internal report 407

The East Alligator mangrove transects:

A series of permanent benchmark monitoring sites in Kakadu National Park

M Saynor, G Begg & G Claridge

March 2003

supervising scientist

Contents

The East Alligator mangrove transects: a series of permanent benchmark monitoring sites in Kakadu National Park

M Saynor, G Begg & G Claridge

1 Background

In June 1981 a field team from the Australian Littoral Society (now Marine Conservation Society) marked and surveyed seven mangrove transects on the East Alligator estuary under contract to the ANPWS (Hegerl et al 1982). The overall aim of the study was to provide an assessment of the biogeographic significance of the tidal wetlands and mangrove forests of the Kakadu National Park (KNP) and to establish permanent quadrats to permit monitoring of growth, mortality and long-term changes in vegetation.

2 Field studies

2.1 The 1981 field study

The positions of each transect were demarcated with marine grade aluminium poles (figure 1), inscribed with an identification code at the top, and hammered into the sediment.

Figure 1 Bench mark and marker pole on T1 (07.10.2002) (Photo: M Saynor)

A benchmark at the landward end of each the transect was set in concrete . The marker poles along the transect were scored 0.6 m above the June 1981 substrate level so that a measure of subsequent erosion or accretion could be obtained. A total of 28 10m x 10m quadrats were positioned along seven transects (table 1) and the trees within each quadrat were individually marked with stainless steel tags. The nature of the soil within each quadrat was also recorded. The vegetation along each transect was described for species composition, canopy density and height. Apart from mangroves, the flora surveyed included algae, fungi and lichens.

Table 1 Plant communities sampled in 1981 at seven transect localities on the East Alligator River (Source: T1- T4 details are from Hegerl et al 1982; T5-T7 details are from G Claridge, pers. comm.)

Transect No.	Quadrat No.	Location	Plant community	No. of Mangrove species	No. of trees tagged
T1	Q1	Point Farewell	Low-closed *Avicennia*	1	50
	Q2		Low-closed *Ceriops*	2	79
	Q3		Open *Rhizophora* scrub	3	50
	Q4		Low-closed *Rhizophora*	2	34
	Q5		Closed *Sonneratia*	3	20
T2	Q1	Point Farewell	Low-closed *Avicennia*	1	18
	Q2		Open *Avicennia* scrub	3	30
T3	Q1	Magela creek	Tall *Lumnitzera* shrubland	1	20
	Q2		Open *Lumnitzera*	2	20
	Q3		*Paspalum/Sporobolus* grassland	1	
T4	Q1	Flying Fox island	Closed riparian scrub	5	50
	Q2		Low-open *Avicennia*	5	63
	Q3		Low-closed *Excoecaria*	5	43
	Q4		Closed *Excoecaria* mixed	6	33
	Q5		Closed riparian scrub	3	35
T5	Q1	West side of Point Farewell			
	Q2				
	Q3		No record	N/r	N/r
	Q4				
	Q5				
	Q5A				
T6	Q1	West bank of East Alligator R, SE of Point Farewell			
	Q2				
	Q3		No record	N/r	N/r
	Q4				
	Q5				
T7	Q1	West bank of East Alligator R opposite mouth of Cooper Cr			
	Q2		No record	N/r	N/r

The fauna surveyed along each transect (table 2) included molluscs, crustaceans, insects, spiders, reptiles, amphibians, birds and mammals. Intertidal invertebrates were collected by Peter Outridge (from OSS) for uranium and heavy metal analysis but a full listing of the results were not available for inclusion in the report. Initial examination of the data showed that high levels of most heavy metals, particularly copper,were significantly higher than those reported in estuarine invertebrates elsewhere in Australia (Hegerl et al 1982).

The position of all seven transects, approximate location drawn by Gordon Claridge onto vertical aerial photographs dated 1991, are shown in figure 2. Sketches of each transect showing the compass bearings, transect lengths and quadrat positions together with steep obliques of transect Nos. 1, 2 & 3 are shown in Appendix 2 and 4 respectively, and the originals archived on File SG 2002/ 0139.

It should be noted that the data contained in Hegerl et al (1982) do not represent a full listing and interpretation of the 1981/1982 survey results. A final report from the Australian Littoral Society to the Australian National Parks and Wildlife Service (ANPWS) was budgeted for / planned in the 1982/83 financial year. However, for some reason (possibly a lack of funding?), a final report has never been produced.

Table 2 Species richness data from collections of fauna made on the East Alligator mangrove transects in 1981 (Source: raw data contained in Hegerl et al 1982)

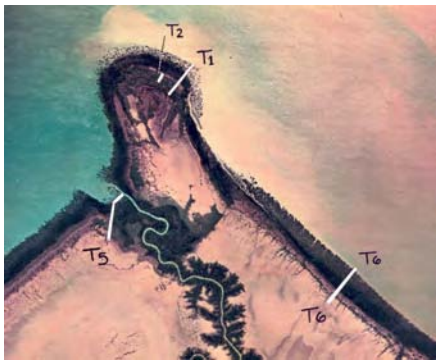
Type of fauna	No. of species	Notes
Insects	84	
Molluscs	42	Ellobiid gastropods of particular interest, including 3 spp of *Melampus* never previously collected by ALS. The abundance of dead gastropods at T3 and T4 reflected the strong influence of wet/dry season change.
Crustaceans	32	Two species new to science, including *Sarmatium* a new species of crab.
Arachnids	60	Primarily web spinners. 11 species new to science.
Birds	39	Pheasant coucal and Tawny frogmouth present at T4. Neither species had previously been recorded from Kakadu mangroves.
Reptiles and amphibia	N/r	Data not yet been processed.
Mammals	4	*Melomys burtoni* was common at T4.

2.2 The 1993 field study

Representatives of the original team, Dr Erroll Stock & T Broderick from Griffith University, remeasured and where necessary reinstated poles on some of the East Alligator transects in 1993. However, only vegetation data (tree height and girth (dbh)), substrate cover and the condition of the poles used to mark the quadrats were recorded. In addition, Q5 on T1 and Q2 on T7 could not be relocated.

A floppy disc containing Paradox files of these data was recently located by Dr Rod Kennett (PAN). The data concerned (*) have since been imported into Excel spreadsheets by James Boyden (***eriss***) but are not considered to be complete and require editing (G Claridge, pers. comm.).

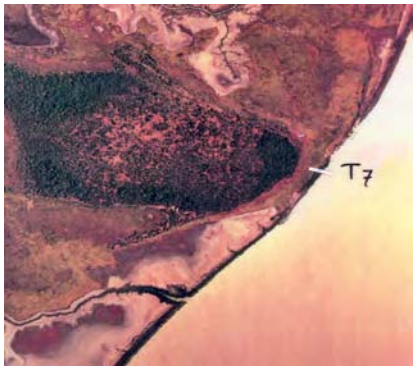
[* Note: These data are are located in SSD explorer in the following directory \\ERA Coastal Assessment & Monitoring\East Alligator Mangrove transects\Data\



T1, T2, T5 and T6 near and on Point Farewell

T3 – on Magela Creek

T4 – on Flying Fox Island



T7 - on West bank opposite Cooper Creek

Figure 2 Approximate position of the East Alligator mangrove transects using 1991 aerial photographs

3 Aim of current investigation

The aim of the investigation reported here was to locate and record the GPS co-ordinates of the East Alligator mangrove transects. The survey undertaken was conducted over the period 7–8 October 2002

3.1 Personnel involved

Gordon Claridge (Aust/Asia Environmental Pty Ltd), a member of the original team that was involved in the 1981 surveys, was engaged by ***eriss*** to relocate the transect positions. Field assistance was provided by Mouse Saynor and Bryan Smith (***eriss***) and Steve Heggie (PAN). A helicopter, hired from Jayrow Helicopters at Jabiru airport, was used for transportation to the Point Farewell and Magela sites and a boat was used to access the site located on Flying Fox Island.

3.2 Record of consultation

Prior to undertaking any field work consultations were held by ***eriss*** staff with Mr Jonathon Nadji (traditional owner of area at Cannon Hill), Lyndall MacLean, Mike Hinsliff, Steve Heggie and Gary Lindner (district rangers, PAN). The outcome of the consultation process was recorded by Matt Daniel (***eriss***) on a TO consult form supplied by PAN.

3.3 Permits obtained

A helicopter landing permit (Permit No C121/2002) and a research permit (Permit No RK 381) was obtained from Mr Chris Haynes (Park Manager, PAN). Copies of the permits concerned appear in Appendix 6.

3.4 Results

All seven transects were successfully located by the study team. The position of each transect and as many of the marker poles as possible was accurately recording with a GPS and the data entered into an Excel spreadsheet (Appendix 1). In addition, the position of each transect was marked on colour aerial photographs dated 1991 (figure 2); the start point of each transect (except for T2) was photographed with a digital camera and the marker poles along the transect were flagged with biodegradable tape and painted orange. In all 78 photographs were taken (digital camera with GPS attached), each of which has been labelled and dated and where it was known the longitude and latitude of the scene recorded. These images are stored in SSD explorer in the following directory:

> \\Coastal Monitoring of Alligator Rivers Region\Mangrove\East Alligator Mangrove transects\Photographs\2002\Digital MJS

A series of steep obliques of the transects were also taken from the air using colour slide film. These images are stored in SSD explorer in the following directory:

> \\Coastal Monitoring of Alligator Rivers Region\Mangrove\East Alligator Mangrove transects\Photographs\2002\Slide Copies

Not all the original marker poles are still in position. Some have been knocked over by tidally transported debris, others have been lost as a result of coastal erosion, others have been vandalised. An initial impression of the vegetation along the transects is that there has been changes in species composition, possibly as a result of changes in inundation frequency. The

changes observed on the landward margin could be fire related. The reason for large patches of dead mangroves, a condition also evident in 1981, remains unexplained.

For ease of reference, a list of previous work done and/or data available on the East Alligator mangroves is presented in chronological order in Appendix 7.

4 Justification and recommendations for future research

In 1999 the Independent Science Panel that was engaged by the World Heritage Committee to assess the Supervising Scientist's report about the Jabiluka project (Johnston & Prendergast 1999) noted that both the Jabiluka minesite and the ARR will possibly be subject to major changes unrelated to mining. The Panel concluded, amongst other things, that

> …a comprehensive monitoring programme and supporting analyses of the environmental systems at the local and regional scale are necessary so that any impacts due to mining can be distinguished from those due to other causes (World Heritage Committee 2000).

Numerous meetings have since taken place between stakeholders to consider a suitable landscape-scale monitoring programme (Finlayson et al 2002). The impact of invasive species, habitat fragmentation, fire, climate change, saline intrusion, land clearing and accelerated erosion were all raised as examples of disturbance factors in Kakadu which, apart from mining, are operative in the region and it was generally agreed that, ideally, all such factors require to be monitored.

What follows focuses on the potential impact of climate change and sea level rise as proximal pressures in the region and serves as justification for both the proposed analysis of the stability of mangrove communities in the ARR (section 4.2) and to compliment ***eriss***'s longstanding multi-disciplinary coastal monitoring program in the region.

4.1 Climate change and sea level rise as proximal pressures

Significant rises in sea level and changes in climate in different parts of the world have been predicted by climatologists and oceanographers for more than a decade (International Panel on Climate Change 1995). As a consequence of such pressures it has been predicted that many of the existing values of the freshwater wetlands of the KNP will be degraded or lost and, in some cases, replaced by wetlands of a different type (Bayliss et al 1997, Eliot et al 2000). Coastal areas in the Alligator Rivers Region are also vulnerable to climate change and sea level rise (Eliot et al 1999). Consequently, it is understandable that the need for baseline surveys of coastal communities (e.g. mangrove species composition and health) is considered crucial for such changes to be understood. This understanding is particularly important if they are to be distinguished from other pressures in the region (Finlayson 1999, Lucas et al 2002).

The assessment proposed in Section 4.2 below would be entirely in keeping with the recommendations of the ISP (World Heritage Commission 2000). It would also be in keeping with the scope of the Landscape Analyses currently supported by the Alligator Rivers Region Technical Committee (ARRTC) and the Kakadu Research Advisory Committee (KRAC), the 'whole ecosystem' concepts advocated by the Convention of Biological Diversity (CBD) and the Ramsar Wetland Convention (Finlayson and Bayliss, 2003). The proposed survey would add to the baseline research that ***eriss*** has been developing over the past decade, a recent example being the West Alligator mangrove project being conducted jointly by eriss, the University of Wales, the UNSW Centre for Remote Sensing and the NT Department of Infrastructure, Planning and Environment. Finally, re-surveying of the existing transects on

the East Alligator estuary, as proposed, would achieve many of the advantages outlined by Finlayson (1999), these being:

- measuring long-term response of mangroves to environmental change, including climate variations and sea level rise,
- describing the process of biological change,
- assessing the significance of predicted changes,
- determining the range of responses to predicted changes, and
- determining the natural trends and variability.

4.2 Recommendations for future research

The East Alligator transects are a unique series of benchmarks that were established with considerable care and precision over 20 years ago. They have no counterpart in Kakadu National Park or elsewhere in the Northern Territory. The transects provide eriss and the wider scientific community with a golden opportunity to look further at long term coastal change and to gather further information about the physical dynamics in van Diemen Gulf as a potential driver for saline intrusion and sea level change in the Alligator Rivers Region.

It is recommended, therefore, that:

- The plant communities of the East Alligator transects are resurveyed in the 2003 dry season using, where possible, the techniques and field data sheets developed by the Australian Littoral Society in 1981 and 1993.
- Where dieback is observed leaf litter and root mass samples should be taken to establish whether the fungi *Phytopthora* is responsible for the mortality being caused.
- The amount of sedimentation along each transect is measured to give an indication of the extent to which tidal inundation frequency may have changed over the last 20 years.
- A sample of oysters (*Crassotrea cucullata*) is collected from the East Alligator mangroves to confirm whether the high levels of heavy metals, particularly copper, that were evident in 1981, is still the case.
- A report is produced in collaboration with Griffith University and Aust/Asia Environmental Pty Ltd that represents, for the first time, a full listing and interpretation of the 1979 / 1981 / 1993 and 2003 survey results.

5 References

Bayliss B, Brennan K, Eliot I, Finlayson CM, Hall R, House T, Pidgeon R, Walden D & Waterman P 1997. *Vulnerability assessment of predicted climate change and sea level rise in the Alligator Rivers Region, Northern Territory Australia*. Supervising Scientist Report 123, Supervising Scientist, Canberra.

Eliot I, Finlayson CM and Waterman P. 1999. *Predicted climate change, sea-level rise and wetland management in the Australian wet-dry tropics*. Wetlands Ecology and Management 7, 63–81.

Eliot I, Saynor M, Eliot M & Finlayson CM 2000. *Assessment and monitoring of coastal change in the Alligator Rivers Region, northern Australia*. Supervising Scientist Report 157, Supervising Scientist, Darwin.

Hegerl EJ, Claridge GF, Davie PJF, Outridge PM, Shanco P & Stock EC 1982. *The Kakadu National Park mangrove forests and tidal marshes : Volume 4, preliminary results of field studies*. Australian Littoral Society, Brisbane : 32p + appendix of 13 revised field sheets.

International Panel on Climate Change 1995. *Climate Change 1995 – impacts, adaptations and mitigation of climate change : scientific – technical analyses*. International Panel on Climate Change, Cambridge University Press.

Johnston A & Prendergast B 1999. *Assessment of the Jabiluka Project: Report of the Supervising Scientist to the World Heritage Committee*. Supervising Scientist Report 138, Supervising Scientist, Canberra.

Finlayson CM 1999. Coastal wetlands and climate change: the role of governance and science. *Aquatic Conservation: Marine and Freshwater Ecosystems* 9, 621–626.

Finlayson et al 2002. Landscape-scale analyses – Kakadu National Park. Informal presentation, 4 Nov 2002.

Finlayson CM & Bayliss P 2003. Conceptual model of ecosystem processes and pathways for pollutant/propagule transport in the environment of the Alligator Rivers Region. Discussion paper (in prep).

Lucas RM, Ellison JC, Mitchell A, Donnelly B, Finlayson M & Milne AK. 2002 Use of aerial photography for quantifying changes in the extent and height of mangroves in tropical Australia. *Wetlands Ecology and Management* 10, 161–175.

World Heritage Committee 2000. Recommendations of the Independent Science Panel (ISP) of International Council of Science Unions (ICSU) and International Union for Nature Conservation (IUCN).

Appendix 1 Mangrove GPS points

The data are in Degrees & Decimal Minutes as well as Degrees Minutes & Seconds.

The datum used is WGS84.
(available in SSD Explorer: \\Coastal Monitoring of Alligator Rivers Region\Mangrove\East Alligator Mangrove transects\Data\Mangrove GPS.xls)

Transect 1. Located on the eastern near the tip of Point Farewell

Name	**South**						**East**					
	Degrees	Decimal Minutes	Degrees	Minutes	Seconds	Decimal Degrees	Degrees	Decimal Minutes	Degrees	Minutes	Seconds	Decimal Degrees
BM	12	5.418	12	5	25.08	12.0903	132	33.651	132	33	39.06	132.5609
2nd Pole	12	5.414	12	5	24.84	12.09023	132	33.661	132	33	39.66	132.561
3rd Pole	12	5.413	12	5	24.78	12.09022	132	33.669	132	33	40.14	132.5612
4th Pole	12	5.406	12	5	24.36	12.0901	132	33.681	132	33	40.86	132.5614
5th Pole	12	5.401	12	5	24.06	12.09002	132	33.697	132	33	41.82	132.5616
6th Pole	12	5.397	12	5	23.82	12.08995	132	33.704	132	33	42.24	132.5617
7th Pole	12	5.392	12	5	23.52	12.08987	132	33.717	132	33	43.02	132.562
8th Pole	12	5.391	12	5	23.46	12.08985	132	33.717	132	33	43.02	132.562
9th Pole	12	5.386	12	5	23.16	12.08977	132	33.727	132	33	43.62	132.5621
10th Pole	12	5.379	12	5	22.74	12.08965	132	33.733	132	33	43.98	132.5622
11th Pole	12	5.352	12	5	21.12	12.0892	132	33.749	132	33	44.94	132.5625
12th Pole	12	5.357	12	5	21.42	12.08928	132	33.743	132	33	44.58	132.5624
13th Pole	12	5.338	12	5	20.28	12.08897	132	33.756	132	33	45.36	132.5626
14th Pole	12	5.334	12	5	20.04	12.0889	132	33.758	132	33	45.48	132.5626
15th Pole	12	5.33	12	5	19.8	12.08883	132	33.763	132	33	45.78	132.5627
Sea end of transect	12	5.314	12	5	18.84	12.08857	132	33.771	132	33	46.26	132.5629

Transect 2. Located near the eastern tip of Point Farewell 80 m away from transect 1 at a bearing of 330 degrees

Name	**South**						**East**					
	Degrees	Decimal Minutes	Degrees	Minutes	Seconds	Decimal Degrees	Degrees	Decimal Minutes	Degrees	Minutes	Seconds	Decimal Degrees
K/T2/Q2/1	12	5.334	12	5	20.04	12.0889	132	33.683	132	33	40.98	132.5614
K/T2/Q2/4	12	5.34	12	5	20.4	12.089	132	33.689	132	33	41.34	132.5615
	12	5.335	12	5	20.1	12.08892	132	33.691	132	33	41.46	132.5615

Transect 5. Located on the Left Bank of the Creek that flows into Van Diemen Gulf just to the South West of Point Farewell

Name	**South**						**East**					
	Degrees	Decimal Minutes	Degrees	Minutes	Seconds	Decimal Degrees	Degrees	Decimal Minutes	Degrees	Minutes	Seconds	Decimal Degrees
K/T5/Q1/1	12	5.995	12	5	59.7	12.09992	132	33.215	132	33	12.9	132.5536
K/T5/Q2/1	12	5.974	12	5	58.44	12.09957	132	33.223	132	33	13.38	132.5537
K/T5/Q3/1	12	5.957	12	5	57.42	12.09928	132	33.228	132	33	13.68	132.5538
K/T5/Q3/2	12	5.957	12	5	57.42	12.09928	132	33.232	132	33	13.92	132.5539
Benchmark	12	6.1	12	6	6	12.10167	132	33.226	132	33	13.56	132.5538

Transect 6 Located to the east of Point Farewell along the left bank of the East Alligator river

Name	**South**						**East**					
	Degrees	Decimal Minutes	Degrees	Minutes	Seconds	Decimal Degrees	Degrees	Decimal Minutes	Degrees	Minutes	Seconds	Decimal Degrees
K/T6/1	12	6.454	12	6	27.24	12.10757	132	34.537	132	34	32.22	132.5756
K/T6/Q1/1 ???	12	6.452	12	6	27.12	12.10753	132	34.538	132	34	32.28	132.5756
K/T6/Q1/2	12	6.449	12	6	26.94	12.10748	132	34.545	132	34	32.7	132.5758
K/T6/2	12	6.449	12	6	26.94	12.10748	132	34.55	132	34	33	132.5758
K/T6/3	12	6.442	12	6	26.52	12.10737	132	34.559	132	34	33.54	132.576
K/T6/Q2/1	12	6.437	12	6	26.22	12.10728	132	34.564	132	34	33.84	132.5761
K/T6/Q2/2	12	6.435	12	6	26.1	12.10725	132	34.571	132	34	34.26	132.5762
K/T6/Q3/1	12	6.428	12	6	25.68	12.10713	132	34.578	132	34	34.68	132.5763

Transect 7. Located along the left bank of the East Alligator river between the ridge of land to the east of the salt water intrusion site and the coast a short transect as one of quadrats was lost prior to the 1992/3 survey

Name	**South**						**East**					
	Degrees	Decimal Minutes	Degrees	Minutes	Seconds	Decimal Degrees	Degrees	Decimal Minutes	Degrees	Minutes	Seconds	Decimal Degrees
K/T7/1	12	8.034	12	8	2.04	12.1339	132	40.148	132	40	8.88	132.6691
K/T7/Q1/1	12	8.029	12	8	1.74	12.13382	132	40.151	132	40	9.06	132.6692
Benchmark	12	8.098	12	8	5.88	12.13497	132	40.116	132	40	6.96	132.6686

Transect 3 . Located on the Magela Creek several bends from the mouth

Name	**South**						**East**					
	Degrees	Decimal Minutes	Degrees	Minutes	Seconds	Decimal Degrees	Degrees	Decimal Minutes	Degrees	Minutes	Seconds	Decimal Degrees
K/T3/1	12	15.881	12	15	52.86	12.26468	132	51.856	132	51	51.36	132.8643
K/T3/Q1/4	12	15.849	12	15	50.94	12.26415	132	51.833	132	51	49.98	132.8639
K/T3/Q1/2	12	15.85	12	15	51	12.26417	132	51.826	132	51	49.56	132.8638
K/T3/2	12	15.841	12	15	50.46	12.26402	132	51.819	132	51	49.14	132.8637
K/T3/2	12	15.838	12	15	50.28	12.26397	132	51.814	132	51	48.84	132.8636
K/T3/Q2/1	12	15.835	12	15	50.1	12.26392	132	51.81	132	51	48.6	132.8635
K/T3/Q2/2	12	15.832	12	15	49.92	12.26387	132	51.808	132	51	48.48	132.8635

Transect 4. Located on Flying Fox Island (East Alligator River) running in a straight line East West (90 to 270)

Name	**South**						**East**					
	Degrees	Decimal Minutes	Degrees	Minutes	Seconds	Decimal Degrees	Degrees	Decimal Minutes	Degrees	Minutes	Seconds	Decimal Degrees
K/T4/Q5/1	12	13.343	12	13	20.58	12.22238	132	49.543	132	49	32.58	132.8257
K/T4/6	12	13.344	12	13	20.64	12.2224	132	49.559	132	49	33.54	132.826
K/T4/Q4/4	12	13.345	12	13	20.7	12.22242	132	49.573	132	49	34.38	132.8262
K/T4/Q4/1	12	13.347	12	13	20.82	12.22245	132	49.576	132	49	34.56	132.8263
K/T4/Q3/2	12	13.348	12	13	20.88	12.22247	132	49.597	132	49	35.82	132.8266
K/T4/Q3/1	12	13.348	12	13	20.88	12.22247	132	49.603	132	49	36.18	132.8267
K/T4/5	12	13.352	12	13	21.12	12.22253	132	49.635	132	49	38.1	132.8273
K/T4 Near Benchmark	12	13.353	12	13	21.18	12.22255	132	49.646	132	49	38.76	132.8274
K/T4/4	12	13.353	12	13	21.18	12.22255	132	49.655	132	49	39.3	132.8276
K/T4/Q2/2	12	13.352	12	13	21.12	12.22253	132	49.663	132	49	39.78	132.8277
K/T4/Q2/1	12	13.354	12	13	21.24	12.22257	132	49.668	132	49	40.08	132.8278
K/T4/3	12	13.355	12	13	21.3	12.22258	132	49.679	132	49	40.74	132.828
K/T4/2	12	13.353	12	13	21.18	12.22255	132	49.689	132	49	41.34	132.8282
K/T4/Q1/2	12	13.354	12	13	21.24	12.22257	132	49.696	132	49	41.76	132.8283
K/T4/Q1/1	12	13.356	12	13	21.36	12.2226	132	49.704	132	49	42.24	132.8284
K/T4/1C	12	13.355	12	13	21.3	12.22258	132	49.719	132	49	43.14	132.8287
K/T4/1B	12	13.356	12	13	21.36	12.2226	132	49.721	132	49	43.26	132.8287
K/T4/1A	12	13.357	12	13	21.42	12.22262	132	49.723	132	49	43.38	132.8287

Appendix 2 Site details of installed quadrats

Site details of quadrats installed in 1981 and reinstated in 1993 (Source: G Claridge, pers. comm.).

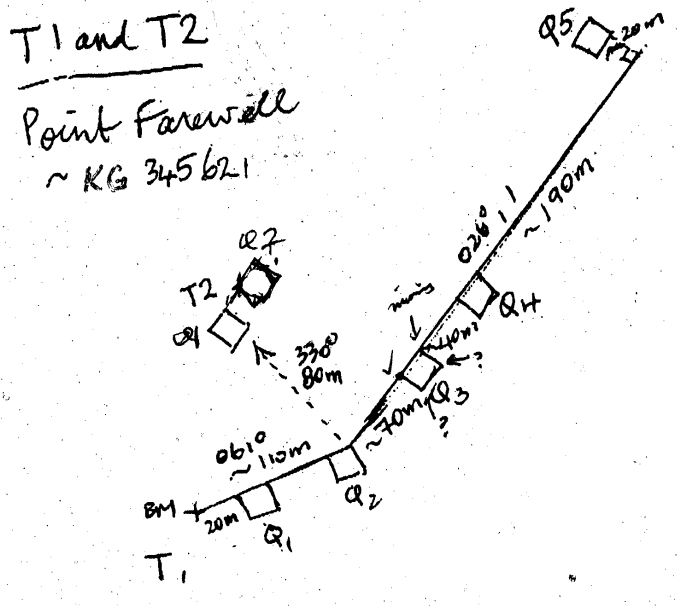
SITE DETAILS OF QUADRATS USED[1] FOR MONITORING INTERTIDAL WETLANDS, KAKADU NATIONAL PARK

Site Code		Name	Location[2]		Year of Quadrat Measurement			Comments
Transect	Quadrat		AMG	GPS	1981	1982	1993	
T1	Q1	Point Farewell	KG345621	234301 mE 8662094 mN	Y		Y	
	Q2			(at pole T1/BR1)	Y		Y	
	Q3					Y	Y	
	Q4					Y	Y	
	Q5					NA	N	Q5 not measured in 1993 as quadrat could not be located in the field
T2	Q1	Point Farewell	KG345621	234301 mE 8662094 mN		Y	Y	
	Q2			(at pole T1/BR1)		Y	Y	
T3	Q1	"Magela Creek"	KG675431	12° 15.944' S 132° 51.814' E		Y	Y	
	Q2			(helicopter site)		Y	Y	
	Q3					(Y)		Grassland; no trees tagged
T4	Q1	Flying Fox Island	KG635478	Not available		Y	Y	
	Q2					Y	Y	
	Q3					Y	Y	
	Q4					Y	Y	
	Q5					Y	Y	
T5	Q1	West side Point	KG337611	Not available		Y	Y	
	Q2	Farewell				Y	Y	
	Q3					Y	Y	
	Q4					Y	Y	
	Q5					Y	Y	
	Q5A						Y	
T6	Q1	West bank of East	KG368602	12° 06.522' S 132° 34.518' E		Y	Y	
	Q2	Alligator River,		(helicopter site)		Y	Y	
	Q3	SE Point Farewell				Y	Y	
	Q4	(about 2 km from				Y	Y	
	Q5	T1)				Y	Y	
T7	Q1	West bank of	KG462574	Not available		Y	Y	
	Q2	East Alligator River opposite mouth of Cooper Creek				Y	-	Q2 missing in 1993; lost to erosion

1. Quadrats installed in 1981 and 1982 by an Australian Littoral Society field team; remeasured and reinstated in 1993 by at least two of members from a small team (E. Stock, P. Davie, N. Good and T. Broderick)
2. Location: AMG reference interpolated on East Alligator 1:100 000 topographic map; GPS coordinates (lat. long.) from helicopter instrument panel or (AMG) from hand-held model

T1 and T2

Point Farewell
~ KG 345621



All bearings magnetic in 1982.

Drawings NOT TO SCALE

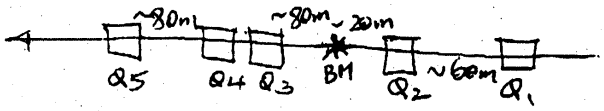
T3 "Magela Ck" KG 675431

average bearing of transect 318° from BM

~ 70m to Q1
~ 30m to Q2
~ 30m to Q3

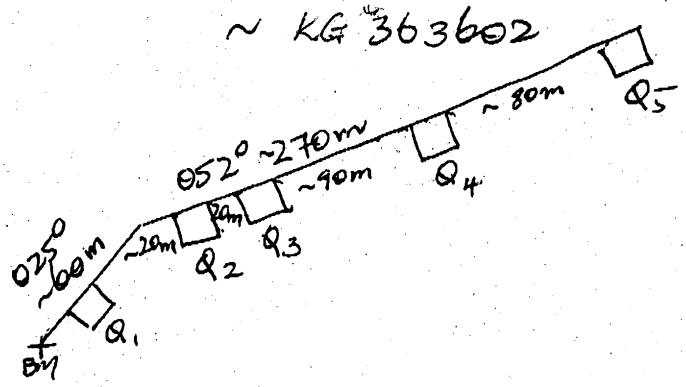
T4 "Flying Fox Island" KG 635478

transect oriented East-West magnetic 1982
transect started from east side of island

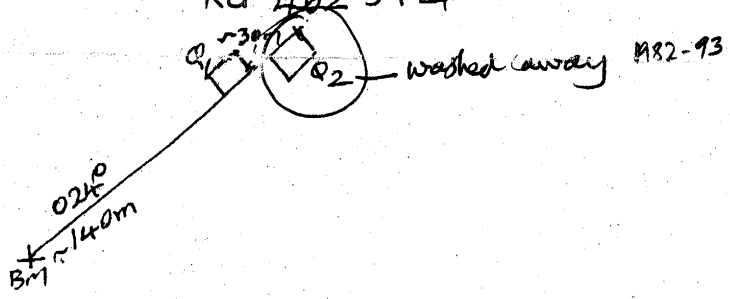


distances approx.

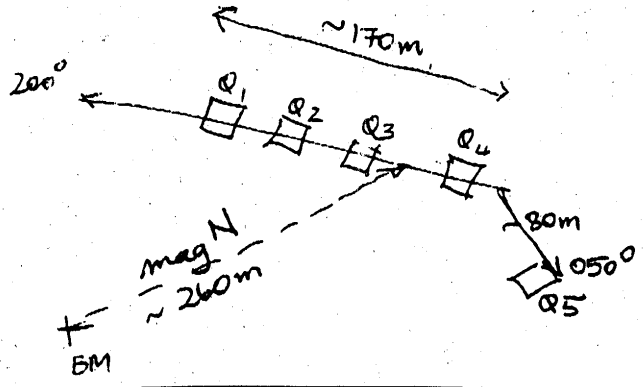
T6 West bank East Alligator River
Near mouth, southeast Point Farewell
~ KG 363602



T7 West bank East Alligator River
opposite mouth of Cooper Ck
~ KG 462 574



T5 West side Pt Farewell
~ KG 337 611



Appendix 3 Aerial photographs (steep obliques) of transects in 1981, 1992 and 2002

1981

Aerial view of Transect 1 & 2 1981. Photo Gordon Claridge

Aerial of Transect 3 at Magela Creek June 1981. Photo Gordon Claridge

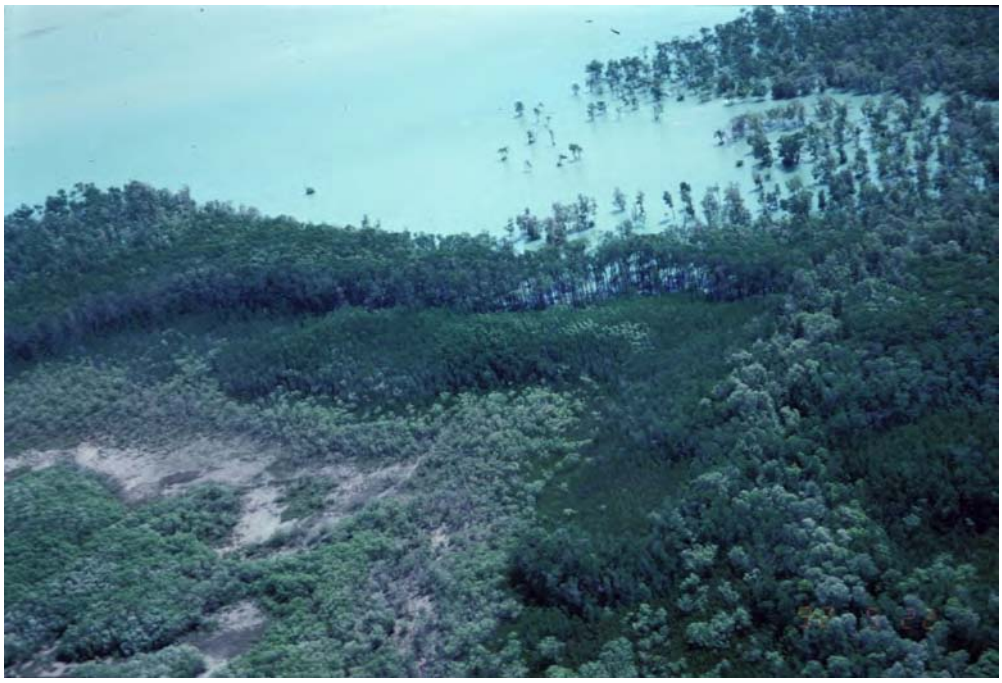
Landward part of Transect 6 June 1981. Photo Gordon Claridge

1992

Aerial view of Transect 1 & 2, 22 May 1992. Photo Gordon Claridge

Different angle aerial shot of transect 3 at Magela Creek 22 May 1992. Photo Gordon Claridge

Transect 4 on Flying fox Island 22 May 1992. Photo Gordon Claridge



Aerial view of transect 5 west of Point Farewell 22 May 1992. Photo Gordon Claridge

2002

Aerial view along Transect 1 - Point Farewell 7 Oct 2002. Photo Mike Saynor

Transect 3 on Magela Creek Bends 7 Oct 2002. Photo Mike Saynor

Aerial shot along transect 5 just West of Point Farewell 7 Oct 2002. Photo Mike Saynor

Aerial shot along transect 6 just east of Point Farewell 7 Oct 2002. Photo Mike Saynor

Appendix 4 Contact details of key personnel

Mr Mike Saynor

Environmental Research Institute of the Supervising Scientist

PO Box 461, Darwin, Northern Territory, 0801

Ph: (08) 8920 0151

e-mail: Mike.Saynor@ea.gov.au

Dr Gordon Claridge

Aust /Asia Environmental Pty Ltd

P.O.Box 529, Gatton Qld. 4343 Australia

Ph: (07) 5462 1028

mobile: 0401 346036

fax to email ++ 31 20 524 1620

e mail: austasia@compuserve.com

Dr Errol Stock

Faculty of Environmental Sciences

Griffith University, Nathan Qld. 4111

Office Telephone: (07) 3875 7485

Email: E.Stock@mailbox.gu.edu.au

Fax: 07 38757459

Appendix 5 Copies of permits obtained

Research permit

COMMONWEALTH OF AUSTRALIA

Environment Protection and Biodiversity Conservation Regulations 2000

Permit for Activity in a Commonwealth Reserve

Reserve For Which Permit Issued	Kakadu National Park
Date of Issue:	Monday, 23 September 2002
Permit valid: 1/10/2002 to 16/09/2002	**Permit Number: RK** 581

Name / address of each person/group to whom permit issued	Dr Max Finlayson Environmental Research Institute of Supervising Scientists PO Box 461 Darwin NT 0801

Provision of Regulations for which permit issued **Regulations 12.06(c) and 12.10**

Research Permitted:

Mangrove transects - GPS marking of existing mangrove transects

Area permitted:

East Alligator River, Point Farewell

Permit Participants:

Dr Gordon Claridge, Dr George Begg, Micheal Saynor

Special Conditions:

Helicopter landing permit required

Report Due:

16/01/2003

Report Details:

As per permit condition # 10

Only these vehicles/vessels/tour guides may be used in the conduct of tours unless prior written approval is obtained from the Director of National Parks to use other vehicles/tour guides.

Failure to adhere to the conditions overleaf is an offence and may also result in suspension or cancellation of this permit.

Delegate

DIRECTOR OF NATIONAL PARKS

Helicopter Landing permit

Kakadu National Park

P.O. Box 71,
Jabiru, N.T. 0886

Phone (08) 8938 1100
Fax (08) 8938 1115

File 29.9

12 September 2002

Permit No. CI
CI21/2002

Manager
Jayrow Helicopters
Jabiru Airport
Jabiru

Dear Sir

PERMISSION TO LAND A HELICOPTER IN KAKADU NATIONAL PARK

Permission is given to **Jayrow Helicopters** on behalf of **Mike Saynor of ERISS** to land a helicopter in Kakadu National Park in the vicinity of **Point Farwell** or as directed by the Public Relations Officer, during the period **7 October 2002** and is subject to the following conditions:

1. It is the responsibility of the pilot to ascertain whether the proposed landing place meets the relevant standards, and is suitable for the particular aircraft in use.

2. This permit is conditional on approval to land being granted by relevant Aboriginal traditional owners. This approval shall be sought by ERISS in co-operation with and the knowledge of Dr. Rod Kennett.

3. This permit is valid only when used in combination with a Kakadu research Permit.

4. The aircraft must be able to land and take off without damage to the environment or interfere with wildlife.

3. The Permittee should keep to a minimum any disturbance to Park visitors in the vicinity.

4. The Permittee and a witness shall sign and attest the Indemnity below and return one copy to the Park Manager, Kakadu National Park Headquarters, prior to commencing activities in the Park under this permission.

Thank you for your cooperation.

Yours sincerely,

Chris Haynes
Park Manager
Kakadu National Park

Appendix 6 Chronology of previous work carried out on East Alligator and reference details

- Historical aerial photography includes coverage in 1943, 1950, 1975, 1984, 1991 and limited coverage in 1996.
- The surveys by Harry Messel (Univ. Sydney) undertaken in 1977 / 78 contain information on the distribution and cover abundance of mangroves in the East Alligator estuary. (See : *Messel H H, Wells AG & Green WJ. 1979. The Alligator Region river systems, Murgenella and Coopers Creek, East, South & West Alligator rivers and Wildman river. In: Surveys of tidal river systems in the Northern Territory of Australia and their crocodile populations. Monograph (4), 70 pp: Pergammon Press, Sydney*).
- The reconnaissance survey conducted by the Australian Littoral Society in 1979 and their subsequent detailed survey in 1981 contains the baseline information on a wide range of fauna and flora. (See : *Hegerl E J, Claridge G F, Davie P J F, Outridge P M, Shanco P and Stock E C. 1982. The Kakadu National Park mangrove forests and tidal marshes : Volume 4, preliminary results of field studies. Australain Littoral Society, Brisbane : 32p + appendix of 13 revised field sheets*).
- A collection of fish and prawns was made in the East Alligator in the late 1980's by Davis & May. (See : *Davis TLO and May JL. 1989. On a collection of fish and prawns from the East Alligator estuary, KNP, Australia. The Beagle (records of the NT Museum of Arts & Sciences) 6 (1): 157 –161*.)
- In the dry season of 1993 the factors influencing leaf litter processing in the *Rhizophora* community was investigated. (See : *Good N M.1994. Factors influencing leaf litter processing in subtropical and tropical Australia. Hons. Thesis, School of Environmental studies, Griffith University, Brisbane*.)
- In 1997 Stephanie Cobb undertook some mangrove mapping work on the East Alligator at a salt water intrusion site east of Point Farewell, but limited ground analyses were undertaken. (See : *Cobb SM 1998. Channel extension and the geomorphology of tidal creeks in Kakadu National Park, Northern Territory. Internal report 280, Supervising Scientist, Canberra. Unpublished paper*).
- A number of steep obliques of Magela / East Alligator confluence were taken in June 1997 and Feb 1998. (See : *Saynor MJ & Erskine WD 1998. Dry and Wet season aerial reconnaissance of Magela Creek and East Alligator River, with brief notes on the geomorphology of the area. October 1998, Internal Report 305, Supervising Scientist, Canberra. Unpublished paper*.)
- Data on element concentrations in the flesh and osteoderms of estuarine crocodiles from the East Alligator from samples taken in 1996 (See : *Jeffree R A et al, 2001 – Arch. Environ. Contam. Toxicol. 40, 236 – 245*)
- A number of steep obliques and digital photos were taken of the Magela / East Alligator confluence in April 2002.
- Using TM satellite imagery the DPI (Queensland) have recently produced a map of mangrove distribution on the East Alligator (copy with John Lowry).

Appendix 7 Photograph names and dates taken

Directory	\\Coastal Monitoring of Alligator Rivers Region\Mangrove\East Alligator Mangrove transects\Photographs\2002\Slide Copies taken by M.J. Saynor	
1	Marker pole for Transect 1 towards the Sea	07-Oct-02
2	Marker pole for Transect 1away from the Sea	07-Oct-02
3	Painted marker pole and benchmark Transect 1	07-Oct-02
4	Shell beach ridge deposit near Point Farewell	07-Oct-02
5	Shell beach ridge deposit near Point farewell	07-Oct-02
6	Mangrove deliniation East of Point Farewell	07-Oct-02
7	Aerial shot along Transect 1 - Point Farewell	07-Oct-02
7	With line Aerial shot along Transect 1 - Point Farewell	07-Oct-02
8	Aerial shot along Transect 1 - Point Farewell	07-Oct-02
9	Aerial shot along Transect 1 - Point Farewell	07-Oct-02
9	line Aerial shot along Transect 1 - Point Farewell	07-Oct-02
10	Looking East from over Point Farewell	07-Oct-02
11	Looking seaward from end of transect 5	07-Oct-02
12	Steve Hegge in mangroves on transect 5	07-Oct-02
13	Looking seaward from end of transect 5	07-Oct-02
14	Storm damage at end of transect 5	07-Oct-02
15	Larry (pilot) points to benchmark for transect 5	07-Oct-02
16	Benchmark for transect 5	07-Oct-02
17	Looking along transect 5	07-Oct-02
18	Looking along transect 5	07-Oct-02
19	Aerial shot along transect 5	07-Oct-02
19	line Aerial shot along transect 5	07-Oct-02
20	Aerial shot along transect 5	07-Oct-02
21	Salt flats and Mangroves	07-Oct-02
22	Mangroves in area near transect 6	07-Oct-02
23	Large storm surge debris	07-Oct-02
24	Large storm surge debris	07-Oct-02
25	Along Mangroves towards Point Farewell near T5	07-Oct-02
26	Aerial shot along transect 6	07-Oct-02
27	Mangrove near transect 6	07-Oct-02
28	seaward side of Mangroves at low tide	07-Oct-02
29	Mangrove & coastline east of Point Farewell	07-Oct-02
30	Mangrove & coastline east of Point Farewell	07-Oct-02
31	Outlet mouth of Point Farewell saltwater instrusion creek	07-Oct-02
32	Mangroves & sand deposits near transect 7	07-Oct-02
33	Overbank salt deposition LB East Alligator	07-Oct-02
34	Sand bar in East Alligator DS of Flying Fox Island	07-Oct-02
35	North side of Flying Fox Island lowish tide	07-Oct-02

36	East Alligator US of Flying Fox island	07-Oct-02
37	Sand bar on East Alligator DS of Magela	07-Oct-02
38	Magela Creek in section where it flows near the East Alligator	07-Oct-02
39	Magela Creek Bends US from East Alligator 3	07-Oct-02
40	Looking US on Magela from end of transect 3	07-Oct-02
41	Looking DS on Magela from end of transect 3	07-Oct-02
42	Magela Creek just US of transect 3	07-Oct-02
43	East Alliagator upstream of Magela	07-Oct-02
44	Interesting circular depression on Koolpinyah surface	07-Oct-02
45	Billabong with Buffalo swim channels North of Cannon Hill	07-Oct-02
46	Landscape near Cannon Hill	07-Oct-02
47	Flying Over Ubirr Rock	07-Oct-02
48	Looking towards East Alligator Gorge	07-Oct-02
Directory	**\\Coastal Monitoring of Alligator Rivers Region\Mangrove\East Alligator Mangrove transects\Photographs\2002\Digital MJS taken by MJ Saynor**	
1	BM Pole Transect 1 looking away	07-Oct-02
2	BM Pole Transect 1 looking along line	07-Oct-02
3	BM & Pole for Transect 1	07-Oct-02
4	Second pole Transect 1	07-Oct-02
5	3rd pole transect 1	07-Oct-02
6	Fourth Pole Transect 1	07-Oct-02
7	5th pole transect 1	07-Oct-02
8	6th Pole transect 1	07-Oct-02
9	7th Pole transect 1	07-Oct-02
10	8th Pole transect 1	07-Oct-02
11	9th Pole transect 1	07-Oct-02
12	10 Pole Transect 1	07-Oct-02
13	11th Pole transect 1	07-Oct-02
14	12 Pole transect 1	07-Oct-02
15	13 Pole transect 1	07-Oct-02
16	14 Pole transect 1	07-Oct-02
17	15th Pole transect 1	07-Oct-02
18	Steve H tying flagging tape at End of transect 1	07-Oct-02
19	Looking from last visible peg (T1) out to sea	07-Oct-02
20	Looking from last visible peg (T1) out to sea	07-Oct-02
21	Not sure which peg this is on transect 1	07-Oct-02
22	Shell beach ridge deposit near Point farewell	07-Oct-02
23	Shell beach ridge deposit near Point farewell	07-Oct-02
24	Peg on transect 2 no GPS	07-Oct-02
25	In the mangroves near transect 5	07-Oct-02
26	In the mangroves near transect 5	07-Oct-02
27	Transect 5 T5-Q1-1	07-Oct-02

28	Transect 5 T5-Q2-1	07-Oct-02
29	Transect 5 T5-Q3-1	07-Oct-02
30	Transect 5 T5-Q3-2	07-Oct-02
31	Steve H in the mangroves at Transect 5 Point Farewell	07-Oct-02
32	Gordon Claridge in the mangroves at Transect 5 Point Farewell	07-Oct-02
33	Transect 5 T5-Q4	07-Oct-02
34	Looking out from end of Transect 5	07-Oct-02
35	Bench mark for Transect 5 5	07-Oct-02
36	Bench mark for Transect 5 & helicopter (VH-BLJ)	07-Oct-02
37	Transect 6 K-T6-1 first peg	07-Oct-02
38	Transect 6 T6-Q1-1	07-Oct-02
39	TRansect 6 K-T6-Q1-2	07-Oct-02
40	Transect 6 T6-2	07-Oct-02
41	Transect 6 T6-3	07-Oct-02
42	Transect 6 T6-Q2-1	07-Oct-02
43	Transect 6 T6-Q2-2	07-Oct-02
44	Transect 6 T6-Q3-1	07-Oct-02
45	Transect 6 In mangroves T6-4 no satelites	07-Oct-02
46	Transect 7 T7-1	07-Oct-02
47	Transect 7 T7-Q1-1	07-Oct-02
48	Benchmark for Transect 7	07-Oct-02
49	Benchmark for Transect 7	07-Oct-02
50	Transect 3 T3-1	07-Oct-02
51	Transect 3 T3-Q1-4	07-Oct-02
52	Transect 3 T3-1-Q1-2	07-Oct-02
53	Transect 3 T3-2	07-Oct-02
54	Transect 3 T3-3	07-Oct-02
55	Transect 3 T3-Q2-1	07-Oct-02
56	Transect 3 T3-Q2-2	07-Oct-02
57	End of Transect 3 looking out to Magela Creek	07-Oct-02
58	Transect T4 T4-Q5-1	08-Oct-02
59	Transect 4 T4-6	08-Oct-02
60	Transect 4 T4-Q4-4	08-Oct-02
61	Transect 4 T4-Q4-1	08-Oct-02
62	Transect 4 T4-Q3-2	08-Oct-02
63	Transect 4 T4-Q3-1	08-Oct-02
64	Transect 4 T4-5	08-Oct-02
65	Transect 4 Near Benchmark	08-Oct-02
66	Transect 4 T4-4	08-Oct-02
67	Transect 4 T4-Q2-2	08-Oct-02
68	Transect 4 T4-Q2-1	08-Oct-02

69	Transect 4 T4-3	08-Oct-02
70	Transect 4 T4-2	08-Oct-02
71	Transect 4 T4-Q1-2	08-Oct-02
72	Transect T4 T4-Q1-1	08-Oct-02
73	Transect 4 T4-1C	08-Oct-02
74	Transect 4 T4-1B	08-Oct-02
75	Transect 4 T4-1A	08-Oct-02
76	looking out from the end of transect 4 Flying Fox Island	08-Oct-02
77	Looking along T4 (Flying Fox) from pegs 1A-B&C	08-Oct-02
78	Flying Fox dissappears behind	08-Oct-02
Directory	**\\Coastal Monitoring of Alligator Rivers Region\Mangrove\East Alligator Mangrove transects\Photographs\2002\Digital GC taken by Gordon Claridge**	**..**
1	GC T1 aerial	07-Oct-02
2	GC T1 seaward	07-Oct-02
3	GC T5 aerial	07-Oct-02
4	GC T5 seaward at bend	07-Oct-02
5	GC Tree tag on Mangrove	07-Oct-02
6	GC T6 rhizophora	07-Oct-02
7	GC T6 seaward	07-Oct-02
8	GC Tree tag	07-Oct-02
9	GC T1 crocodile	07-Oct-02
Directory	**\\Coastal Monitoring of Alligator Rivers Region\Mangrove\East Alligator Mangrove transects\Photographs\1992 taken by Gordon Claridge**	
1	1992 Aerial view of Flying fox Island G-Claridge	22-May-92
2	1992 Flying fox Island G-Claridge	22-May-92
3	1992 T1 & T2 Looking back over T1 & T2	22-May-92
4	1992 T1 Aerial view of T1 G-Claridge	22-May-92
5	1992 T3 Diiferent angle Aerial shot of Magela Creek	22-May-92
6	1992 T5 Aerial view of transect 5	22-May-92
Directory	**\\Coastal Monitoring of Alligator Rivers Region\Mangrove\East Alligator Mangrove transects\Photographs\1981 taken by Gordon Claridge**	
1	Buffalo tracks - East Alligator funnel June 1981.JPG	Jun-81
2	T1 Aerial view of T1 & T2 G-Claridge 1981.JPG	Jun-81
3	T1 Amongst mangroves at seaward end of T1 G-Claridge 1981.JPG	Jun-81
4	T1 Seaward end amongst mangroves of T1 G-Claridge 1981.JPG	Jun-81
5	T3 Aerial of Magela Creek June 1981.JPG	Jun-81
6	T3 In Trees at Magela Creek transect 3 1981.JPG	Jun-81
7	T3 Magela Creek Bend opposite T3 G-Claridge 1981.JPG	Jun-81
8	T3 Magela Creek Quadrat G-Claridge 1981.JPG	Jun-81
9	T4 Flying Fox island T4Q4 G-Claridge 1981.JPG	Jun-81
10	T6 Landward part of T6 G-Claridge 1981.JPG	Jun-81