

# NATURE TERRITORY

February 2010

Newsletter of the Northern Territory Field Naturalists Club Inc.

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**Meetings** are generally held on the second Wednesday of every month, commencing at 7:45 PM, in Blue1.1.14 (Business Faculty Building) on the Casuarina Campus of Charles Darwin University.

**Subscriptions** are on a financial-year basis and are: Families/Institutional - \$30; Singles - \$25; Concessions - \$15. Part-year discounts are available for new members from January 1 each year.



This magical sunrise at Knuckeyes Lagoon was photographed by Keith McGuinness. More of Keith's photos taken at the lagoon are featured on page 5.

## CONTENTS

<b>Club activities .. p2</b>	<b>Club notices .. p3</b>
<b>WW Hoare .. p4</b>	<b>Knuckeyes Lagoon .. p5</b>
<b>wildlife crime .. p7-8</b>	<b>land management .. p6</b>
<b>bird observations .. p9</b>	<b>recent literature .. p10</b>

## Club activities

**Goyder's Day re-enactment.** Friday Feb. 5, 5:30 – 8 PM.  
Re-enactment of this historic event – the arrival of Surveyor-General George Goyder and his Northern Territory Survey Expedition at Port Darwin on 5 Feb. 1869 – will commence at 5:30 PM. Location: Darwin: The Foreshore, End of Jervois Rd, Off Kitchener Drive (near the Deckchair cinema). Displays (including by NTFNC and TENPS), hands-on activities, hand-outs & light refreshments will be available. For more information, contact Deb Jones of the National Trust on 8981 2848 or email [events.ntnt@internode.on.net](mailto:events.ntnt@internode.on.net).



The Expedition's illustrator, William Hoare, produced this untitled painting of crabs (SLSA: PRG 294/4/16) whilst in the Top End. For more information about Hoare and his work in the Top End, see page 4.

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**February meeting.** Wednesday February 10, 7:45 PM. Blue1.1.14 (Business Bldg.), CDU.

### Gay Crowley

#### "Landscapes and land use in Turkey"

Turkey has a long and fascinating human history. You would expect it to have little left in the way of natural landscapes. This is certainly the case in Istanbul, with its mosques, museums and markets. However, all along the Mediterranean coast, gravelly donkey trails linking small villages pass through vast expanses of forest. In central Antalya, it is hard to tell where landforms end and landuse begins, with churches built into cliff faces and villages extending seven storeys underground. Gay will take you on a whirlwind tour of Turkey, visiting some of these remarkable places along the way.

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**February field trip: East Point in the Wet.**

Sunday Feb. 14, commencing at 9AM. Meet at the carpark outside Peeweess.

It is the season of fruits and butterflies in the vine-thicket, and the Rainbow Pittas should be calling well. This is a general natural history excursion to be led by Fiona Douglas and Don Franklin. Come prepared for the conditions, whatever they may be; binoculars, camera and/or field guides may be handy. For more information, contact Fiona on 8985 4179 or [fiona.douglas@octa4.net.au](mailto:fiona.douglas@octa4.net.au).

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**March 2010 meeting.** Wednesday March 10. Richard Noske: *Birds and Bird Tourism in Papua.*

**April 2010 meeting.** Wednesday April 14. Steven Reynolds: *Pig-nosed Turtles and the Kikori region of Papua New Guinea.*

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## Top End Native Plant Society activities

**February field trip.** Census of the ground orchid *Nervilia peltata*, Sunday Feb. 21. Meet at the Charles Darwin National Park picnic ground carpark at 8:30 AM..

**March meeting.** Thurs. Mar. 18. Ben Stuckey: *The Wildflowers of the Darwin region web-site.*

**March field trip.** Survey of the cryptic, threatened herb *Typhonium taylori* in the Howard River system, Sunday March 21. Meet at the corner of the Stuart Hwy and Girraween Road at 8:30 AM.

General meetings are held on the 3<sup>rd</sup> Thursday of the month at the Marrara Christian College, corner Amy Johnson Ave. and McMillans Road, and commence at 7:30 PM (speaker at 8 PM). For more information, contact Russell Dempster on 8983 2131.

# Club notices

## Thank you

The previous issue was proof-read by **Christine Maas** and collated and mailed by **Susan Jacups**. It was printed by **Gay Crowley** and **Don Franklin** using equipment kindly made available by **Collections, Biodiversity and Biological Parks** from the Department of Natural Resources, Environment, the Arts & Sport, and the **School for Environmental Research** at Charles Darwin University.

## Change of meeting room number

No, we have NOT shifted meeting room; CDU has changed the room number (again!). It is now Blue1.1.14.

## Newsletter contributions welcome

Sightings, reports, travelogues, reviews, photographs, sketches, news, comments, opinions, theories ..... , anything relevant to natural history. Please forward material to Don at [eucalypt@octa4.net.au](mailto:eucalypt@octa4.net.au) or the Club's postal address, or contact him on 8948 1293.

Deadline for the March newsletter: Friday February 19.

**Need a Club membership form?** Go to: <http://sites.google.com/site/ntfieldnaturalists/membership-1>.

## Club library

The Club's journal and book collection is available to members. Lists of holdings can be found on our website: <http://sites.google.com/site/ntfieldnaturalists/home/library/>. The library is housed in two sections:

**Books, reports and CDs:** at the medical clinic of Dr. Lyn Reid in the Rapid Creek Business Village. This can be accessed directly between 9 AM and 2:30 PM Tuesday to Thursday, and 4–6 PM on Tuesday, or indirectly by phoning Lyn at work on 8985 3250.

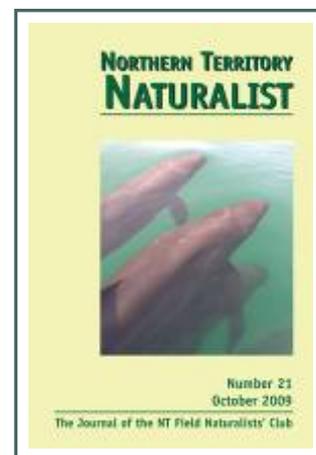
**Journals:** in the office of Don Franklin at CDU Casuarina (Red 1.2.34 = room 31.2.34). These can be accessed directly during working hours, or by ringing Don on 8946 6976 (w) or 8948 1293 (h).

## Northern Territory Naturalist

The Editorial Committee of the Club's journal, the *Northern Territory Naturalist*, is now calling for manuscripts for issue no. 22. The journal publishes works concerning any aspect of the natural history and ecology of the Northern Territory or adjacent areas of northern Australia. and may include Research Papers (Articles or Short Notes), Reviews and Species Profiles.

The *Northern Territory Naturalist* is a registered, peer-reviewed journal (ISSN 0155-4093). Author instructions may be downloaded from <http://sites.google.com/site/ntfieldnaturalists/home/journal>. If possible, manuscripts should be submitted in digital form by emailing to [michael.braby@nt.gov.au](mailto:michael.braby@nt.gov.au). Editors of the journal are Dr Lynda Prior, Dr Michael Braby and Dr Chris Tracy.

Back issues of the *Northern Territory Naturalist* are available individually (some are out of print and available as photocopies only) or as a set. The cost of a set is \$50- for nos. 1-20 or \$60- for nos. 1-21. Contact Don Franklin, [eucalypt@octa4.net.au](mailto:eucalypt@octa4.net.au).



## Sewage Pond Keys – Leanyer and Alice Springs

NT Field Naturalists have access to this world-famous bird-watching spot. The key can be collected from Graham Brown (h) 8945 4745. A refundable \$50.00 deposit is required at time of collecting the key, which is available only to members. Conditions imposed by PowerWater Corporation apply to all visitors to the ponds. These are not onerous and are made clear at time of picking up the keys.

Bryan Baker has keys for the Alice Springs Sewage Ponds, available for collection in Darwin by members before they head south. Bryan can be reached in Darwin on 8948 2196.

## William Hoare – natural history illustrator

The Northern Territory Survey Expedition under the leadership of George Goyder arrived by boat at Port Darwin on 5 Feb. 1869. The Expedition included the naturalist Friedrich Schultze and the surgeon's assistant William Webster Hoare. During the expedition's stay in the Top End, Schultze collected about 8,000 natural history specimens, and a number of plants were named after him – for example, the Kapok Mangrove *Camptostemon schultzei*.

However, it was the surgeon's assistant that perhaps left the greater natural history legacy. Goyder apparently recognised Hoare's ability as an illustrator and encouraged his activity. He painted landscapes and Aboriginal artefacts as well as "perishable specimens of Natural History". The images included here are of paintings held in the State Library of South Australia (SLSA) and reproduced with permission. You can view more of Hoare's paintings at <http://images.slsa.sa.gov.au/samemory/FoundationDocuments/PRG294/4/>. [Notes compiled from a variety of sources provided by Brigid Oulsnam.]

Below, a mistletoe, labelled as *Amyema loranthacea*. (SLSA PRG 294/4/1)



Above: untitled lily, possibly *Crinum angustifolium*. (SLSA PRG 294/4/5)

Below: the fish *Gerres filamentosus*. "And no it doesn't have a fish in its mouth - that is its highly protrusible mouth with all the mouth bones and folds visible. It's one of those coastal marine/estuarine flexible lifestyle fish that may go up rivers a good way but only where the water has some salt. It doesn't like pure fresh water" (Helen Larson). (SLSA PRG 294/4/22)



Above: a ray, labelled as *Taeniura lymma*. (SLSA PRG 294/4/8)



# Knuckkeys Lagoon

Photographs by Keith McGuinness taken during the 2009 dry season. You can view more of Keith's photos at <http://www.naturalumina.com.au/photo/index.htm> and <http://www.redbubble.com/people/keithmcguinness>.

Birds, clockwise from top left: young Comb-crested Jacana; Forest Kingfisher; Magpie Goose; Little Pied Cormorant.



# Land management (from *Recent Literature*, page 10)

## How good is the management of Kakadu?

A comparison of management planning for fire, alien species and biodiversity conservation in two of the world's premier savanna nature reserves, Kruger National Park in South Africa and Kakadu National Park (Parr *et al.* 2009), makes interesting and challenging reading. Kruger has “notably more detailed and prescribed planning for biodiversity conservation” and “in general it is far more straightforward to understand the management framework and to measure biodiversity conservation performance for Kruger than for Kakadu”. The authors politely suggest that “conflicting park objectives (e.g., biodiversity and cultural management)” hamper the ability of Kakadu staff to deal effectively with biodiversity concerns.

South Alligator River floodplain (Kakadu) at sunset.  
Photo: Don Franklin.



## Is re-growth savanna worth protecting?

How useful is re-growth for the conservation of mammals, birds and reptiles in the Top End? John Woinarski *et al.* (2009) compared the faunal assemblages of eucalypt savanna at various stages of regrowth with that of nearby cleared and never-cleared areas, all in the Daly River area. Not too surprisingly, the fauna of regrowth was intermediate between that of cleared and never-cleared areas, that of taller regrowth being nearer to that of never-cleared eucalypt savanna. An important proviso is that regrowth of any age supported relatively few species associated with hollow trees. Further analysis revealed that the value of regrowth for wildlife was dependent on how fire, weeds and grazing pressure were managed. The authors recommend that regrowth be afforded protection under existing vegetation clearing regulations, but that the level of protection increase with the age of the regrowth and that conservation decisions be made in the context of the landscape setting.



## Options for savanna land management

The western economic base for the use of the northern Australian savannas has traditionally been cattle grazing, but this has expanded in recent years to include nature-based tourism. Much land has also been set aside for conservation. This broadening of our view of the economic and other value of our landscapes can be extended further. The notion that our landscapes provide ecosystem and environmental services, and that managers/owners could be paid for providing these services, is explored for the Gulf of Carpentaria region by Greiner *et al.* (2009). Payment of Aboriginal landowners to manage their land for conservation is one such option. Garnett *et al.* (2009) argued that this provides a double benefit: for conservation and for Aboriginal health, values of such importance that they should be incorporated into policy and funded by a number of government agencies.



## Climate change and pastoral production

The “‘safe’ livestock carrying capacity” of north Australian rangelands, i.e. the maximum level of stocking “required to maintain resource condition”, “is strongly dependent on climate”, and we may thus expect carrying capacity to vary as climate varies. McKeon *et al.* (2009) provided a detailed consideration and analysis of the issues. Change may be considered to have three relevant elements; rainfall, temperature and atmospheric CO<sub>2</sub>. Increases in CO<sub>2</sub> favour plant growth but trees may be favoured over grasses, with uncertain implications for pastoralism. In north Australia, rainfall is declining in the east but increasing in the centre and west. Modelling suggests that increases in temperature alone could decrease productivity by an average of 21%, effects that may be exacerbated or minimised by changes in rainfall. An increase in CO<sub>2</sub> may almost entirely compensate for losses due to temperature. As each element may theoretically have a substantial impact alone, understanding the uncertainties in both climate modelling and in modelling its consequences for pastoral productivity is critical to interpreting the interaction between them.

# Wildlife crime

Reporting back on the December 2009 meeting talk by Peter Phillips

Fiona Douglas

Peter Phillips is one of few Wildlife Rangers with the NT's Department of Natural Resources, Environment, Arts & Sport who have extended powers in order to help them combat the unfortunately lucrative crime of wildlife poaching and smuggling. Working closely with police much of the time, they themselves can also, for example, stop and search vehicles. But there are not nearly enough of them to cover the vast area of the Northern Territory and, even when perpetrators are caught and prosecuted, the penalty usually falls very far short of the maximum.

Internationally, the wildlife smuggling trade is worth around US\$20 billion a year and is less risky than drug smuggling, although apparently these two illegal activities often go hand in hand. Australia, one of around 25 biodiversity hotspots around the world, is a specific target for wildlife smuggling. Around 80% of our animals are endemic and some Australian cockatoos are worth more per kilogram than cocaine. This alone indicates the huge money which our unique wildlife can command. Our reptiles, especially snakes and lizards, are very common targets as they are charismatic and relatively easy to catch and transport. Parcels containing live animals are not X-rayed, so that marking a parcel as such, but including illegal species, is one way smugglers attempt to evade customs.

Peter showed us a chilling 12 minute film consisting of short extracts from much longer footage taken by a group of South African smugglers. The pursuit and capture of large numbers of reptiles, with assistance by local people, was shown in detail, as was the preparation of containers for transport and subsequent packing of animals. Film is taken by the smugglers to provide proof of authenticity when animals are later sold; it confirms that the animals were indeed wild caught and are thus more highly prized and priced. Such footage is also ideal for use as evidence in court.

Animals confiscated when such smuggling attempts are discovered are kept for presentation as evidence, although many may perish before a case comes to trial. After the trial, there is a lot of debate as to what should happen to the animals. Usually the exact site an animal is taken from is not known and animals from many sites are packaged together, so that questions of disease and balance of populations in most cases prevent them being released back into the wild. As many as possible are given to zoos and similar institutions, but frequently the numbers are just too large for this to be practical. Many animals are currently euthanased. Discussions about alternatives

Below and above right: victims. Photos: Peter Phillips.



on illegally-procured wildlife.

Peter encouraged everyone to be on the lookout for suspicious activity. Such signs might include a vehicle stopped along a remote road at night with people possessing such items as spotlights or torches, cloth bags and snake hooks. This description also fitted several people in the audience with legitimate reasons for having these items in their vehicles. Another giveaway is possession of a wet suit in the middle of the desert far from water – these are used to prevent scratches and injury when climbing trees to pursue reptiles.

It is difficult to determine the extent of the problem and who is winning. A fine of a couple of thousand dollars, after a costly and protracted prosecution against a well-organised group who had captured many dozens of animals, seems manifestly derisory. Smugglers accept that some, even a majority, of tightly packed animals will die, but prices commanded by even a few survivors means that the perpetrators will have made a profit. The intense and sometimes prolonged suffering of captured animals, and the death of many, means the crime is anything but ‘victimless’.

Peter brought along various smugglers’ tools-of-the-trade and captivated many of the audience with Miss Monty, a large and friendly python who lives in his household. Peter even admitted to use of his wife’s hairdryer to defrost a rat for her on occasion!



Miss Monty the Olive Python, with Peter Phillips and Louise Finch. Photo: Eric ter Laare.

Wildlife smuggling seems not to be regarded seriously by the public, but Peter is clearly passionate about combating this criminal disregard for the rights of wildlife and for the rights of Australians to safeguard their heritage. He urged us all to report vehicles possibly involved in wildlife smuggling.

**Spider drinking?** These photos of a Huntsman were taken in Kalgoorlie by Doug Finch.



**The Tropical Savannas CRC in hindsight** (from *Recent Literature*, page 10)

With its recent demise due to the lack of on-going funding, some leading participants in the 10-year life of the Tropical Savannas Cooperative Research Centre have reviewed its contribution to sustainable management of the north Australian landscapes (Duff *et al.* 2009). The TS-CRC involved researchers, pastoralists, Aboriginal landholders, miners, the military and other land users. The authors argue that the “adaptive collaborative” approach adopted by the TS-CRC – in which “research providers and users work closely together on projects to develop resources” – has been successful. The adaptive collaborative approach contrasts with “integrative projects where participants merely join their separate contributions”. In the face of cultural diversity, integrative approaches “seldom achieved sustainable solutions because it devalued the position of the less empowered participants”. Furthermore, “positive outcomes were achieved when participants developed trust and respect for each other by embracing and respecting their differences and by sharing unifying concepts such as savanna health. Another lesson learned was that a collaborative organization must act as an honest broker by resisting advocacy of one view point over another.”



**Smoke** (from *Recent Literature*, page 10).

Smoke over Darwin and downwind of fires in the region decreases the ultraviolet radiation reaching the surface by up to 50% in some wavelengths (Kalashnikova *et al.* 2007). This rather technical paper has implications “for many ongoing climate, biophysical, and air pollution studies”.

# Interesting bird sightings

23 November 2009 to 22 January 2010

Compiled by Ian Hance

Sightings are as reported (unvetted, unconfirmed) and have been mostly compiled from the e-mail digest of the NT birder website (<http://groups.yahoo.com/group/ntbirds>) moderated by Niven McCrie.

Species	Date	Location	Observer/s	Nos./comments
<b>Waterbirds</b>				
Plumed Whistling-Duck	2/01	Cnr Trower & Nightcliff Rds.	Johnny Estbergs	30
Little Grebe (Eurasian)	28/11	Leanyer Sewage Ponds	various	1; still present 19/12
Great-billed Heron	25/12	Kulaluk Bay	Fiona Douglas <i>et al.</i>	1
~	7/01	Leanyer Sewage Ponds	Jeff Stenning, David Percival	1
~	21/01	Liverpool River	Marc Gardner	1
Chestnut Rail	21/01	Liverpool River & tributary	Marc Gardner	5
Spotless Crake	24/11	Harrison Dam	Jeff Stenning, Ian Hance	1
~	24/11	Fogg Dam	Jeff Stenning, Ian Hance	1
White-browed Crake	25/11	McMinns Lagoon	Ian Hance	2
Black-tailed Native Hen	28/11	Katherine Sewage Ponds	Andrew Bell	1; still present 13/12
Eurasian Coot	28/11	Leanyer Sewage Ponds	Peter Kyne, Micha Jackson	1
<b>Seabirds</b>				
Lesser Frigatebird	4/01	Kulaluk Bay	Fiona Douglas	1F
~	4/01	Museum & East Point	Michael Braby	9
~	4/01	Harbour	Clive Garland	4
~	5/01	Kulaluk Bay	Fiona Douglas	flocks of 5 to 60 birds
Brown Booby	30/12	Stokes Hill Wharf	Darryel Binns	1; other sightings other obs.
Black-headed Gull	30/12	Stokes Hill Wharf	Darryel Binns	1; subsequent sightings other obs.
~	15/01	Lee Point	Arthur & Sheryl Keates	1
<b>Waders</b>				
Red-necked Avocet	25/11	Leaning Tree Lagoon	Jeff Stenning, Ian Hance <i>et al.</i>	2
Little Ringed Plover	22/11	Leanyer Sewage Ponds	Peter Kyne <i>et al.</i>	4; still present 8/1
Red-kneed Dotterel	28/11	Katherine Sewage Ponds	Andrew Bell	quite a few
Little Curlew	29/11	Gunbalanya	Marc Gardner	1270+; other location other obs.
Swinhoe's Snipe	6/12	South Alligator Floodplain	Marc Gardner	1
~	11/12	Wagman School	Niven McCrie	1
~	12/12	McMinn's area	Darryel Binns <i>et al.</i>	12; up to 25 on 11/01
~	16/12	CDU Casuarina	Heather Moorcroft	1
~	19/12	Fiddlers Lagoon	Peter Kyne, Micha Jackson	7
Pin-tailed Snipe	c. 19/1	McMinn's area	Darryel Binns & Ian Davies	1
Broad-billed Sandpiper	3/12	Lee Point	Gavin & Meg O'Brien	1
Oriental Pratincole	21/11	Snipe lagoon	Jeff Stenning <i>et al.</i>	1; 9 on 22/11, 24 on 23/11
~	25/11	Knott's Crossing, Katherine	Peter Kyne, Micha Jackson	500+
~	6/12	South Alligator River floodplain	Marc Gardner	200+
<b>Birds of prey</b>				
Black-shouldered Kite	8/01	Anzac Parade	Jeff Stenning, David Percival	10
Wedge-tailed Eagle	31/12	Palmerston Sewage Ponds	Mike Jarvis	2
Grey Falcon	7/12	N.T. Section Barkly H'way	Clive Garland	1
Rufous Owl	22/11	Botanic Gardens	Arthur & Sheryl Keates	2
Eastern Grass Owl	30/12	Anzac Parade, Middle Point	Ian Hance <i>et al.</i>	2; also 3, possibly 4 on 2/1, A&S Keates, Darryel Binns
<b>Other birds</b>				
Partridge Pigeon	5/12	Marlow Lagoon	Dicaeum	1
Mangrove Golden Whistler	11/11	Leanyer Sewage Ponds	Jeff Stenning & David Percival	1
White-breasted Whistler	1/01	Mouth of South Alligator River	Marc Gardner	1
~	28/12	Kulaluk Bay	Richard Noske <i>et al.</i>	2 (♂♀); seen again since
(Eastern) Yellow Wagtail	13/12	Katherine Sewage Ponds	Andrew Bell	1
~	11/12	Leanyer Sewage Ponds	Jeff Stenning, David Percival	1

## Fire (from *Recent Literature*, page 10)

Analysis of a 16-year fire history (Edwards & Russell-Smith 2009) demonstrates that the fire regimes of the Arnhem Land Plateau are "characterised generally by high annual frequencies (mean = 36.6%) of large (>10 km<sup>2</sup>) fires that occur mostly in the late dry season under severe fire-weather conditions". "Collectively, such conditions substantially exceed defined ecological thresholds for significant proportions of fire-sensitive indicator rain forest and heath vegetation types, and the long-lived obligate seeder conifer tree species, *Callitris intratropica*."

# Recent literature about Top End natural history

Back listings and summaries may be viewed at <http://www.cdu.edu.au/ser/profiles/ecologyintopend.htm>.

## CONSERVATION, LAND MANAGEMENT, FIRE

Compiled by Don Franklin

### Not so technical

- Anon. 2009. Arafura Harbour canal estate – developers don't get the Point. *News. of Environ. Centre NT* June '09: 3-4.
- Anon. 2009. Pungaline-Seven Emu. *Wildlife Matters* Spring 2009: 6-10. [AWC conservation properties in Gulf region]
- Anon. 2009. Removing feral animals to safeguard ecological health. *Wildlife Matters* Summer 09/10: 8-9. [Wongalara]
- Jacklyn P. 2009. Fire brings back country. *Savanna Links* 36: 8-13. [Aboriginal fire management]
- Woinarski J, Fisher A. 2009. Narrow path between hope and despair: the north's environmental future. *Savanna Links* 36: 14-16.

### Conservation

- Harrison L, McGuire L, Ward S, Fisher A, Pavey C, Fegan M, Lynch B. 2009. *An inventory of sites of international and national significance for biodiversity values in the Northern Territory*. Department of Natural Resources, Environment, The Arts and Sport: Darwin. <http://www.nt.gov.au/nreta/environment/conservation/reports.html>.
- Parr CL, Woinarski JCZ, Pienaar DJ. 2009. Cornerstones of biodiversity conservation? Comparing the management effectiveness of Kruger and Kakadu National Parks, two key savanna reserves. *Biodiversity and Conservation* 18: 3643-3662.
- Ward S, Harrison L. 2009. *Recognising sites of conservation significance for biodiversity values in the Northern Territory*. Department of Natural Resources, Environment, The Arts and Sport: Darwin. Available at <http://www.nt.gov.au/nreta/environment/conservation/reports.html>. [see article in *Nature Territory* July 2009, p5]
- Woinarski JCZ, Rankmore B, Hill B, Griffiths AD, Stewart A, Grace B. 2009. Fauna assemblages in regrowth vegetation in tropical open forests of the Northern Territory, Australia. *Wildlife Research* 36: 675-690.

### Land management

- Duff G, Garnett D, Jacklyn P, Landsberg J, Ludwig J, Morrison J, Novelly P, Walker D, Whitehead P. 2009. A collaborative design to adaptively manage for landscape sustainability in north Australia: lessons from a decade of cooperative research. *Landscape Ecology* 24: 1135-1143.
- Garnett ST, Sithole B, Whitehead PJ, Burgess CP, Johnston FH, Lea T. 2009. Healthy country, healthy people: policy implications of links between Indigenous human health and environmental condition in tropical Australia. *Australian Journal of Public Administration* 68: 53-66.
- Greiner R, Gordon I, Cocklin C. 2009. Ecosystem services from tropical savannas: economic opportunities through payments for environmental services. *The Rangeland Journal* 31: 51-59.
- McKeon GM, Stone GS, Syktus JI, Carter JO, Flood NR, Ahrens DG, Bruget DN, Chilcott CR, Cobon DH, Cowley RA, Crimp SJ, Fraser GW, Howden SM, Johnston PW, Ryan JG, Stokes CJ, Day KA. 2009. Climate change impacts on northern Australian rangeland livestock carrying capacity: a review of issues. *The Rangeland Journal* 31: 1-29.
- NRETAS Weed Management Branch. 2009. *Northern Territory Weed Management Handbook*. Northern Territory Government: Darwin. 42 pp. Available at: <http://www.nt.gov.au/nreta/natres/weeds/index.html>.
- Puig CJ, Huchery C, Greiner R, Collier N, Garnett S, Bowen L, Perkins I. 2009. Beef, biodiversity and burning: modelling pasture futures for the Northern Territory cattle industry. In *The 2009 ANZSEE Conference*. The Australian New Zealand Society of Ecological Economics: Darwin.
- Sithole B, Hunter-Xenie H. 2008. *Aboriginal land and sea management in the Top End: A community driven evaluation*. CSIRO Sustainable Ecosystems, Darwin. 150 pp.
- Straton A, Jackson S, Marinoni O, Proctor W, Woodward E. 2008. *Evaluating scenarios for the Howard catchment: summary report for workshop participants and stakeholders*. CSIRO, Darwin.
- Wood R, Garnett S. 2009. An assessment of environmental sustainability in Northern Australia using the ecological footprint and with reference to Indigenous populations and remoteness. *Ecological Economics* 68: 1375-1384.

### Fire

- Edwards AC, Russell-Smith J. 2009. Ecological thresholds and the status of fire-sensitive vegetation in western Arnhem Land, northern Australia: implications for management. *International Journal of Wildland Fire* 18: 127-146.
- Kalashnikova OV, Mills FP, Eldering A, Anderson D. 2007. Application of satellite and ground-based data to investigate the UV radiative effects of Australian aerosols. *Remote Sensing of Environment* 107: S1: 65-80.
- Russell-Smith J, Whitehead P, Cooke P, eds. 2009. *Culture, ecology and economy of fire management in north Australian savannas*. CSIRO Publishing: Collingwood, Vic. 416 pp.



### Land use and ecological footprints in northern Australia

Ecological footprints are measured as the area of land required to support an individual. The average "footprint" of a Territorian is 8.3 ha, 25% more than the national average (Wood & Garnett 2009). Though town dwellers in the NT don't occupy much land and Aborigines on communal land do, the former import much more services and thus have the greater footprint; remote Indigenous people had the lowest footprint of all Territorians.