonomic issues within the *Syncomistes* genus that would require further work to better understand the status of the species we collected during this survey. *Syncomistes kimberleyensis* was not identified during this survey, however juvenile fish we have identified as *S. rastellus* have a lot of similarities to this species. Given the range of sites sampled in the upper Ord River catchments, which includes the type locality for *S. kimberleyensis* (Bow River, site 20), it seems unlikely that we would not have collected and identified this species if it were present. Given the absence of information on adults of *S. kimberleyensis* it is possible this species is a senior synonym to *S. rastellus*, or synonymous with *S. trigonicus*. The three species appear to be quite difficult to distinguish as juveniles. Hopefully genetic investigation of this issue by the NAFF project, using specimens collected will resolve the confusion.

The families of macroinvertebrates recorded are commonly and frequently encountered in northern western Australia. Further taxonomic resolution of the mayfly family Leptophlebiidae has identified a range extension for *Tillyardophlebia dostinei* and the possible intolerance of *Austrophlebioides* sp AV10 to waters with higher concentrations of naturally-occurring ions (observed as elevated electrical conductivity). Observations of freshwater shrimps, *Macrobrachium* spp collected by the back pack electrofisher have identified an absence of *M. rosenbergii* from sites above the Ord River Dam (ORD). Given this species requires an estuarine larval stage this suggests that the ORD prevents the movement of this species into the upper Ord River, as also identified for catadromous fish species.

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Appendix 1 Fish species average, maximum and minimum fork length (FL) for each site

Table A.1 Fish species average, maximum and minimum fork length (FL) recorded from surveys in the upper Ord River catchment. Measurements of Fork length are in mm. Avg = the average FL, (n) = number of fish measured for Avg FL, Max = maximum recorded FL, Min = minimum recorded FL. Obs = species recorded by visual observation. Info = Anecdotal record from landowners. Site codes are explained in Tables 1 & 2.

Fish species	FL (mm)	Site code							
		1	2	4	6	7	8	9	11
Ambassis sp (previously *mulleri*)	Avg(n)	31(8)						Obs(5)	
	Max/Min		40/19					~40	
Parambassis gulliveri	Avg(n)			157(1)					
	Max/Min				157				
Glossamia aprion	Avg(n)								
	Max/Min								
Neoarius graeffei	Avg(n)	265(1)		320(1)				228(5)	203(19)
	Max/Min		265		320			242/200	285/115
Neoarius midgleyi	Avg(n)							233(9)	
	Max/Min								500/142
Craterocephalus stramineus	Avg(n)	34(4)	26(14)		42(7)	47(20)		55(7)	31(8)
	Max/Min	40/23		31/15	53/7		57/34	61/43	52/11
Strongylura kreffti	Avg(n)	500(1)						Obs(2)	
	Max/Min	500/500						~400	
Nematalosa erebi	Avg(n)	185(7)	127(30)	189(17)	250(4)			187(4)	233(7)
	Max/Min	265/87	238/68	232/94	268/238			253/160	242/214
Mogurnda mogurnda	Avg(n)					46(37)			
	Max/Min					70/23			
Oxyeleotris selheimi	Avg(n)	101(25)	135(32)	75(14)	47(2)			204(4)	178(1)
	Max/Min	245/45	322/44	207/43	49/44			239/150	178
Oxyeleotris lineolata	Avg(n)	85(5)	69(2)	140(2)	199(5)			185(1)	172(2)
	Max/Min	179/56	74/63	145/134	250/152			185/185	180/164
Glossogobius giuris	Avg(n)	69(32)	68(21)	53(39)	73(29)	89(9)		125(2)	88(12)
	Max/Min	144/43	152/44	93/30	90/46		106/75	146/104	160/62
Melanotaenia australis	Avg(n)	36(22)	39(43)	37(23)	49(3)	45(33)	54(15)	33(11)	34(11)
	Max/Min	58/29	65/27	47/28	60/42	71/25	66/41	60/15	62/28
Neosilurus ater	Avg(n)							245(3)	94(1)
	Max/Min							310/200	94
Neosilurus hyrtlii	Avg(n)	75(1)	204(1)	Obs	(12)	110(1)		145(6)	
	Max/Min	75/75	204/204		~250/150		110/110	152/131	
Neosilurus pseudospinosus	Avg(n)	326(1)		84(1)	218(11)	Obs(1)	72(3)	269(7)	86(6)
	Max/Min		326/326	84/84	350/108	~200	75/69	338/204	100/72
Porochilus rendahli	Avg(n)								
	Max/Min								
Amniataba percoides	Avg(n)	62(39)	66(17)	47(54)	64(42)	69(15)		63(42)	61(50)
	Max/Min	90/20	83/40	85/15	84/45		88/50	93/45	82/42
Hephaestus jenkinsi	Avg(n)	200(1)		219(3)	76(39)	93(12)		141(43)	58(31)
	Max/Min		200/200	335/89	175/49		132/65	273/72	113/32
Leiopotherapon unicolor	Avg(n)	89(26)	70(18)	65(16)	76(9)	102(16)	84(7)	101(8)	60(4)
	Max/Min	188/38	212/48	172/49	94/65	250/47	99/67	119/80	62/56
Syncomistes butleri	Avg(n)							256(1)	
	Max/Min							256/256	
Syncomistes trigonicus	Avg(n)								
	Max/Min								
Syncomistes rastellus	Avg(n)			83(2)				149(3)	
	Max/Min				87/80			182/93	
Toxotes chatareus	Avg(n)	70(1)	138(8)		161(8)			138(2)	132(14)
	Max/Min	70/70		185/57	186/127			138/138	180/107
Total Species Richness		**11**	**12**	**11**	**15**	**4**	**8**	**18**	**14**

Table A.1 (cont) Fish species average, maximum and minimum fork length (FL) recorded form surveys in the upper Ord River catchment. Measurements of Fork length are in mm. Avg = the average FL, (n) = number of fish measured for Avg FL, Max = maximum recorded FL, Min = minimum recorded FL. Obs = visual observation. Info = Anecdotal record from landowners. Site codes are explained in Tables 1 & 2.

Fish species	FL (mm)	Site Code								
		12	**13**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
Ambassis sp (previously *mulleri*)	Avg(n)							31(1)	34(14)	28(3)
	Max/Min							31	40/29	32/26
Parambassis gulliveri	Avg(n)									
	Max/Min									
Glossamia aprion	Avg(n)									
	Max/Min									
Neoarius graeffei	Avg(n)	187(3)		206(2)						
	Max/Min		195/172	217/195						
Neoarius midgleyi	Avg(n)	701(3)		387(14)						
	Max/Min		826/526	520/185						
Craterocephalus stramineus	Avg(n)	31(7)							39(4)	
	Max/Min		38/25						42/35	
Strongylura kreffti	Avg(n)		Info							
	Max/Min									
Nematalosa erebi	Avg(n)	79(26)	225(4)	123(13)	104(2)	129(5)	81(4)		Obs	
	Max/Min	55/26	235/215	192/94	131/76	152/86		82/80		
Mogurnda mogurnda	Avg(n)				43(3)	(19)	***** 56(18)		60(20)	
	Max/Min				48/37			77/36		100/30
Oxyeleotris selheimi	Avg(n)	110(4)		75(3)		230(1)			85(4)	276(2)
	Max/Min		255/50		100/52	230			130/65	312/240
Oxyeleotris lineolata	Avg(n)									
	Max/Min									
Glossogobius giuris	Avg(n)	63(20)		52(10)	44(3)	54(20)			59(15)	
	Max/Min		115/36	98/29	55/36	131/28			100/44	
Melanotaenia australis	Avg(n)	34(20)	39(20)	38(20)	52(3)	37(20)	(5)***** 62(21)		51(20)	41(9)
	Max/Min	54/22	51/20	48/28	61/35	51/28		70/36	64/24	55/31
Neosilurus ater	Avg(n)									
	Max/Min									
Neosilurus hyrtlii	Avg(n)	174(1)	167(1)	118(1)		133(2)	114(22)		116(2)	88(3)
	Max/Min	174	167		118	138/128		139/93	120/112	100/73
Neosilurus pseudospinosus	Avg(n)	277(2)		325(2)	225(1)			208(3)	82(2)	
	Max/Min		285/269	355/295	225			255/134	90/74	
Porochilus rendahli	Avg(n)									97(1)
	Max/Min									97
Amniataba percoides	Avg(n)	34(6)		34(10)	45(2)	43(17)			46(13)	
	Max/Min		50/23	48/24	57/32	60/28			71/29	
Hephaestus jenkinsi	Avg(n)	209(6)				81(3)	94(1)		48(10)	
	Max/Min		295/96			130/55		94	74/39	
Leiopotherapon unicolor	Avg(n)	56(21)	71(3)	68(7)	62(4)	63(7)	113(21)		79(20)	123(3)
	Max/Min	138/36	84/53	110/39	85/45	110/45		236/53	130/49	165/82
Syncomistes butleri	Avg(n)	152(5)								
	Max/Min		178/128							
Syncomistes trigonicus	Avg(n)			88(1)						
	Max/Min			88						
Syncomistes rastellus	Avg(n)	197(2)		200(1)	99(3)		141(2)			
	Max/Min		200/194	200		122/54		171/110		
Toxotes chatareus	Avg(n)	43(3)		122(1)	165(1)					
	Max/Min		47/40	122		165				
Total Species Richness		**4**	**16**	**11**	**9**	**10**	**2**	**9**	**11**	**7**

***** fish not measured

Table A.1 (cont) Fish species average, maximum and minimum fork length (FL) recorded form surveys in the upper Ord River catchment. Measurements of Fork length are in mm. Avg = the average FL, (n) = number of fish measured for Avg FL, Max = maximum recorded FL, Min = minimum recorded FL. Obs = visual observation. Info = Anecdotal record from landowners. Site codes are explained in Tables 1 & 2.

Fish species	FL (mm)	Site Code							
		22	A1	A2	A3	A4	A5	A6	A7
Ambassis sp (previously *mulleri*)	Avg(n)			27(16)	22(13)	29(5)	44(1)		
	Max/Min			34/23	32/16	34/21		44	
Parambassis gulliveri	Avg(n)	148(11)		98(2)			77(2)	104(1)	
	Max/Min		168/134	107/89			104/50		104
Glossamia aprion	Avg(n)			62(5)					
	Max/Min			73/55					
Neoarius graeffei	Avg(n)	198(5)		225(1)	221(7)	195(29)		166(3)	175(24)
	Max/Min		350/158	225	300/196		290/155	168/165	272/101
Neoarius midgleyi	Avg(n)	336(4)					286(9)		
	Max/Min		480/159				435/187		
Craterocephalus stramineus	Avg(n)	38(31)		30(84)	18(1)			47(2)	
	Max/Min		53/20	53/13	18			47	
Strongylura kreffti	Avg(n)			336(2)	500(1)		480(1)		
	Max/Min			392/280		500		480	
Nematalosa erebi	Avg(n)	199(24)		148(10)	55(22)	197(16)	142(9)	51(21)	44(56)
	Max/Min		276/54	222/55	233/32	265/120	205/80	123/41	152/33
Mogurnda mogurnda	Avg(n)					53(6)			
	Max/Min					64/40			
Oxyeleotris selheimi	Avg(n)	139(1)	216(7)	227(10)	122(3)	71(3)	240(1)	73(3)	101(10)
	Max/Min	139	354/79	310/106	133/101	107/42	240	85/52	125/82
Oxyeleotris lineolata	Avg(n)	161(2)							
	Max/Min	167/154							
Glossogobius giuris	Avg(n)	86(5)	85(3)	110(7)	119(4)	75(6)	75(2)	76(10)	90(13)
	Max/Min	131/48	108/66	173/76	150/83	150/35	80/70	118/45	149/42
Melanotaenia australis	Avg(n)	53(20)	35(28)	34(52)	38(21)	42(48)	48(30)	46(21)	40(22)
	Max/Min	77/32	73/16	57/20	71/22	74/24	72/36	63/25	52/30
Neosilurus ater	Avg(n)			136(1)	391(2)		238(5)	42(1)	
	Max/Min			136		440/341	377/46	42	
Neosilurus hyrtlii	Avg(n)	101(8)	89(1)		108(13)		102(5)	97(9)	114(7)
	Max/Min	128/85		89		177/70	122/72	121/66	138/72
Neosilurus pseudospinosus	Avg(n)	78(4)		254(8)	61(13)	169(3)	132(6)	93(7)	105(4)
	Max/Min		98/58	410/116	96/40	336/68	296/69	118/54	169/50
Porochilus rendahli	Avg(n)					155(1)			
	Max/Min					155			
Amniataba percoides	Avg(n)	41(8)	63(40)	75(25)	50(25)	52(3)	60(43)	52(49)	60(43)
	Max/Min	50/33	129/33	90/50	88/23	63/41	81/38	78/32	87/29
Hephaestus jenkinsi	Avg(n)	174(3)	117(8)	99(19)	63(5)	59(3)	125(41)	63(22)	70(25)
	Max/Min	250/97	180/50	275/49	152/32	127/54	380/34	162/35	208/31
Leiopotherapon unicolor	Avg(n)	68(18)	58(34)	77(53)	58(11)	66(32)	71(45)	62(23)	65(46)
	Max/Min	112/48	130/32	167/35	80/32	162/44	166/42	91/46	144/38
Syncomistes butleri	Avg(n)	269(4)				166(17)	162(20)	116(2)	
	Max/Min		308/209			275/38	263/87	134/97	
Syncomistes trigonicus	Avg(n)	98(1)				115(3)	121(2)		
	Max/Min	98				154/94	132/110		
Syncomistes rastellus	Avg(n)	82(5)				81(5)	94(15)	65(4)	69(1)
	Max/Min	118/68				160/52	202/68	70/54	69
Toxotes chatareus	Avg(n)	188(2)		155(1)	32(1)	165(4)	126(6)	101(5)	70(3)
	Max/Min		197/179	155	32	183/120	150/71	171/71	105/37
Total Species Richness		**10**	**14**	**17**	**12**	**18**	**17**	**17**	**13**

Appendix 2 Site notes and site pictures

Matilda Creek, Site 1 (Photos: plates 1 and 2)

Site located just downstream from the Duncan Hwy crossing. A small to medium sized river with turbid water. Relatively shallow site with average depth around 1m. Cattle disturbance around the edges has more than likely caused the turbid water. Mud around edges extremely soft and easily disturbed when walking within the water. It is unlikely the site retains permanent water during the dry season.

Creek had ceased surface flow, thus macroinvertebrates were not collected.

Fish sampled on downstream side of Duncan Highway using multi-panel gillnet and backpack electrofisher.

Plate 1 Site 1 – Matilda Creek looking upstream towards Duncan Highway

Plate 2 Site 1 – Matilda Creek looking downstream

Stockade Creek, site 2 (Photos: plates 3 and 4)

Site located upstream from the Duncan Hwy crossing, via side road, at Rosewood Stn stockyards. A medium sized river with relatively clear water. The pool had a bedrock substrate with various depths. Along the edges, undercut banks and pandanus over hangs. Informed by land owners that pool retains permanent water.

Creek had ceased surface flow, thus macroinvertebrates were not sampled.

Fish sampled using multi-panel gillnet in the pool and backpack electrofisher at the shallow upstream end of pool.

Plate 3 Site 2 – Stockade Creek, shallow reach sampled for fish

Plate 4 Site 2 – Stockade Creek, Small pool sampled for fish

4 Mile Creek, site 3 (Photos: plates 5 and 6)

Small creek which appeared to originate from a spring just upstream of the Duncan Highway. The site had very little surface water flow. The road crossing forming a small dam resulting in small pool on upstream side. Riffle downstream of road sampled for macroinvertebrates.

Site sampled for macroinvertebrates only.

Plate 5 Site 3, 4 Mile Creek – small pool on upstream side of Duncan Highway

Plate 6 Site 3, 4 Mile Creek – riffle sampled approx 50 m downstream of Duncan Highway

Behn River, site 4 (Photos: plates 7 and 8)

Site located upstream from Duncan Hwy, via side road - approx 15km. Large river with no flow at the time of sampling. large pool that was relatively shallow with steep banks, possibly undercut. Edges of the pool were lined with overhanging aquatic pandanus and monsoon forest vegetation, suggesting permanent water. Rock bars were located at either end of the pool with deposits of fine loosely packed silts.

Creek had ceased surface flow, thus macroinvertebrates were not sampled.

Site sampled for fish using multi-panel gillnets, backpack electrofisher, seine net and handline.

Plate 6 Site 4 – Behn River, large pool sampled for fish

Plate 7 Site 4 – Behn River, downstream shallow end of pool sampled for fish

Johnny Cake Creek, site 5 (Photos: plates 8 and 9)

Small creek flowing over Duncan Highway. Very low flow, however site still sampled for macroinvertebrates.

Plate 8 Site 5 – Johnny Cake Creek, macroinvertebrate sampling in shallow riffle

Plate 9 Site 5 – Johnny Cake Creek, shallow riffle sampled for macroinvertebrates

Negri River, site 6 (Photos: plates 10 and 11)

Site just downstream from Duncan Hwy crossing. Very large river, clear flowing water. Large flood channel approx 200 m wide, dominated by coarse gravel and cobbles. Small area of bed rock influence – good diversity of habitats (various substrate sizes, undercut banks, woody debris, bedrock ledges).

Site sampled for fish and macroinvertebrates on downstream side of Duncan Highway. Fish sampled using multi-panel gillnets, backpack electrofisher, night spotlighting and handline.

Plate 10 Site 6 – Negri River looking downstream at pool below Duncan Highway

Plate 11 Site 6 – Negri River, looking downstream from Duncan Highway crossing

Stirling Spring, site 7 (Photos: plates 12 and 13)

Permanent spring flowing into Stirling Ck, rocks calcium encrusted and armoured by calcrete. Clear water with good diversity of habitats. Station owner informed us the spring permanently flows, the emergent vegetation (typha) supporting this. This site was originally divided into two sites, one above and one below a moderate sized waterfall – however, the sites were found to be similar and subsequently combined.

Fish sampled upstream and downstream of small water fall using backpack electrofisher and multi-panel gill nets.

Macroinvertebrates sampled downstream of water fall in riffle habitat – notably rocks were fused together by calcium.

Plate 12 Site 7 – Stirling Spring, small shallow pool located upstream of small water fall

Plate 13 Site 7 – Stirling Spring, riffle site sampled for macroinvertebrates

Forrest Creek, site 8 (Photos: plates 14 and 15)

Site sampled either side of Duncan Highway road crossing. Medium sized river, water clear with filamentous algae growing in riffles and runs (approx 30% cover). A good diversity of substrate. Road crossing restricting flow and forming a shallow but large pool on the upstream side.

Fish sampled mostly from the downstream side of road crossing, however edges of the pool upstream were sampled also. Backpack electrofisher used to sample fish.

Macroinvertebrates collected from riffles on downstream side of road crossing.

Plate 14 Site 8 – Forrest Creek, looking upstream towards Duncan Highway road crossing

Plate 15 Site 8 – Forrest Creek, looking upstream from Duncan Highway road crossing

Linnekar Creek, site 9 (Photos: plates 16, 17 and 18)

Medium sized river, site located at the junction of Linnekar Ck and Brook Ck. Accessed via old Old Turner/Old Ord River Station track that follows south-west along the Ord River main channel. Clear water with good diversity of habitat (overhanging vegetation, rocks, boulders, logs, undercut banks, emergent veg). Site in good condition little evidence of siltation/fine silts or loosely packed sediments.

Fish collected from downstream of road crossing (below Linnekar and Brook ck confluence) up into Linnekar Ck until riffles started using backpack electrofisher and night spotlight.

Macroinvertebrates sampled in riffles approximately 200 m upstream of Linnekar/Brook creek confluence.

Plate 16 Site 9 – Linnekar Ck, looking upstream at riffle just below road crossing – situated downstream from Linnekar/Brook creek confluence

Plate 17 Site 9 – Linnekar Ck, looking along pandanus lined banks upstream from Brook creek confluence

Plate 18 Site 9 – Linnekar Ck, riffle sampled for macroinvertebrates – approximately 200 m upstream from Brook creek confluence

Brook Creek, site 10 (Photos: plates 19 and 20)

Site located approximately 100 m upstream from confluence with Linnekar Creek (see site 9 for details). Site sampled for macroinvertebrates only. Macroinvertebrates sampled below small water fall in narrow stretch of riffle/run.

Plate 19 Site 10 – Brook Creek, looking upstream at macroinvertebrate site with small waterfall upstream

Plate 20 Site 10 – Brook Creek, looking downstream from macroinvertebrate site towards Linnekar Creek confluence

Nicholson River, site 11 (Photos: plates 21 and 22)

Large river, turbid water, fine layer of silt (redish orange) covering most surfaces (including riffles). Substrate (silt, fine gravel, coarse gravel, cobble, rock).

Fish sampled through riffles either side of road crossing using back pack electrofisher and in large pool upstream of road crossing using multi-panel gillnets. Night spotlight also used.

Macroinvertebrates sampled downstream from road crossing – road infrequently used.

Plate 21 Site 11 – Nicholson River, looking upstream along pool on upstream side of road crossing

Plate 22 Site 11 – Nicholson River, riffles looking upstream towards road crossing

Nicholson River – Mirella Gorge, site 12 (Photos: plates 23, 24 and 25)

Located on the upper Nicholson River approx 5 km downstream from Duncan Hwy, via well used side road. Medium river, site above main Mirella gorge – water fall downstream from sampling site would possibly limit fish movement upstream. Unfortunately, the steep cliff gorge prevented access below water fall.

Site sampled was bedrock influenced, deep water with emergent aquatic plants along margins (typha), submerged feathery plant in shallower regions of pools (potomogeton), fine algae covering most rock surfaces.

No suitable riffle habitat – thus macroinvertebrates not sampled.

Fish sampled only using Backpack electrofisher and multi-panel gillnets.

Plate 23 Site 12 – Mirella Gorge on the upper Nicholson River, typical bedrock influence

Plate 24 Site 12 – Mirella Gorge on the upper Nicholson River, typical typha lined edges

Plate 25 Site 12 – Mirella Gorge on the upper Nicholson River, main gorge downstream from sampling site

Elvire River Gorge, site 13 (Photos: plates 26 and 27)

Access via old Laura Homestead road. Large river, no flow, large pool varying in depth, bedrock influenced (some areas of shoreline and large outcrops within river). Water turbid, fine silts disturbed when walking in water. Loosely pacted sediments (primarily sand and fine gravel) was difficult to walk through.

Creek had ceased surface flow, thus macroinvertebrates were not sampled.

Fish sampled using Backpack electrofisher, multi-panel gillnets and handline.

Plate 26 Site 13 – Elvire River Gorge, bed rock influenced – water turbid

Plate 27 Site 13 – Elvire River Gorge, looking upstream along pool sampled for fish

Palm Spring Creek, site 14 (Photos: plates 28 and 29)

Site just downstream from Palm Springs (approx 20 m downstream), access by parking area on the Duncan Highway. Macroinvertebrates sampled only.

Plate 28 Site 14 – Palm Spring Creek, macroinvertebrate sample site

Plate 29 Site 14 – Palm Spring Creek, macroinvertebrate sample site

Ord River Gorge, site 15 (Photos: plates 30 and 31)

Just downstream from Springvale/Bedford Lansdowne Rd crossing. Medium to large river. Located at flow gauging station site number 809310, rainfall station 502015.

Turbid water, bedrock influenced at top end of Ord River Gorge.

Creek had ceased surface flow, thus macroinvertebrates were not sampled.

Fish sampled using backpack electrofisher, multi-panel gillnet, handline and night spotlight.

Plate 30 Site 15 – Ord River Gorge, looking downstream from gauging station

Plate 31 Site 15 – Ord River Gorge, looking upstream towards gauging station

Crossland Springs, site 16 (Photos: plates 32 and 33)

Upstream from Springvale/Bedford Lansdowne Rd crossing. Small stream, low flow, water clear, site in good condition, aquatic macrophytes and filamentous algae present. Steep banks/undercut in areas. Variety of substrates (rock, cobble, coarse gravel and fine gravel).

Fish sampled with Backpack electrofisher only.

Macroinvertebrates sampled.

Plate 32 Site 16 – Crossland Springs, looking downstream along small pool above road crossing

Plate 33 site 16 – Crossland Springs, looking downstream from road crossing

Wilson River (Fig Tree Hole), site 17 (Photos: plates 34 and 35)

Access via Bedford downs station. Medium sized river, no flow, pool bed rock influenced, banks eroded, fine silts present and loosely packed sediments. Heavy cattle pressure on surrounding land. Fish had lesions/fungal infections with a notable absence of larger (adult) grunters (Locals had reported catching them a number of years earlier). The degraded nature of this site and the presence of lesions on juvenile fish suggests that larger fish may have died off in the previous dry season(s).

Creek had ceased surface flow, thus macroinvertebrates were not sampled.

Fish sampled using backpack electrofisher, multipanel gill net and night spotlight.

Plate 34 Site 17 – Wilson River, Fig tree hole, looking downstream from fig tree pool

Plate 35 Site 17 – Wilson River, Fig tree hole, looking downstream, along large pool

Mt King Bore Creek, site 18 (Photos: plates 36 and 37)

Access via Bedford Downs Station. Very small creek leading from foot of Mount King which, according to station owners, always maintains flow. Creek flows through grassland/open woodland. Very clear water.

Fish sampled using backpack electrofisher.

Macroinvertebrates sampled.

Plate 36 Site 18 – Mt King Bore Creek, looking upstream

Plate 37 Site 18 – Mt King Bore Creek, looking upstream

Upper Ord - Elgee Spring Creek, site 19 (Photos: plates 38 and 39)

Access via Bedford Downs Station. Small creek, downstream of Elgee springs headwater of the Ord River. Clear water, good diversity of habitat, abundance of fish/species, small deep pools – bedrock influenced – undercut banks – overhanging grasses, woody debris – large boulders.

Fish sampled using backpack electrofisher.

Macroinvertebrates sampled.

Plate 38; Site 19 – Upper Ord, Elgee Spring Creek, looking upstream from road crossing

Plate 39; Site 19 – Upper Ord, Elgee Spring Creek, looking downstream from road crossing

Bow River, site 20 (Photos: plates 40 and 41)

Upstream from Great Northern Hwy bridge via access track on the Kununurra side. Large river, channel approx 200m wide - primarily sand. Water flowing in the centre ~20 m wide low-flow channel amongst sand, rocks and boulders (possibly basalt). Water clear, low flow with filamentous algae and brown algae present in runs and pools (approx 40% area).

Fish sampled using Backpack electrofisher and night spotlight.

Macroinvertebrates sampled.

Plate 40 Site 20 – Bow River, looking downstream towards Great Northern Hwy

Plate 41 Site 20 – Bow River, looking downstream towards Great Northern Hwy

Arthur Creek, site 21 (Photos: plates 42 and 43)

At Great Northern Hwy Bridge, upstream side at Kingston's Rest. Small tributary into the Dunham River (not above lakes Argyle and Kununurra), approx 100m downstream from diversion dam (Dunham pilot dam). Pandanus lined stretch. Creek flowing/seeping from pilot dam. Abundance of aquatic plants (potomogeton). Run dominated by fine pandanus roots, pool sediment loosely compacted, gas bubbles released when walking through, difficult to wade.

Fish sampled using backpack electrofisher.

Macroinvertebrates sampled – although site not representative of AusRivas riffle habitat.

Plate 42 Site 21 – Arthur Creek, typical pandanus dominated riffle

Plate 43 Site 21 – Arthur Creek, small pandanus lined pool just upstream from Great Northern Hwy

Teronis Creek (Gorge), site 22 (Photos: plates 44 and 45)

Site on the Chamberlain River catchment.

Access via Bedford Downs Station. Small - medium sized creek flowing into the Chamberlain River catchment. Creek braiding within flood channel (~50m wide). Creek flows within sedges and grasses. Large rocks and woody debris present. Clear flowing water.

Fish sampled using backpack electrofisher and night spotlight.

Plate 44 Site 22 – Teronis Creek Gorge, braided creek hidden by grass

Plate 45 Site 22 – Teronis Creek Gorge, small pool along one braid of creek

Limestone Creek, sites A1, A2 and A3 (Site A1 photos: plates 46 and 47, Site A2 photos: plates 48 and 49, Site A3 photos: plate 50)

Sites accessed via Lissadel Station road, medium sized creek flowing directly into Lake Argyle. Sandy creek with typha present around pools and slower flowing areas. Pools typically shallow with maximum depth of 2 m recorded (table 8).

Fish sampled using backpack electrofisher, multi-panel gillnet and seine net.

Plate 46 Site A1 – Limestone Creek, typha lined pool above narrow riffles

Plate 47 Site A1 – Limestone Creek, narrow riffles

Plate 48 Site A2 – Limestone Creek, shallow riffles

Plate 49 Site A2 – Limestone Creek, shallow pool

Plate 50 Site A3 – Limestone Creek, shallow sandy riffles

Flying Fox Creek –sites A4, A5, A6 and A7 (Site A4 photos: plate 51, Site A5 photos: plates 52 and 53, Site A6 photos: plates 54 and 55, Site A7 photos: plate 56 and 57)

Sites accessed via small cattle station roads – difficult to describe. Upper sites are influenced by steep sided gorges which provide permanent water holes during the dry season. Lower sites are dominated by alluvial sediments amongst cattle grazing paddocks. Water is clear flowing in pool riffle sequence.

Fish sampled using backpack electrofisher, multi-panel gillnet and seine net.

Upper sites (A4 and A5) recorded three species of *Syncomistes*, *S. butleri*, *S. rastellus* and *S. trigonicus*. Lower sites (A6 and A7) only recorded *S. rastellus*.

Plate 51 Site A4 – Flying Fox Creek, looking upstream into gorge

Plate 52 Site A5 – Flying Fox Creek, downstream end of large pool

Plate 53 Site A5 – Flying Fox Creek, riffles at outflow from large pool

Plate 54 Site A6 – Flying Fox Creek, shallow pool

Plate 55 Site A6 – Flying Fox Creek, shallow pool and riffles

Plate 56 Site A7 – Flying Fox Creek, riffles and runs

Plate 57 Site A7 – Flying Fox Creek, pool above earthen road crossing