APPENDICES

Appendix 1

Benthic metabolism chamber

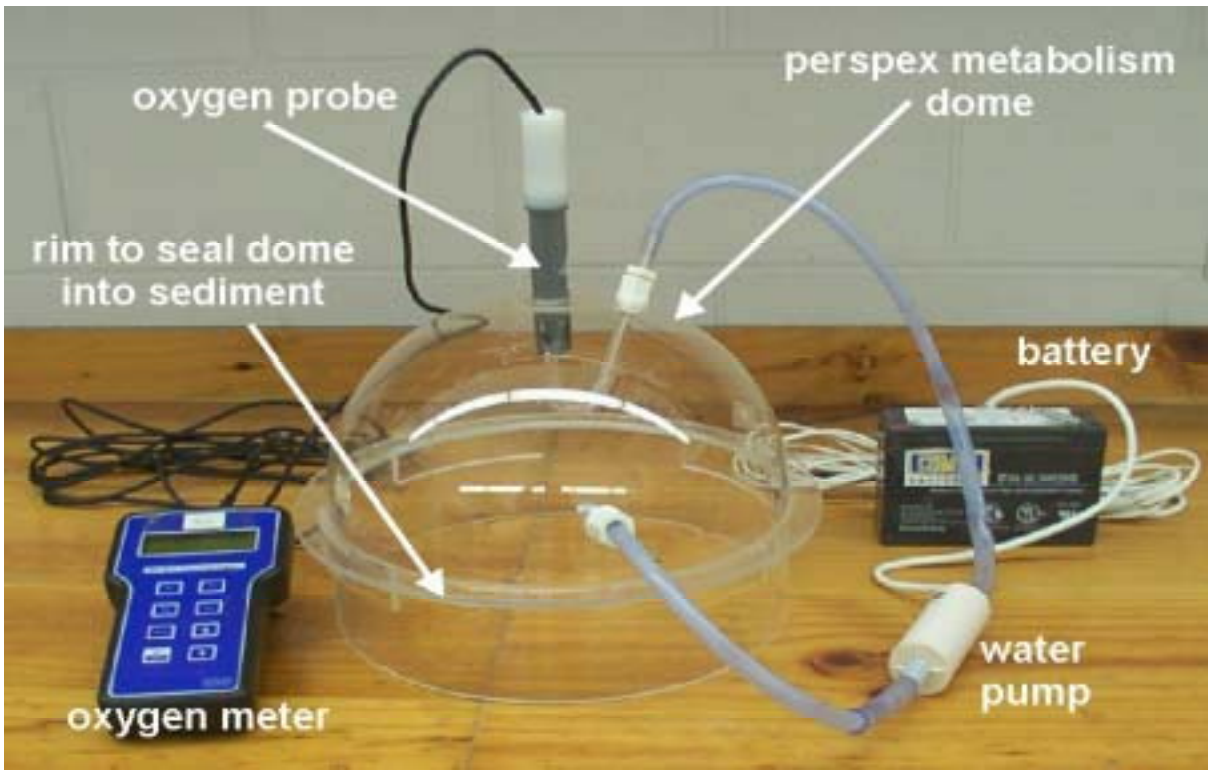


PLATE 1: Open-bottomed metabolism chambers used to measure in-stream metabolism. The dome of the perspex chamber is 29.5cm in diameter and 35cm high. *(PHOTO: **P.DAVIES**)*

Appendix 2

Riparian vegetation at transects

Table 1: Cover of dominant species (June 2002) at House Roof Hill.

Site		House Roof Hill							
5m x 5m quadrat		CCu1	CCu2	CCu3	CCu4	CCd1	CCd2	CCd3	
distance (m)		0	12	25	40	0	15	31	
elevation (m)		0	4.29	10.8	12.16	0	9.88	13.73	Total
total sp		4	3	4	3	7	4	2	19
total cover	Life form[1]	7.1	27	45.2	110	82.2	93	150	73.5
Barringtonia angulata	t	5[2]							5
**Cenchrus ciliaris*	pg		20	35	85		90	95	325
Cyperus bifax	ph					50			50
Acacia farnesiana	s							55	55
**Malvastrum americanum*	ah			10	20				30

Table 2: Cover of dominant species (June 2002) at Button's Crossing.

Site		Buttons Crossing					
5m x 5m quadrat		B1	B2	B3	B4	B5	
distance (m)		0	8	45	60	145	
elevation (m)		0	1.63	3.15	11.62	11.03	Total
total sp		3	10	3	7	6	21
total cover	Life form[1]	75	71.6	102	175.2	141.2	113
Phragmites australis	pg	45					45
**Passiflora foetida*	v		25	15	15	35	90
Flueggea virosa	s		25		20		45
**Cenchrus ciliaris*	pg			85	90	90	265
**Caloptropis procera*	s				35		35
Pandanus spiralis	t	20					20

Table 3: Cover of dominant species (June 2002) at Lake Kununurra.

Site		Lake Kununurra		
5m x 5m quadrat		LK1	LK2	
distance (m)		0	6	
elevation (m)		0	1	
total sp		6	6	8
total cover	Life form[1]	147	111	129
**Clitoria ternatea*	v	45[2]	25	70
**Macroptilium atropurpureum*	v	10	25	35
Pandanus spiralis	t	70		70
**Passiflora foetida*	v	15	25	40
Vine sp#1 (white flower)	v	5	25	30

Table 4: Cover of dominant species (June 2002) at Parry Lagoons.

Site		Parry Lagoon					
5m x 5m quadrat		PL1	PL2	PL3	PL4	PL5	
distance (m)		0	38	48	62	74	
elevation (m)		0	0.33	0.43	0.4	0.37	Total
total sp		3	4	3	3	2	11
total cover	Life Form[1]	75	107	110	36	125	90.6
Sporobolus virginicus	pg	60[2]	90	45			195
Marsilea mutica	ph			60			60
Cressa cretica	ph				25	35	60
Senna sp	s				10	90	100

Table 5: Cover of dominant species (June 2002) at Dunham River.

Site		Dunham River							
5m x 5m quadrat		D1	D2	D3	D4	D5	D6	D7	
distance (m)		0	11	22	42	54	72	95	
elevation (m)		0	2.45	1.39	2.36	2.68	3.41	5.28	Total
total sp		2	5	11	9	9	4	6	28
mean cover	life form[1]	20.1	81.1	58.7	72.2	72.5	95	76	68
Barringtonia angulata	t	20[2]	50						70
**Passiflora foetida*	v			50	1	0.1		1	52
**Cynodon dactylon*	pg	0.1	15		50	10			75
Eulalia aurea	pg					55			55
Paspalum sp	pg					0.1	90	2	92
Atalaya hemiglauca	t							30	30

Table 6: Cover of dominant species (June 2002) at Pentecost River.

Site		Pentecost River								
5m x 5m quadrat		Pu1	Pu2	Pu3	Pd1	Pd2	Pd3	Pd4	Pd5	
distance (m)		0	75	108	0	20	40	80	95	
elevation (m)		0.05	1.14	2.15	0	1.84	2.64	3.66	4.08	Total
total sp		4	2	6	5	9	3	5	2	20
total cover	Life form[1]	11.2	61	71.2	51.1	39.3	60	85.2	100	59.88
Melaleuca argentea	t	10[2]		0.1						10
Arundinella nepalensis	pg		60	20	5	2	5			92
Dichanthium fecundum	pg			40		4				44
Eleocharis sp	ph				25					25
Cyperus large	ph		1	0.1		20			15	36.1
Aristida sp2	pg						30			30
**Passiflora foetida*	v				0.1			45		45
Poaceae sp4	pg								85	85

Table 7: Cover of dominant species (June 2002) at Keep River.

Site		Keep River						
5m x 5m quadrat		Ke1	Ke2	Ke3	Kw1	Kw2	Kw3	
distance (m)		0	8	20	0	6	24	
elevation (m)		0	3.89	4.19	0	2.23	2.28	Total
total sp		6	3	4	5	7	5	16
total cover	Life form[1]	53	45	68	41	28.3	37.2	41.25
Barringtonia angulata	t	20[2]			5			25
Terminalia oblongata	t	2	25	60				87
Atalaya hemiglauca	t	5		5	20	1	20	51
Petalostigma pubescens	t				10	25		35
Acacia holosericea	t					1	15	16

[1]Life form: t = tree; s = shrub; ph = perennial herb; pg = perennial grass; v = vine; * = exotic
[2] foliage cover

Table 8: Species richness of exotic species.

Exotics	**Wet 00**	**Wet 01**	**Dry 00**	**Dry 01**	**Mean**	**Std error**	**Std dev**
House Roof Hill	7	7	7	7	7.00	0.00	0.00
Buttons Crossing	7	7	7	7	7.00	0.00	0.00
Lake Kunun.	3	3	3	3	3.00	0.00	0.00
Parry Lagoons	0	0	0	0	0.00	0.00	0.00
Dunham River	3	3	3	3	3.00	0.00	0.00
Pentecost River	1	1	1	1	1.00	0.00	0.00
Keep River	1	1	1	1	1.00	0.00	0.00

Table 9: Species diversity of native species.

Natives	**Wet 00**	**Wet 01**	**Dry 00**	**Dry 01**	**Mean**	**Std error**	**Std dev**
House Roof Hill	12	12	10	12	11.50	0.50	1.00
Buttons Crossing	14	14	13	14	13.75	0.25	0.50
Lake Kunun.	5	5	5	5	5.00	0.00	0.00
Parry Lagoons	11	11	11	11	11.00	0.00	0.00
Dunham River	25	25	23	25	24.50	0.50	1.00
Pentecost River	19	19	18	19	18.75	0.25	0.50
Keep River	15	15	15	15	15.00	0.00	0.00

Table 10: Species diversity of annual species.

Annual	**Wet 00**	**Wet 01**	**Dry 00**	**Dry 01**	**Mean**	**Std error**	**Std dev**
House Roof Hill	1	1	1	1	1.00	0.00	0.00
Buttons Crossing	4	4	4	4	4.00	0.00	0.00
Lake Kunun.	0	0	0	0	0.00	0.00	0.00
Parry Lagoons	3	3	3	3	3.00	0.00	0.00
Dunham River	8	8	7	8	7.75	0.25	0.50
Pentecost River	1	1	1	1	1.00	0.00	0.00
Keep River	7	7	6	7	6.75	0.25	0.50

Table 11: Species diversity of perennial species.

Perennial	**Wet 00**	**Wet 01**	**Dry 00**	**Dry 01**	**Mean**	**Std error**	**Std dev**
House Roof Hill	19	19	16	18	18.00	0.71	1.41
Buttons Crossing	17	17	16	17	16.75	0.25	0.50
Lake Kunun.	8	8	8	8	8.00	0.00	0.00
Parry Lagoons	8	8	8	8	8.00	0.00	0.00
Dunham River	20	20	19	20	19.75	0.25	0.50
Pentecost River	15	15	15	15	15.00	0.00	0.00
Keep River	13	13	13	13	13.00	0.00	0.00

Appendix 3

Invertebrate Taxa and Abundance

TABLE 1: Number of times each taxon of aquatic macroinvertebrate occurred at each site across the four sampling occasions (late dry 2000, late wet 2001, late dry 200 & late wet 2002), with sites grouped by type (Regulated, Unregulated and Floodplain) (Site codes; BC = Buttons Crossing, DR = Dunham River, HR = House Roof Hill, KR = Keep River, LK = Lake Kununurra, PR = Pentecost River, PR = Parry Lagoon). Total number of taxa collected from each site is also presented, as well as the number of sites each taxa occurred at (occurrences).

TAXA IDENTIFICATIONS			Regulated	Regulated	Regulated	Unregulated	Unregulated	Unregulated	Floodplain	Occurrences
ORDER	**FAMILY**	**SPECIES**	**BC**	**HR**	**LK**	**DR**	**KR**	**PR**	**PL**	
PLATYHELMINTHES	TURBELLARIA									
		Turbellaria sp.			1					1
	NEMERTEA									
		Nemertea sp.			1					1
	NEMATODA									
		Nematoda sp.	2	1				1	2	4
MOLLUSCA										
GASTROPODA										
	Ancylidae									
		Ferrissia petterdi	2	3	2	4	3	1		6
	Planorbidae									
		Amerianna carinata			2				3	2
		Glytophysa gibbosa								
		Gyraulus sp.		1	2		1		4	4
	Viviparidae									
		Notopala sp.	1		3				1	3
	Thiaridae									
		Thiara (Plotiopsis) sp.		1	4					2
	Lymnaeidae									
		Austropeplea lessoni		1					3	2
	Bithniidae									
		Bithniidae (Gabbia) sp.							2	1
	Hydriidae									
		Hydriidae sp.				1				1
BIVALVIA										
	Corbiculidae									
		Corbicula (corbiculina) sp.	4	4	3	4	1		1	6
ANNELIDA										
	Oligochaeta	*Oligochaeta* spp								
		Allonais ranauana			1				1	2
		Allonais pectinata	1							1
		Aulodrilus cf. *limnobius*					1	1		2
		Aulodrilus pigueti								
		Branchiodrilus hortensis							1	1
		Dero digitata					1			1
		Dero ?nivea			1	1	1	1	1	5
		Dero furcata						1		1

Table 1: Continued.

TAXA IDENTIFICATIONS			Regulated	Regulated	Regulated	Unregulated	Unregulated	Unregulated	Floodplain	Occurrences
		Nais variabilis			1					1
		Nais variabilis		1						1
		Pristina longiseta				1				1
		Pristina sp. *1*	1							1
		?Slavinia sp.						1		1
		Stylaria lacustris								
		Tubificidae			1		1			2
	HIRUDINEA									
		Hirudinea sp.			1				1	2
ARACHNIDA										
ACARINA	HYDRACARINA									
		Hydracarina sp.	1	2	3	2			1	5
CRUSTACEA										
BRANCHIURA										
		Branchiura sp.				1				1
CLADOCERA										
		Cladocera sp.			1	1				2
	Daphniidae									
		Daphniidae sp.		2	3	1	1	1	2	6
COPEPODA										
CYCLOPOIDA										
		Macrocyclops albidus			1		1			2
		Macrocyclops darwini			1					1
		Microcyclops varicans	1	1			1	1		4
		Mesocyclops sp.							1	1
		Mesocyclops ?pseudospinosus								
CONCHOSTRACA										
		Cyclestheria hislopi (Baird)							1	1
OSTRACODA										
		Ostracoda spp.								
	Cyprididae									
		Bennelongia sp. 673 nr *australis*			1				1	2
		Stenocypris malcomsi			1					1
		Herpetocypris sp. 676			1					1
		Cypretta baylyi			1					1
DECAPODA										
	Atyidae									
		Caridina cf *longirostris*		2						1
		Caridina "nilotica"		3	1		2	4		4
		Cardina serratirostris	3	3	4	2	4			5
	Palaemonidae									
		Macrobrachium australiense	1							1
		Macrobrachium bullatum	2	3	3	4	4		1	6
		Macrobrachium rosenbergii	1	3	1		4	4		5

TABLE 1: Continued.

TAXA IDENTIFICATIONS			Regulated	Regulated	Regulated	Unregulated	Unregulated	Unregulated	Floodplain	Occurrences
	Parastacidae									
		Cherax ?quadricarinatus			1					1
	Sundathelphusidae									
		Holthuisana transversa						1		1
INSECTA										
EPHEMEROPTERA										
		Genus 1 WA sp. 1	4	4		1		1		4
	Baetidae									
		Cloeon sp.	3	2	4	2	4	4	4	7
	Caenidae									
		Tasmanocoenis arcuata	3	3	2	4	4	4	2	7
		Wundacaenis dostini	1	1		3	1	3		5
	Leptophlebiidae									
		Thralulus sp AV *1*	1		1	3		2		4
ODONATA										
ZYGOPTERA										
	Coenagrionidae									
		Pseudagrion microcephalum	3	2	4	2	3	1		6
		Pseudagrion aureofrons	2	2		2			1	4
		Agriocnemis rubescens			3				1	2
		Ischnura auora		1	1			1	1	4
		Ischnura heterosticta	1		1				3	3
	Protoneuridae									
		Nososticta sp.	1							1
ANISOPTERA										
	Austrocorduliidae									
		Austrocordulia territoria				1				1
	Libellulidae									
		Crocothemis nigriefrons							2	1
		Diplacodes bipunctatus							1	1
		Diplacodes haematodes			1	2	1	2		4
		Nannophlebia risi	3	2		3	1			4
		Orthetrum caledonicum	1		1	2	1	2	1	6
		Rhyothemis graphiptera							3	1
		Trapezostigma ?steneloba/loewii			1				1	2
		Zyxomma elgneri	1	1					1	3
	Hemicorduliidae									
		Hemicordulia intermedia	1	1		2				3
	Aeshnidae									
		Hemianax papuensis			2				1	2
	Gomphidae									
		Austrogomphus (A) mjobergi	2	1		4		3		4
		Antipodogomphus neophytus /hodgkini	2	2		2				3
		Ictinogomphus australis			1		1		1	3

TABLE 1: Continued.

TAXA IDENTIFICATIONS			Regulated	Regulated	Regulated	Unregulated	Unregulated	Unregulated	Floodplain	Occurrences
HEMIPTERA										
	Nepidae									
		Ranatra sp.	1	1			4	1	2	5
	Gerridae									
		Limnogonus (L) fossarum	1	1	1	3			2	5
		Limogonus sp.			1	1				2
		Rhagadotarsus anomalus		1	1	3	1		1	5
		Rhagadotarsus sp	1			1				2
		Tenagogerris sp. (early instar)	1						1	2
	Corixidae									
		Agraptococorixa halei							3	1
		Micronecta annae sp.	1		1		1	1	1	5
		Micronecta halei	1							1
		Micronecta spp.								
	Pleidae									
		Plea sp.	1		3					2
		Plea brunni	2	2	4	4	4	4	4	7
	Notonectidae									
		*Anisops spp. (*female*)*	1				1	1	2	4
		Anisops douglasi							1	1
		Anisops hackeri				1				1
		Anisops nodulata							2	1
		Anisops ?semita				1	1			2
		*Anisops ?stali (*female*)*							1	1
		Nychio sappho	2	1	1	2	3	1		6
		Enithares nr *loria*		1	2	2	1		4	5
	Naucoridae									
		Aphelocheirus australicus	2	3	4	3	2	1	4	7
		Naucoris subopacus							3	1
	Veliidae									
		Microvelia peramoena				2	1			2
		Microvelia sp.	1		1			1	1	4
		Veliidae spp. (immature*)*	1	2		1		2	2	5
	Mesoveliidae									
		Mesovelia vittigera			1					1
		Mesovelia sp. *(*juvenile*)*	2	1	2	2			3	5
	Hebridadae									
		Merragata hackeri			4	1				2
MEGALOPTERA										
	Sisyridae									

TABLE 1: Continued.

TAXA IDENTIFICATIONS			Regulated	Regulated	Regulated	Unregulated	Unregulated	Unregulated	Floodplain	Occurrences
		Sysira sp.			1	1				2
DIPTERA										
	Chironomidae									
		Chironomidae spp.								
	Ceratopogonidae									
		Bezzia sp.	2	1	1	1	1	1	1	7
		Nilobezzia sp.	2	1	1	1	1	2	1	7
	Culicidae									
		Annopheles (cel) annulipes sp. D				1				1
		Anopheles (cellia) farauti			1					1
		Chaborus sp.				1				1
		Culex (culex) annulirostris			1				2	2
		Culex (culex) sitiens			1					1
		Culicidae sp.	1	1	1	1	1	1	2	7
		Culicini sp. (pupa)		1					1	2
	Stratiomyidae									
		Stratiomyidae sp.			4	2	2	1	2	5
	Simulidae									
		Simulum ornatipes	2	2		1				3
	Empididae									
		Empididae sp. (Hemerodromia Tribe)		1		2				2
	Tabanidae									
		Tabanus sp.	1	3	1	4	1	1	1	7
	Ephydridae									
		Ephydridae sp.	1							1
LEPIDOPTERA										
	Pyralidae									
		Pyralidae sp.	4	3	4	2				4
TRICHOPTERA										
		Trichoptera pupae	1			1				2
	Ecnomidae									
		Ecnomus sp.	4	2	3	4	3	1		6
	Polycentropodidae									
		Paranyctiophylax sp. AV46	2		1	1	1			4
	Hydropsychidae									
		Cheumatopsyche sp. AV11	1	2		1		1		4
	Leptoceridae									
		Leptocerus atsou			1	1	1			3
		Oecetis sp.	3	2	1	3	1	1	2	7
		Triaenodes sp.	1	1	2	2	1			5
		Triplectides ciuskus seductus	2	2		3	3		2	5
		Triplectides helvolus			1	1	2	1	1	5
		Triplectides sp AV 18.						1		1
		Triplectides sp. (juvenile)	1	1			1			3

TABLE 1: Continued.

TAXA IDENTIFICATIONS		Regulated	Regulated	Regulated	Unregulated	Unregulated	Unregulated	Floodplain	Occurrences
Hydroptilidae									
	Orthotrichia sp.				1				1
	Tricholeiochiton sp.			1					1
	Hellyetheria ramosa			1					1
Philopotamidae									
	Chimarra uranka				2		1		2
Calamoceratidae									
	Anisocentropus sp.				1	2			2
COLEOPTERA									
Dytiscidae									
	Batrachomatus wingi					1			1
	Bidessodes mjobergi				1		1		2
	Bidessodes flavosignatus			1	4				2
	Clypeodytes bifasciatus				1				1
	Clypeodytes migrator		1		3		1	1	4
	Copelatus nigrolineatus		2	1	3	1			4
	Cybister godeffroyi							3	1
	Cybister sp.							1	1
	Cybister tripunctatus							2	1
	Cybister sp. (L)							1	1
	Hydaticus consanguineus				1	1			2
	Hydroglyphus basalis	2		1	1	3	1		5
	Hydroglyphus daemeli	2	1		2	1	1	1	6
	Hydroglyphus godeffroyi		1		2	1	1		4
	Hydroglyphus leai	1	2	3	1	2	1	3	7
	Hydroglyphus trilineatus	1			3	1			3
	Hydrovatus parallelus		1		1	1			3
	Hydrovatus rufoniger					1			1
	Hydrovatus (L)			1					1
	Hyphydrus eligans					2		1	2
	Hyphydrus lyratus		1		1	1		2	4
	Laccophilus cingulatus		1		2	2			3
	Laccophilus clarki		1	1	2	3	2	1	6
	Laccophilus sharpi	1				3		2	3
	Laccophilus unifasciatus				1	2			2
	Laccophilus (L)								
	Megaporus ruficeps		1	1	1	2	3	4	6
	Necterosoma regulare				1	1			2
	Onychohydrus attratus							1	1
	Onychohydrus attratus (larvae)							1	1
	Sternopriscus sp.						1		1
	Tiporus centralis		1		1				2
	Tiporus undecimaculatus				1		1		2

TABLE 1: Continued.

TAXA IDENTIFICATIONS		Regulated	Regulated	Regulated	Unregulated	Unregulated	Unregulated	Floodplain	Occurrences
Hydraenidae									
	Hydreana impercepta				1	1			2
	Hydraena sp.	1	1		2	1	1	1	6
	Octhebius sp.		1					1	2
Noteridae									
	Hydrocanthus waterhouseii							1	1
	Neohydrocoptus subfasciatus		1	2	2	4			4
Hydrophilidae									
	Amphiops duplopunctatus			1		1			2
	Amphiops australicus	1			2				2
	Amphiops queenslandicus							1	1
	Berosus australaie							3	1
	Berosus dallasae		1						1
	Berosus josephenae							3	1
	Berosus pulchellus	1	1		2	1		2	5
	Berosus sp. (larvae)	2			2			3	3
	Berosus sp. (indet.)				1				1
	?Coelosoma fabriccii	1							1
	Enochrus (methydrus) deserticola			2		3	1		3
	Enochrus (methydrus) esuriens			1			1	3	3
	Helochares (Hydrobaticus) clypeatus							1	1
	Hydrochus imamkhani						1		1
	Hydrochus spp.	3	2	2	3	4	2	4	7
	Hydrophilidae sp. (larva)			1	1				2
	Paracymus pygmaeus	3	2	3	3	3	2	2	7
	Paracymus sp.		1						1
	Regimbartia attenuata	2	2	2	1	2	1	3	7
	Sternolophus marginatus				1	2			2
Gyrinidae									
	Macrogyrus paradoxus	1	2		3				3
	Gyrinidae sp. (larva)	1			3				2
Haliplidae									
	Haliplus sp.							1	1
ELmidae									
	Austrolimnius sp. (larva)	1	1		3		1		4
	Elmidae sp.		1		1				2
Scirtidae									
	Scirtidae sp. (L)				2				1
Limnichidae									
	Limnichidae	2			1				2
Curculionidae									
	Curculionidae sp.		2					1	2
	Number of Taxa	73	74	85	100	74	58	87	**196**

Appendix 4

Results of statistical significance testing

TABLE 1. Two-way ANOVA on each water quality parameter by river types (regulated, unregulated and floodplain) and sampling trips (dry 2000, dry 2002, wet 2000, wet 2001). Tukeys HSD multiple comparison test was applied to locate differences where there were significant main effect. Levels joined by a common line are not significantly different at p = 0.05, samples/means are arranged in descending order.

Effect	df	F	p	Tukeys HSD			
TURBIDITY							
Trip	3	7.30	0.0027	*Dry 2000* (34.0)	*Wet 2001* **(22.4)**	**Dry 2002** (8.1)	**Wet 2002** (7.5)
Type	2	2.08	ns	Floodplain (32.1)	Regulated (18.2)	Unregulated (13.1)	
Trip * Type	6	2.98	0.0378				
TEMPERATURE							
Trip	3	36.93	< 0.0001	Dry 2000 (27.2)	**Dry 2002** **(26.8)**	Wet 2001 (25.4)	**Wet 2002** (21.1)
Type	2	1.14	ns	Unregulated (25.5)	Regulated (24.9)	Floodplain (24.5)	
Trip * Type	6	1.75	ns				
DO (mg/l)							
Trip	3	13.24	< 0.0001	**Wet 2002** (7.4)	Wet 2001 **(6.8)**	Dry 2000 (5.6)	**Dry 2002** (2.7)
Type	2	4.75	0.0241	Regulated (6.5)	Floodplain (5.1)	Unregulated (4.9)	
Trip * Type	6	0.89	ns				
DO (% saturation)							
Trip	3	0.79	ns	**Wet 2002** (83.9)	Wet 2001 **(82.6)**	Dry 2000 (69.8)	**Dry 2002** (68.9)
Type	2	4.45	0.0291	Regulated (88.4)	Floodplain (69.4)	Unregulated (66.5)	
Trip * Type	6	0.74	ns				

TABLE 1. Continued

Effect	df	F	p	Tukeys HSD			
REDOX							
Trip	3	19.81	< 0.0001	Dry 2000 (89.7)	Wet 2001 **(8.7)**	**Dry 2002** (-46.9)	**Wet 2002** (211.6)
Type	2	9.03	0.0024	Unregulated (-17.8)	Regulated (-22.3)	Floodplain (-159.8)	
Trip * Type	6	4.85	0.0053				
pH							
Trip	3	4.52	0.0177	Dry 2000 (8.3)	Wet 2001 **(8.1)**	**Wet 2002** (7.8)	**Dry 2002** (7.2)
Type	2	0.97	ns	Floodplain (8.1)	Regulated (7.9)	Unregulated (7.7)	
Trip * Type	6	1.60	ns				
SALINITY							
Trip	3	1535	< 0.0001	**Dry 2002** (0.96)	Dry 2000 **(0.27)**	**Wet 2002** (0.25)	Wet 2001 (0.17)
Type	2	1852	< 0.0001	Floodplain (1.46)	Unregulated (0.26)	Regulated (0.21)	
Trip * Type	6	574	< 0.0001				
CONDUCTIVITY							
Trip	3	639	< 0.0001	**Dry 2002** (1126.3)	**Wet 2002** **(463.4)**	Dry 2000 (414.3)	Wet 2001 (390.4)
Type	2	1554	< 0.0001	Floodplain (2430.2)	Unregulated (349.0)	Regulated (237.7)	
Trip * Type	6	419	< 0.0001				

TABLE 2: Two-way ANOVA to test for differences in macroinvertebrate taxa richness amongst river types (regulated, unregulated and floodplain) and sampling trips (dry 2000, dry 2002, wet 2000, wet 2001). Tukeys HSD multiple comparison test was applied to locate differences where there were significant main effect. Levels joined by a common line are not significantly different at p = 0.05, samples are arranged in descending order and mean number of taxa is in parenthesis.

Effect	**df**	**F**	***p***	**Tukeys HSD**			
Trip	3	0.93	ns	Wet 2002	Dry 2002	*Wet 2001*	*Dry 2000*
				(41.1)	(39.6)	(38.0)	(27.1)
Type	2	0.43	ns	Floodplain	Unregulated	Regulated	
				(41.8)	(36.8)	(34.6)	
Trip * Type	6	0.40	ns				

TABLE 3: Two-way ANOVA to test for differences in species richness, abundance and biomass amongst river types (Regulated and unregulated) and trip (1 = Dry 2000, 2 = Wet 2001, 3 = Dry 2001, 4 = Wet 2002). Tukeys HSD multiple comparison test was applied to locate differences where there were significant main effects. Levels joined by a common line are not significantly different at p = 0.05, samples are arranged in descending order with arithmetic means in parentheses.

Effect	df	F	p	Tukeys HSD			
Species Richness							
Trip	3	2.48	ns	Dry 2000	Wet 2001	*Dry 2001*	*Wet 2002*
				(5.5)	(5.2)	(4.4)	(3.8)
Type	1	0.31	ns		Unregulated	Regulated	
					(4.8)	(4.6)	
Trip * Type	3	0.43	ns				
Abundance							
Trip	3	2.95	ns	Wet 2001	Dry 2000	*Dry 2001*	*Wet 2002*
				(26.4)	(23.7)	(20.8)	(12.3)
Type	1	0.42	ns		Unregulated	Regulated	
					(22.0)	(19.7)	
Trip * Type	3	2.10	ns				
Biomass (kg)							
Trip	3	0.95	ns	Dry 2001	Wet 2001	*Dry 2000*	*Wet 2002*
				(8.9)	(8.0)	(7.0)	(5.1)
Type	1	1.75	ns		Regulated	Unregulated	
					(8.3)	(6.1)	
Trip * Type	3	2.57	ns				

TABLE 4: Summary of three-way ANOVA on fish weight (g)(*viz*. size) to test for differences amongst river types (Regulated and unregulated), trips (1 = Dry 2000, 2 = Wet 2001, 3 = Dry 2001, 4 = Wet 2002) and fish species. Tukeys HSD multiple comparison test was applied to locate differences where a significant main effect existed for river type and trips (species differences analysed separately). Levels joined by a common line are not significantly different at p = 0.05, samples are arranged in descending order with arithmetic means in parentheses.

Effect	df	F	p	Tukeys HSD			
Species	21	16.68	<0.0001				
Type	1	10.18	0.0014	Regulated (427.9)	>	Unregulated (282.9)	
Trip	3	3.04	0.0281	Dry 2001 (424.9)	Wet 2002 (415.2)	Wet 2001 (304.5)	Dry 2000 (291.9)
Type * Species	11	3.90	<0.0001				
Trip * Species	40	2.14	<0.0001				
Type * Trip	3	9.05	<0.0001				
Type * Trip * Species	23	7.58	<0.0001				

TABLE 5. Results of two-way ANOVA's comparing mean GPP, R_{24}, and NDM at regulated and unregulated systems and between seasons. Seasonal comparisons were conducted using June 2001, June 2002 and September 2002 results.

Variable		df	F	P	Scheffe's test (p<0.05)
Season	**GPP**	2	24.7	<0.05	Small significant differences
Site	**GPP**	6	128.0	<0.001	Marlgu > lower Ord River sites > Pentecost = Dunham = Keep = Lake Kununurra.
Season * Site	**GPP**	12	31.4	<0.05	
Residual	**GPP**	101			
Season	**R_{24}**	2	64.4	<0.001	Sept 2002>June 2001 = June 2002
Site	**R_{24}**	6	58.0	<0.001	Marlgu > lower Ord River sites > Pentecost = Dunham = Keep = Lake Kununurra.
Season * Site	**R_{24}**	12	7.8	<0.05	
Residual	**R_{24}**	101			
Season	**NDM**	2	31.2	<0.05	Scheffe's test (p<0.05)
Site	**NDM**	6	30.0	<0.001	Sept 2002>June 2001 = June 2002
Season * Site	**NDM**	12	17.4	<0.05	Marlgu > lower Ord River sites > Pentecost = Dunham = Keep = Lake Kununurra.
Residual	**NDM**	101			

TABLE 6. Two-way ANOVA on % algal material in consumers (sqrt transformation) by season (n=2), and site (n=7). *** p<0.001, ** p<0.01, * p<0.05, ns, non-significant.

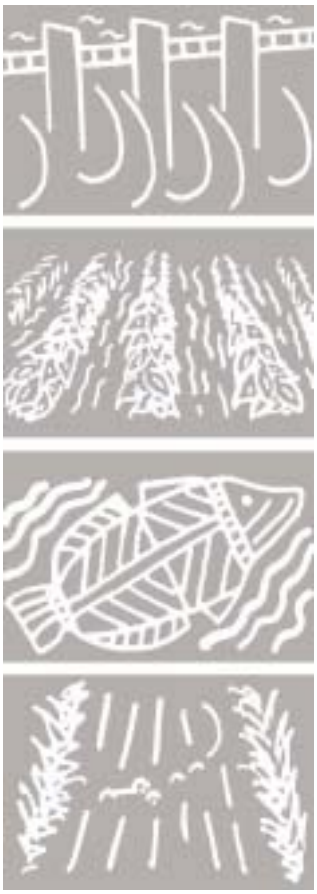
Source	df	MS	F	Results of Scheffe's tests (at p<0.0.5) on % algal incorporation
Site	6	25.8	3.96 **	Buttons Crossing=House Roof Hill = Marlgu > Dunham = Keep = Pentecost = Lake Kununurra
Season	1	40.8	6.27 **	Wet > Dry
Site*Season	6	30.2	4.64**	
Residual	120			

TABLE 7. Summary of two-way ANOVAs on $\delta^{13}C$ signature by site (riverine versus floodplain) and source. Tukey's multiple comparison test was used to located between-level differences for significant main effects. A common line joins levels not significantly different. (NB between-source differences are not indicated, refer Table 2 for individual source by site differences).

Effect	**df**	**F**	**p**	Tukeys HSD		
Source	12	6.40	<0.0001			
Site	1	8.38	0.0046	Floodplain (-20.33)	>	Riverine (-25.02)
Source * Site	5	0.94	ns			

TABLE 8. Summary of one-way ANOVAs on $\delta^{13}C$ signatures of sources by site (riverine versus floodplain). Tukey's multiple comparison test was used to located between-level differences for significant main effects.

Effect	**df**	**F**	**p**	Tukeys HSD		
Emergent macrophyte	1,4	2.05	ns	Floodplain (-27.54)	=	Riverine (-28.22)
Fish	1,43	17.93	0.0001	Floodplain (-20.82)	>	Riverine (-24.60)
Filamentous algae	1,2	0.89	ns	Floodplain (-16.31)	=	Riverine (-17.44)
Macrobrachium prawns	1,4	15.27	0.0298	Floodplain (-19.69)	>	Riverine (-25.63)
Macroinvertebrates (predators)	1,10	8.44	0.0174	Floodplain (-19.05)	>	Riverine (-24.00)
Riparian vegetation	1,13	1.55	ns	Floodplain (-27.93)	=	Riverine (-28.90)



Appendix 5

Ord Research and Development Update

Issue 1

Dear Kununurra community, This document represents the first of a series of bulletins designed to inform you of progress on water-related research and development (R&D) projects being undertaken in the Ord River region. The various projects to be highlighted in this series are sponsored wholly or in part by the Water and Rivers Commission and are aimed at improving waterways planning and management. The Commission is keen to promote the key findings of these studies within the broad community and to see that new knowledge facilitates improved management of this important system.

Susan Worley
North West Regional Manager
Water and Rivers Commission

VALUE OF ORD R&D PROJECTS

A plan that defines the allocation of water from the Ord River for consumptive users will shortly be published by the Water and Rivers Commission. The Ord River Interim Allocation Plan will also define water provisions for social and environmental needs. The plan has been developed in consultation with community, government, industry and scientific stakeholders, but is based on limited understanding of the socio-cultural and environmental needs. A number of projects are currently underway to address these additional information requirements and inform the revision of the water allocation plan. The projects include investigations of:

- Fish and invertebrate habitat requirements in the lower Ord River
- Ecosystem function and productivity in relation to flow
- Interaction between vegetation and sediment
- Aboriginal cultural values
- Nutrient cycles

The Commission is also planning and cooperating in the development of projects investigating estuarine dynamics, surface hydrology and groundwater management. The full range of projects underway and in development will influence water allocation planning, water use and waterways management into the future. The projects are intended to link in with the community's Ord Land and Water Plan and the Water Use Improvement Plan being developed by the Ord Irrigation Cooperative.

ABORIGINAL CULTURAL VALUES STUDY NEARING COMPLETION

Field work is now complete for this project and a report is expected to be submitted to the Water and Rivers Commission in late December. During the fieldwork period, various locations between Lake Argyle and the lower Ord River were visited. Traditional owners with knowledge of, and interests in, the area were engaged to visit sites to discuss and record their values including religious beliefs, environmental understandings and their relationships and interactions with the river ecosystems

These documents are invaluable in contributing to improvements in water quality and subsequent benefits to the lower Ord ecosystem.

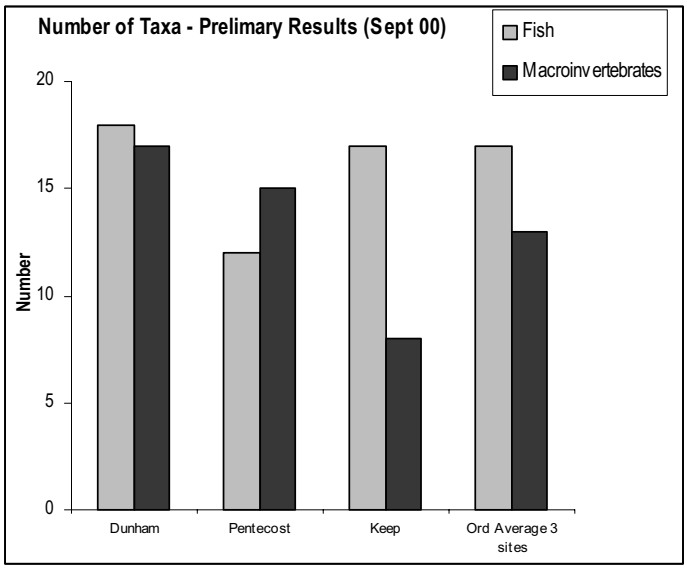
UNDERSTANDING HOW THE ORD ECOSYSTEM WORKS

Ecologists have completed a year's worth of investigation on the Ord River and are moving closer to understanding how the ecosystem functions. Results available thus far suggest that the Ord supports similar numbers of species compared with nearby river systems, but may be driven by a different energy base.

Photo by Andrew Storey

In the Ord, terrestrial inputs of organic material (eg. leaf litter) are an important energy source for the ecosystem. In contrast, the key energy source driving the Pentecost River ecosystems appears to come from algae produced in-river. The differences may be associated with changes caused by Ord regulation. If these preliminary findings are correct, they will be important in determining future flow regimes in the Ord and will influence waterway management for other north-west rivers. However, there is still another year's worth of sampling to be undertaken before the picture becomes clearer.

The project, which involves three universities, is partly funded by Environment Australia as part of their Australia-wide, Environmental Flows Initiative. The project aims to determine the ecological structure and function of regulated and unregulated rivers in the Kimberley. This is important because, in comparison to the south west of WA, very little is known about ecological processes and food webs in large floodplain rivers. This information is also needed for determining accurately the ecological water requirements of the lower Ord. Progress reports for this study will shortly be made available on the Commission's web site: http://www.wrc.wa.gov.au/



Habitat surveys underway

In October this year the first of two habitat surveys was carried out in the lower Ord River. Consultants engaged to undertake this project sampled invertebrates and fish and recorded the characteristics of the areas in which they were found. The aim of the surveys, which will occur again in the wet season, is to define fauna habitat requirements. Understanding habitat, especially in relation to depth and vegetation cover, provide information about water level and flow requirements that will enable better management of the system and influence water allocation planning. The study, which will be completed in October 2002, will also be used to develop protocols for monitoring in relation to altered flow regimes and water quality.

Photo by Andrew Storey

Barramundi habitat requirements are being investigated

Appendix 6

Workshop Outcome

Investigation and monitoring projects under-way or required to inform final Ord Water Allocation Plan

Study Area	Key information required	Study Type (partners)	Status
Riverine ecology and management	Fish and invertebrate habitat surveys	Contracted (WRC)	On-going
	Productivity and water flow regulation	Research (WRC, UWA, ECU, GU, EA)	On-going (Phase 2)
	Water quality and aquatic biota responses to low flow	Monitoring investigation (WRC)	Concept
	Riparian eco-geomorphology	Research (UWA)	On-going
	Management of riparian and aquatic vegetation	Management (WRC)	Concept
Estuarine	River-estuary project	Research (CSIRO – OBP)	Concept
Surface water hydrology	Updated estimates of flows	Hydrologic (WRC)	Identified need
	River hydraulics linked to ecological studies	Hydrologic (WRC)	Ongoing
	Reservoir simulations	Hydrologic (WRC)	Identified need
	Parry Lagoon hydrology	Management (WRC)	Concept
Groundwater	Improved management options for areas without deep gravels	Research (AgWA, OBP)	Ongoing
	Effectiveness of de-watering bores Stage 1 area	Monitoring (OIC)	Licensee reports
	Effect of improved irrigation scheduling on recharge	Monitoring (M2)	Licensee reports
Irrigation management	Evaluation of approaches to reduce irrigation return flows and improve drainage water quality	Research (CSIRO-OBP, AgWA, OIC)	Under-way
	Distribution efficiency and estimates of nutrient discharge Stage 1	Research (WRC, ECU, NPIRD)	On-going (Phase 2)
Aboriginal issues	Cultural values	Contract (WRC)	Nearing completion
	Developing management objectives that protect aboriginal cultural values	Contract (WRC)	Concept
Socio-economic	Update agricultural and non-market benefits of river regulation	Contract (WRC)	Concept
	Attitudes survey to waterway management and flow objectives	Contract (WRC)	Concept