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# Kakadu, Northern Territory

4.1 Several submissions to the inquiry identified the wetlands of Kakadu as a nationally important ecosystem that the Committee should consider as a case study for its inquiry. The Committee was told that, not only are these wetlands iconic and of high biodiversity value nationally and internationally, they are also at risk of significant damage due to future climate change.

4.2 Kakadu National Park (KNP) is listed by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as a World Heritage Area for both its cultural and natural values. It is located 200 kilometres east of Darwin in the wet–dry tropics of the Alligator Rivers region, and covers an area of 19 798 square kilometres. The park has a high degree of connectivity with adjacent areas—Arnhem Land (Indigenous land) to the east, Nitmiluk National Park to the south, pastoral properties to the west, and the Arafura Sea to the north. Landforms and habitats in the park include the sandstone plateau and escarpment, extensive areas of savanna woodlands, open forest, floodplains, mangroves, tidal mudflats, coastal areas, and monsoon forests.

4.3 KNP is jointly managed by its Traditional Owners and the Australian Government, under the direction of a Board of Management, which has an Indigenous majority representing the Traditional Owners. Day-to-day management of the park is carried out by Parks Australia, a division of the federal government Department of Sustainability, Environment, Water, Population and Communities.

4.4 Key issues canvassed during the Committee's site inspections in KNP on 3 July 2012 included: existing threats to biodiversity; expected impacts of climate change; the complexity of climate considerations in the Yellow Water Wetlands; co-management of the park; the impact of biodiversity loss on human communities; and research and monitoring needs in the region.

# Committee activities

## Kakadu National Park

4.5 The Committee was accompanied by, and received briefings from, the following representatives from Kakadu National Park:

- Mr Michael Bangalang, Traditional Owner, and Member, Kakadu National Park Board of Management;
- Ms Sarah Kerin, Park Manager; and
- Mr Steve Winderlich, Manager, Natural and Cultural Programs.

4.6 Throughout the visit, the Committee received the following documents:

- *A shared vision for tourism in Kakadu National Park*, Kakadu Board of Management, 2005.
- *Wetland tourism: Australia – Kakadu Ramsar site*, Ramsar secretariat, 2012.
- *Kakadu National Park: Climate change strategy 2010–15*, Director of National Parks, 25 May 2010.
- *Economic Activity of Australia's World Heritage Areas: Final report*, Department of Environment, Water, Heritage and Arts, July 2008.
- *Kakadu: Vulnerability to climate change impacts*, Department of Climate Change and Energy Efficiency, 2011.
- *An-garregen: A strategy for cultural heritage management in Kakadu National Park,* Kakadu Cultural Heritage Working Group, 2011—
  - ⇒ *Volume 1: The strategy.*
  - ⇒ *Volume 2: Appendices.*
- *Kakadu National Park management plan 2007–14*, Director of National Parks, 2007.
- *Kakadu National Park visitor guide*, Director of National Parks, 2008.
- *The impacts of climate change on Australian tourism destinations: Developing adaptation and response strategies – A scoping study*, Cooperative Research Centre for Sustainable Tourism, 2009.
- *The impacts of climate change on Australian tourism destinations: Developing adaptation and response strategies*, Cooperative Research Centre for Sustainable Tourism, 2009.

4.7 The Committee was briefed on issues relating to the management of KNP, including existing threats to biodiversity and how these might be affected by changes in climate, co-management of the park, and research and monitoring needs.

## Yellow Water Wetlands

4.8 KNP's landscapes comprise coastal ecosystems to the north, stone country to the south, and extensive wetlands. In response to submissions to the inquiry, the focus of the Committee's site inspection was the wetlands.

4.9 The Yellow Water Wetlands include Yellow Water Billabong and Yellow Water Floodplains. During the dry season, the area consists of a series of large billabongs, which become connected during the wet season, becoming a free-flowing system. Yellow Water Billabong is located at the end of Jim Jim Creek, a tributary of the South Alligator River. The river system, which is the largest in Kakadu, contains extensive wetlands that include river channels, floodplains and backwater swamps.

4.10 Accompanied by the KNP representatives listed above, the Committee inspected parts of the Yellow Water Wetlands and received detailed briefings from local guides. The briefings centred on the biodiversity and complexity of the wetlands system, and the potential consequences of climate-induced biodiversity loss for human communities dependent on the wetlands.

Figure 4.1 Yellow Water Wetlands, with floodplains and melaleuca woodlands in the distance

*Photograph courtesy of committee secretariat*

# Issues explored in Kakadu

4.11 Inspections of the Yellow Water Wetlands raised issues relating to the complexity of the system and how it might be affected by future climate change, and the impacts of biodiversity loss for human communities that rely on healthy ecosystems. Discussions during the Committee's visit also addressed broader issues of park management in a changing climate, co-management and engagement with Indigenous communities, and research and monitoring needs in the region.

## Key threats to biodiversity in Kakadu National Park

4.12 The Committee was informed that KNP has been progressively inscribed as a national park since 1979. The park is locally, nationally and internationally significant with respect to its biodiversity. It is home to approximately 2000 plant species, 271 bird species (over one third of Australia's bird species), 77 mammal species (about one quarter of Australia's land mammals), 132 reptile species, 27 frog species and 246 fish species.[1] The Committee heard that the southern parts of KNP, especially the highlands, have particularly high levels of endemism, with many species being unique to the area and not found anywhere else in the world. This was suggested to be due to the highly fractured landscape, which has created ecological niches for species.

4.13 Losses in biodiversity have occurred for various reasons. For example, the Committee heard about a dramatic decline in species of small mammals, although the cause is unclear. The pattern of decline has been consistent with disease, although the fact that some species have not been affected suggests there may be an alternative explanation. Fire regimes, predation, and off-park grazing have been identified as other possible causes.

4.14 More broadly, the Committee heard that there was some resilience in the landscape, due to it being subject to wet-dry seasonality and periodic disturbances from extreme weather events such as tropical cyclones. However, the resilience of Kakadu's ecosystems to future climate change could be improved through the effective management of feral animals, weeds, and fire. The Committee heard about some of these existing threats to biodiversity, as well as the possible effects of climate change. These are discussed below.

1 Director of National Parks, *Kakadu National Park: climate change strategy 2010–15*, Department of the Environment, Water, Heritage and the Arts, Canberra, 2010, p. 1.

## Feral and pest animals

4.15 The Committee heard that feral and pest animals have had a detrimental impact on the ecosystems of KNP. These animals include Asian water buffalo, cattle, pigs, horses, donkeys, dogs, cats, European bees, cane toads, and introduced ants.[2]

4.16 The Committee was briefed on the history of ecological damage from Asian water buffalo in KNP. Water buffalo had been introduced to the Northern Territory from Indonesia in the 1800s.[3] Over many years, feral populations had damaged floodplains and eroded the banks of freshwater river systems. This had facilitated saltwater intrusion and resulted in the death of trees and other vegetation that provided habitat for naturally and culturally important animal species. The activity of buffalo had also exacerbated the spread of weeds.

4.17 The Committee heard that the Brucellosis and Tuberculosis Eradication Campaign of the 1990s removed most buffalo from KNP, allowing damaged areas to recover over time. However, buffalo numbers have since increased gradually. Strategies now used to manage many feral animals, including water buffalo, consist mainly of aerial shooting, although some opportunistic shooting also takes place, often in conjunction with weed and other land management activities.

4.18 The Committee was interested to hear about the presence of cane toads in KNP. Cane toads started to colonise the park in the 1990s and quickly became a threat to lizards, goannas, and quolls. These species have continued to do well in the stone country, where cane toads have not been as pervasive. The Committee heard that efforts to eradicate cane toads are usually inefficient and ineffective, and such programs are therefore generally not pursued. The Committee was interested to note, however, that early results from a University of Sydney program to train quoll young to avoid cane toads suggested some success in adaptive learning.

4.19 The difficulty of isolating the impact of invasive species was noted. For example, quoll populations in KNP were declining before the arrival of the cane toad, but the presence of the cane toad had certainly exacerbated existing threats, leading to a more rapid decline in quoll numbers.

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2 Director of National Parks, *Kakadu National Park management plan 2007–14*, Australian Government, Darwin, 2007, p. 79.

3 Northern Territory Department of Primary Industry and Fisheries, 'Buffalo—Primary Industry', <http://www.nt.gov.au/d/Primary_Industry/index.cfm?newscat1=Other%20Animals&newscat2=&header=Buffalo> viewed 16 October 2012.

## Weeds

4.20 The Committee was briefed on the management of weeds in KNP. *Mimosa pigra* is an aggressive floodplain weed with a very long period of seed viability: germination is possible for up to 25 years for each seed. Once a seed germinates, growth is very rapid. The Committee was pleased to hear that, as a result of significant, early investment in weed management, KNP was largely free from *Mimosa pigra*. However, in view of the weed's long period of seed viability, management is an ongoing challenge.

4.21 The Committee heard about two other floodplain weeds that are significant in KNP: olive hymenachne (*Hymenachne amplexicaulis*) and salvinia (*Salvinia molesta*). Olive hymenachne is a prolific seeder, and seeds are spread by water, including during flooding events, and through mud by animals.[4] Feral animals and more frequent extreme weather events due to climate change may therefore result in greater adverse impacts in the Kakadu wetlands.

4.22 Salvinia, which is a free-floating, mat-forming fern that has invaded KNP's wetlands, reproduces by fragmentation and is characterised by very prolific growth. The Committee had an opportunity to view parts of the Yellow Water Wetlands covered in salvinia during its site inspection. Management of the weed has been a major undertaking in KNP, and the Committee was pleased to hear that the salvinia weevil had provided some control over the spread of the plant under certain conditions.

4.23 The Committee was also briefed about two types of grassy weed, Para grass (*Urochloa mutica*) and Mission grass (*Pennisetum polystachion*), which are native to the African tropics and were introduced to Australia to be trialled as pasture grasses.[5] However, both species have since established themselves in the Northern Territory as invasive weeds. The Committee was informed that these weeds tend to quickly dominate and create monocultures in the ecosystems they invade, and have the potential to significantly alter fire regimes due to the resultant increased fuel loads.

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4 Northern Territory Government, 'Olive hymenachne (*Hymenachne amplexicaulis*)', <http://www.nretas.nt.gov.au/natural-resource-management/weeds/find/?a=13313> viewed 21 October 2012.

5 Department of Primary Industry, Fisheries and Mines, *Management of mission grass*, Agnote, no. F38, Northern Territory Government, Darwin, 27 June 2006; MM Douglas, SE Bunn, RJW Pidgeon, PM Davies, P Barrow, RA O'Connor and M Winning, *Weed management and the biodiversity and ecological processes of tropical wetlands: draft final report*, National Wetlands R&D Program, Environment Australia, and Land and Water Australia, 2001.

Figure 4.2 Salvinia (foreground) at the edges of the Yellow Water Wetlands

*Photograph courtesy of committee secretariat*

## Fire management

4.24 The Committee heard that fire is a significant issue in KNP, the landscape having adapted in the presence of fire over many thousands of years. The approach taken by park management is based on Indigenous methods, where burning was traditionally carried out to increase hunting opportunities, improve access to the land, and to facilitate communication.

4.25 In KNP, a program of burning is undertaken annually, although the fire interval varies according to ecosystem type. In the early fire season, patch or mosaic burning is carried out at low intensities, which reduces the risk of wildfires caused by lightning strikes later in the season. The Committee heard that the shift from late, highly destructive wildfires, to early, cooler season fires had introduced greater biodiversity into KNP's ecosystems by allowing a diversity of plant species to flourish.

4.26 In addition to the traditional reasons for burning and modern hazard reduction purposes, fire is currently also used to manage specific species. For example, Leichhardt's grasshopper is a species found in only three places in the world, including Kakadu. It is also important in Indigenous mythology. The grasshopper relies almost exclusively on one type of plant (pityrodia) throughout most parts of its life cycle. Any loss of pityrodia is therefore likely to be accompanied by declines of Leichhardt's grasshopper. Understanding these interrelationships enables fire regimes

to be used to protect the habitat of species that are important for ecological and cultural reasons.

## Climate change

4.27 The Committee was informed that, in the context of geological timeframes, the region had adapted to many changes. For example, the freshwater floodplains in the region were estimated to be 4000 years old. Prior to that, the area was completely inundated with saltwater. The biodiversity of the area has therefore adapted over time to significantly different landscapes. However, climate change is likely to demand more rapid adaptation than may be possible. This was therefore one of the challenges in managing the park to ensure resilience to relatively rapid changes in climate.

4.28 As the Committee heard during this site inspection, and previously throughout the inquiry, one of the most effective ways of building resilience to climate change is by managing existing threats, such as those discussed above. However, it is also necessary for land managers to be aware of the possible impacts of climate change in order to anticipate how these might affect system dynamics in a given ecosystem.

4.29 The predicted effects of climate change in Kakadu include sea level rise, temperature rises, variation in the amount and pattern of rainfall, and changes in the frequency and intensity of extreme weather events. The related threats to KNP's biodiversity are discussed below.

4.30 Saltwater intrusion into freshwater ecosystems may transform landscapes, particularly in the wetlands where even very small rises in sea level could have significant consequences. The Committee heard that, although there had been some suggestion that the effects of rising sea levels had already been observed in some places, it was unclear whether there were other causes, such as past damage by water buffalo.

4.31 Predicted temperature rises could have direct impacts on the viability of crocodiles and other reptile species with temperature-dependent sex determination. Sex ratios could be altered, resulting in nesting failure and species decline. Temperature rises are also predicted to result in changes to fire regimes, which could transform ecosystems.

4.32 The frequency and severity of extreme weather events is expected to have detrimental impacts on the biodiversity of KNP. More intense storms are likely to contribute to the changes in fire regimes discussed above, particularly due to more frequent lightning strikes. The Committee viewed photographs illustrating the devastating effects of tropical cyclones in the region, and heard about the increased risk of invasive species being spread during severe weather events.

4.33 Aside from the direct impacts, climate change is likely to exacerbate existing threats to biodiversity in Kakadu. For example, the Committee was advised that predicted changes to a number of aspects of climate, including temperature and precipitation patterns, would provide more favourable conditions for weeds. The Committee heard that grasses ordinarily make up approximately six to eight per cent of woodland ecosystems in the region. However, this proportion is two to three times greater in woodland ecosystems that are invaded by grassy weeds such as para grass and mission grass. Should this disparity be amplified by climate change, there is potential for dramatic changes in ecosystem dynamics and the diversity of plant and animal life supported by these ecosystems.

### Committee comment

4.34 The Committee notes the range of threats currently facing the biodiversity of Kakadu, including feral and pest animals and invasive weeds. The Committee is also mindful of the need for careful management of fire regimes in the Northern Territory in particular, where many landscapes have evolved in the presence of fire over many thousands of years.

4.35 The Committee was pleased to hear that there is some resilience built into the ecosystems of Kakadu, due to the landscapes having had to evolve over long periods of time to starkly different conditions. However, the Committee notes advice that current environmental management challenges are likely to be exacerbated by climate change, as ecosystems may be transformed and conditions may become more favourable for pest species. Of concern is the suggestion that climate change may require much more rapid adaptation than will be possible for many ecosystems.

4.36 The Committee was pleased to hear acknowledgment by park management that threatening processes do not recognise arbitrary boundaries, and that KNP is therefore managed at a landscape scale. The Committee was also pleased to find a culture of constructive collaboration with Traditional Owners, allowing management to benefit from the traditional knowledge of local Indigenous communities.

## Complexity of the Yellow Water Wetlands ecosystem

4.37 As discussed earlier, the Yellow Water Wetlands are part of the South Alligator River system, the vast size of which makes it a very important area to monitor for climate change impacts, due to the far-reaching consequences of any adverse impacts.

4.38 During its site inspection, the Committee received briefings on, among other things, the biodiversity of Kakadu. Local wildlife includes saltwater

crocodiles, buffalo on the floodplains, snakes, and a range of endemic flora. Kakadu is home to about one third of Australia's bird species, and at least 60 species are found in the wetlands.

4.39 The Committee was also briefed on the complex climatic conditions of KNP. Kakadu's climate is monsoonal, characterised by two main seasons: the dry season (May to October) and the wet season (November to April). Local Indigenous communities recognise six different seasons, as well as subtle variations that signpost the transition from one season to another:

- *Gudjewg*: Monsoon season, December to March;
- *Banggerreng*: Knock 'em down storm season, April;
- *Yegge*: Cooler but still humid season, May to June;
- *Wurrgeng*: Cold weather season, June to August;
- *Gurrung*: Hot dry weather, August to October; and
- *Gunumeleng*: Pre-monsoon storm season, October to December.[6]

4.40 The understanding of these six seasons informs expectations regarding rainfall, temperature, humidity, wind and stormy conditions, abundance and location of plant and animal life, the timing of life cycle events (phenology), and the condition of wetlands. It provides guidance on how and when land management practices such as burning should be carried out. In the past, it also helped Traditional Owners determine when to move camp from the floodplains to the stone country, to seek shelter from violent storms.[7]

4.41 In addition to these seasonal variations, the Committee heard that KNP is subject to other periodic climate patterns, such as the El Niño–Southern Oscillation (ENSO), and episodic disturbances, such as tropical cyclones and other extreme weather events. These longer-term and episodic variations have meant that Kakadu's ecosystems have a level of ecological resilience built into them. For example, the wet–dry seasonality allows the floodplains to act as refugia for animals during dry periods.

4.42 However, these complexities also make the management of KNP more challenging. And, because climate change is an additional threat to biodiversity while also interacting with the range of existing threats, all of

6 Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC), 'Kakadu National Park—Six seasons of Kakadu', <http://www.environment.gov.au/parks/kakadu/nature/seasons.html> viewed 25 October 2012.

7 DSEWPAC, 'Kakadu National Park—Six seasons of Kakadu', <http://www.environment.gov.au/parks/kakadu/nature/seasons.html> viewed 25 October 2012.

these variables make it more difficult to predict the effects that climate change is likely to have in Kakadu.

### Committee comment

4.43 The Committee notes the complexity of the wetlands ecosystems in Kakadu, particularly in relation to reliably predicting the impacts of climate change in the region. The Committee's inspection of the Yellow Water Wetlands and briefings from local experts highlighted the importance of land managers having a thorough and nuanced understanding of the dynamics of the specific ecosystems involved, supported by insights from traditional knowledge and scientific research and monitoring.

## Co-management of Kakadu National Park

4.44 The Indigenous people of Kakadu—the Bininj in the north and Mungguy in the south—have leased their land to the Australian Government for the formation of the national park.[8] The Committee heard about the approach taken to managing KNP and co-management structures, which combine traditional culture and modern practice.[9] The Committee was also briefed on some of the benefits of working with Traditional Owners, as well as some of the issues that need to be managed.

4.45 As with discussions in South Australia regarding co-management of national parks with the Ngarrindjeri in the Coorong, Lower Lakes and Murray Mouth region, the visit to KNP underscored the inseparability of nature and culture for Indigenous communities and highlighted the relevance of this to the way the park is managed.

4.46 Briefings were provided on KNP's co-management structure, which involves a Board of Management that includes Traditional Owner representatives, the Director of National Parks, and nominees from the tourism and environmental sectors. The Committee was informed that just under half of KNP is subject to Indigenous land claims, but that the park is consciously managed as though all of the park is Indigenous land. As a result, there would be little practical impact on the way the park is managed should pending claims be successful. The Committee heard that the resolution of land claims would, however, assist with the co-management of KNP by providing both management and Traditional

8 Kakadu Board of Management, *A shared vision for tourism in Kakadu National Park*, Australian Government and Northern Territory Government, 2005, p. 3.

9 Kakadu Board of Management, *A shared vision for tourism in Kakadu National Park*, Australian Government and Northern Territory Government, 2005, p. 3.

Owners with more clarity on the appropriate representatives for each part of the park.

4.47 Briefings addressed the approach taken to managing KNP, which includes the integration of natural and cultural resource management. The Committee was told about cultural programs that included working with Traditional Owners out on country to collect oral history, with the aim of sharing and recording some of the customary knowledge of country. KNP representatives also discussed clan-based projects that seek to link customary knowledge and traditional practices on the one hand, with scientific information and modern methods on the other. Through these cultural programs, the environmental knowledge of Traditional Owners is able to be incorporated into management plans, while scientific knowledge can enhance management approaches and on country practices, particularly as climate change introduces uncertainty and variability into ecosystem processes.

4.48 The Committee was also informed about KNP's cultural heritage strategy, which results, among other things, in park management benefiting from the knowledge of Traditional Owners. Much of the cultural information held by Traditional Owners also has ecological applications. For example, the Committee heard about traditional knowledge that recognises phenologically linked relationships between species, such as observed flowering of one plant species coinciding with the nesting behaviour of a particular, otherwise unrelated, animal species.

4.49 One aspect of the KNP's cultural heritage strategy includes the establishment of a 'cultural information management system'. The database facilitates the collection, retention and retrieval of cultural information relating to the park, with access restrictions to ensure information is collected from and shared with only the appropriate people. The Committee heard about the need to protect culturally sensitive information, while ensuring effective knowledge transfer and reducing the risk of losing important cultural heritage information.

4.50 KNP management also benefits from the knowledge of Traditional Owners through consultation processes in relation to the management plan for the park, as well as other specific plans. Community meetings are also held on an ongoing basis, allowing further consultation with Traditional Owners on matters directly relating to their immediate geographical area.

### Committee comment

4.51 The Committee notes that there are some challenges associated with the co-management of national parks. This may be particularly true in the Northern Territory, where the Committee heard there are social, economic and political dynamics that need to be taken into account.

4.52 Nonetheless, the Committee sees value in the co-management of national parks with Indigenous communities where appropriate, and considers that the combination of traditional wisdom and modern approaches can provide real ecological and cultural benefits for all stakeholders. The Committee commends KNP's governance bodies for their efforts towards collaboration, inclusion, and the engagement of local Indigenous communities.

## Biodiversity loss and its impact on humans

4.53 The Committee heard that KNP's biodiversity has a direct impact on local communities, particularly as many Traditional Owners rely on local plant and animal species as food sources, for cultural activities, and to provide habitat for totemic species. For example, the Committee heard about some of the important food sources in the Yellow Water Wetlands, including lilies, melaleuca trees, and magpie geese. The Committee also heard about some of the cultural applications of the paperbark from melaleuca trees, including as an aid to food preparation and fishing.

4.54 Apart from the intrinsic value of Kakadu's iconic, nationally important ecosystems, the Committee heard that many local communities are dependent on the tourism industry for their livelihoods. In turn, the industry relies on the unique biodiversity of the region in order to attract visitors.

4.55 Gagudju Dreaming, which is an Indigenous owned collection of Kakadu cruises, tours, cultural experiences, and accommodation, is the largest collection of facilities catering to tourism in Kakadu.[10] Among its goals is positive Indigenous outcomes, particularly for the Bininj people of KNP. Principal stakeholders include the federal government's Indigenous Business Australia, and the Traditional Owners are represented through Kakadu Tourism.[11]

10 Gagudju Dreaming, 'The spirit of Kakadu: Gagudju Dreaming—Overview', <http://www.gagudju-dreaming.com/About-Us/Overview.aspx> viewed 22 October 2012.

11 Gagudju Dreaming, 'The spirit of Kakadu: Gagudju Dreaming—Indigenous experience', <http://www.gagudju-dreaming.com/Indigenous-Experience/Overview.aspx> viewed 22 October 2012.

4.56 As part of the charter for the operation of Gagudju Dreaming, an Indigenous Employment Program (IEP) exists to create opportunities for local Bininj to train and interact with the tourism industry. The Committee notes that part of KNP's charter is to only develop tourism at a pace that is comfortable for and set by the Traditional Owners of Kakadu.[12]

4.57 The conservation of Kakadu's rich biodiversity is both directly and indirectly important for communities that rely on the landscape for cultural and economic reasons. The loss of biodiversity due to climate change would therefore have significant repercussions for the local Indigenous communities in particular.

### Committee comment

4.58 The Committee notes that nature and culture are inseparable for Kakadu's Traditional Owners. Apart from the intrinsic value of KNP's biodiversity, local communities depend on healthy ecosystems for cultural as well as economic reasons. The Committee therefore notes the significance of efforts to manage and conserve biodiversity in KNP, particularly in a changing climate.

## Research and monitoring

4.59 The Committee heard about the importance of research and monitoring in Kakadu to provide land managers with adequate information about the impacts of climate change on biodiversity. The Committee was informed of some of the current research gaps, as well as some of the challenges associated with carrying out research in KNP.

4.60 During the Committee's inspection program, KNP representatives identified the expansion of its research and monitoring program as one of the park's most pressing needs in responding to the threat of climate change. KNP management emphasised the importance of collecting baseline data to ensure that climate change impacts can be reliably assessed in future.

4.61 Although there had been an ongoing debate about the relevance of long-term biodiversity monitoring, its value has now become more apparent. With the uncertainties associated with climate change impacts, and the move towards a more adaptive approach to biodiversity management, there is an increasing need for reliable, thorough, and long-term baseline data on the abundance, distribution and conditions of

12 Gagudju Dreaming, 'The spirit of Kakadu: Gagudju Dreaming—Indigenous experience', <http://www.gagudju-dreaming.com/Indigenous-Experience/Overview.aspx> viewed 22 October 2012.

species and ecosystems. This would enable land managers to monitor changes closely, and would provide better guidance on the type and timing of appropriate interventions.

4.62 The Committee heard that the size of Kakadu, its remote location, and access to adequate resources posed challenges for the collection of such data. The Committee was advised that KNP management is constrained to an extent regarding the type and scope of research it can initiate on its own. For example, the Committee heard that there had been varied reports of observed changes in the timing of the seasons in Kakadu, such as earlier or later than usual flowering of particular plants. The Committee heard that there would be benefit in carrying out research into the timing of sightings of migratory birds in the region, to determine whether climate changes are driving any systematic shifts in arrival or departure times. However, there was no capacity for KNP management to carry out this research internally.

4.63 KNP management has therefore adopted a cooperative approach to ensuring adequate and appropriate research and monitoring is carried out in Kakadu. The Committee was briefed on some of the mechanisms by which research is carried out, including the roles of the Kakadu Research Advisory Committee (KRAC) and the National Environmental Research Program (NERP) Northern Australia Hub. The KRAC contributes to identifying research priorities, with research being carried out by partner organisations. Research outcomes are then used to guide KNP management decisions. The NERP Northern Australia Hub was established with federal government funding and is hosted by Charles Darwin University. The Hub brings together research partners from across the country to 'improve biodiversity conservation in northern Australia through sound planning, innovative policy and strong partnerships'.[13]

## Committee comment

4.64 As with several other site inspections, briefings in KNP underscored the importance of thorough research and long-term baseline environmental data to help guide environmental management decisions. The Committee notes that such data will play an even more significant role in biodiversity conservation as the need to respond to climate change impacts becomes greater.

4.65 The Committee acknowledges the challenges facing KNP management in collecting such data, due to the park's size and location and the

13 DSEWPAC, 'National Environmental Research Program: research hubs', <http://www.environment.gov.au/biodiversity/science/nerp/hubs.html> viewed 20 October 2012.

availability of resources. The Committee therefore considers the collaborative approach taken by KNP to be beneficial and appropriate given the circumstances.

## Concluding remarks

4.66 The Committee appreciated the opportunity to inspect Kakadu's iconic ecosystems, including the wetlands identified by submissions as an example of an ecosystem of national importance. The Committee also valued hearing about some of the existing threats to Kakadu's biodiversity and how these might be affected by climate change. Valuable discussions were had regarding the management of a national park in complex circumstances, and KNP representatives' insights about the need for research and monitoring were also useful. By seeing parts of the Yellow Water Wetlands firsthand, the Committee gained a more thorough understanding of the ecosystem's complexity and the threats it faces.

4.67 The Committee wishes to extend its thanks to Kakadu National Park management for facilitating the visit and for making representatives available to provide extensive briefings and supporting material during the site inspection. The Committee is also grateful for the assistance and insights of local guides who it met with during its inspection.