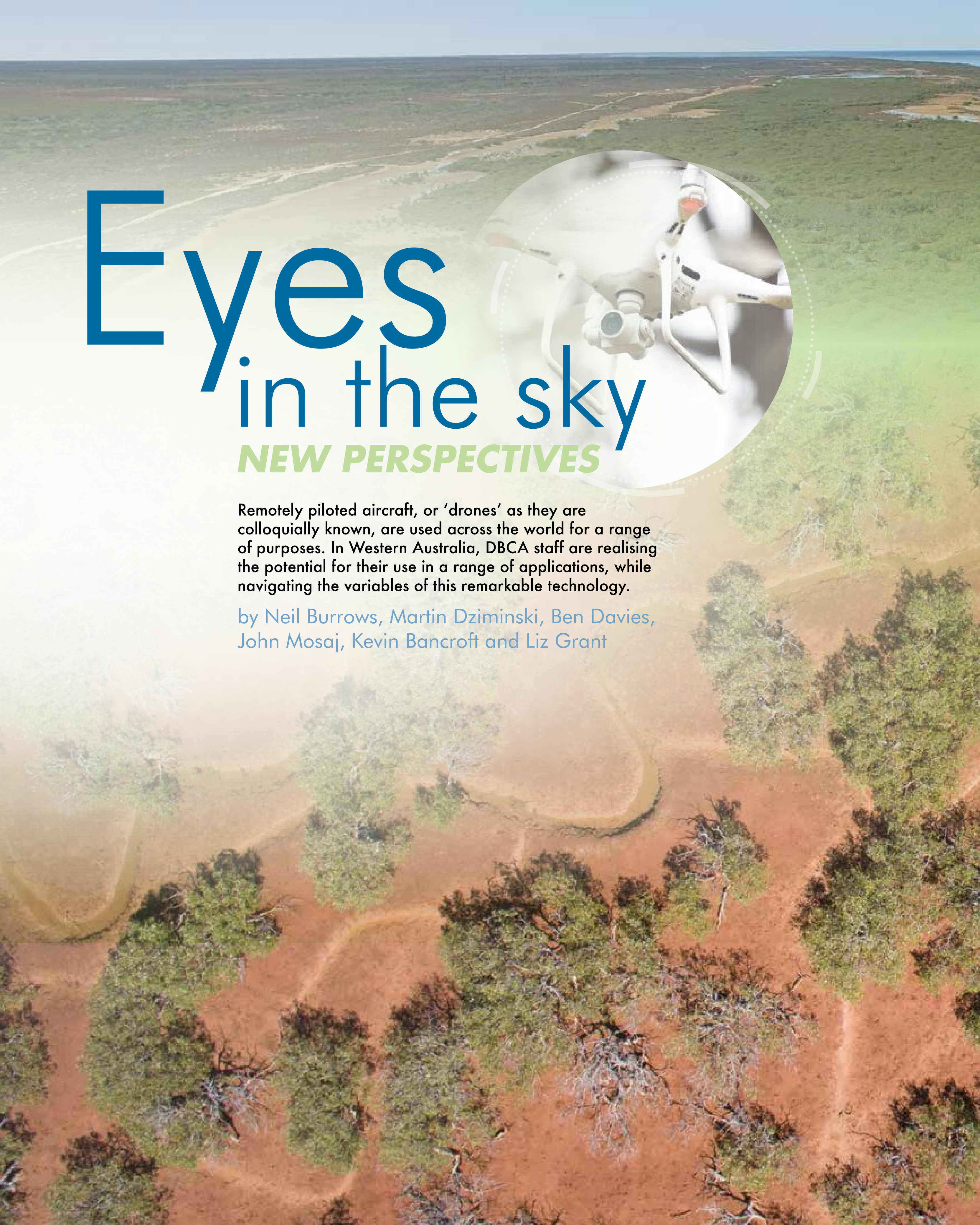

Eyes in the sky

NEW PERSPECTIVES

Remotely piloted aircraft, or 'drones' as they are colloquially known, are used across the world for a range of purposes. In Western Australia, DBCA staff are realising the potential for their use in a range of applications, while navigating the variables of this remarkable technology.

by Neil Burrows, Martin Dziminski, Ben Davies, John Mosaj, Kevin Bancroft and Liz Grant

Remotely piloted aircraft (RPAs), or 'drones' as they are known have been used in surveillance and military operations since WWI. In the years since, the associated technology has become considerably more advanced and the devices have become more affordable and easier to operate, making them popular for a range of uses in a variety of landscapes. Throughout the world, they are commonly used for search and recovery operations; photography and filming; shipping and delivery; auditing construction and agriculture; law enforcement; weather surveillance and in many other applications. In recent years they have also become an important tool in conservation, land and fire management, and research. As the technology becomes increasingly mainstream, more and more research undertaken by DBCA's scientists are making use of their capability, and realising their potential.

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Main Mangrove communities, such as these in the Kimberley, will be subject of studies made more viable by the use of RPAs.
Photos – Peter Nicholas/DBCA
Inset bottom PhD student Elizabeth Bevan operates an RPA.
Photo – Ryan Douglas/DBCA

Above Diggings reveal the presence of cryptic animals such as the bilby.

Right A multi-rotor RPA being used to survey bilby habitat.

Below A comparison of what can be seen at 12 metres and 45 degrees (left) and 25 metres and 45 degrees (right).
Photos – Fiona Carpenter/DBCA

SPYING BILBIES

The threatened greater bilby (*Macrotis lagotis*) occurs throughout the Pilbara and other arid areas of northern Western Australia. While this distribution is a fraction of what it used to be, their home ranges are large, individuals are sparsely distributed across a broad area and they are also known to move across the landscape. To make things even more challenging for those who are trying to research them, bilbies are nocturnal and cryptic by nature, so they are not easily observed and researchers rely on observations of signs such as tracks, scats, diggings and burrows. In the past, helicopters have been used to carry out aerial surveys. However, the cost and logistics of these operations have proved limiting, so scientists and field staff have often resorted to traversing the landscape on foot, by car and even on horseback.

At the end of 2016 a research team from the former Department of Parks and Wildlife began a trial of using the photographic capacity of RPAs to survey bilbies in the Pilbara. Twelve flights were carried out over an area known to be inhabited by bilbies to test variables such as altitude flown, flight speed and camera angles. The flights were all carried out at midday to avoid shadows. The device used – a small multi-rotor RPA – was enabled with a live HD video feed onto a portable monitor, so research scientist Martin Dziminski and his team could watch in real time what the RPA was recording. The diggings observed by the RPA were then ground-truthed by staff and volunteers who travelled out to each sighting. While verification of the sightings was necessary for the trial, being able to watch the footage in real time while in the field avoided the need for lengthy post-processing of the footage.

The trial revealed that areas with bilby diggings rather than individual burrows,

See some examples of RPA use in WA

Scan this QR code or visit Parks and Wildlife's '*LANDSCOPE*' playlist on YouTube.

Above left An RPA was used at Cape Domett in an attempt to unlock the secrets of marine turtles.
Photo – Peter Nicholas/DBCA

Above PhD student Elizabeth Bevan with the RPA she and the research team used to monitor the turtles at sea.
Photo – Ryan Douglas/DBCA

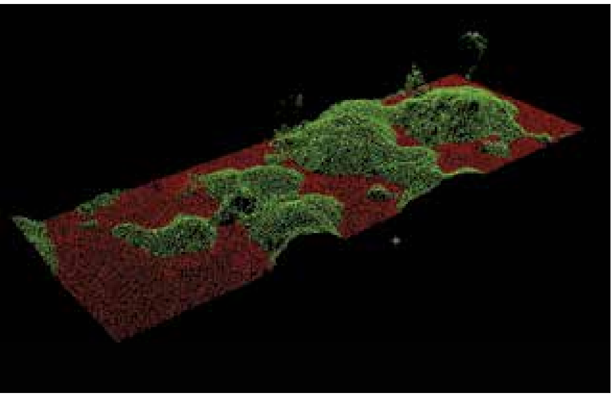
which were often beneath a bush or spinifex clump, were more easily identified from aerial imagery. Martin and his team also found more signs of bilbies the slower and lower the RPA travelled. However, this style of flying used more battery power than if the RPA was flown higher and faster. In fact, they found that by increasing the speed of the RPA to eight kilometres per hour, increased the amount of ground covered by 30 per cent over a 20-minute flight. While this resulted in a slight cost in detectability, the team is confident that with the rapid development of RPA and battery technology, RPAs will soon become a critical tool in detecting the presence of species, particularly those that leave signs of diggings, in remote locations or across large areas.

SPOTTING SEA TURTLES

RPAs are thought to also hold the key to help unlock some of the secrets of another cryptic creature – marine turtles. Little is known about the decades between when sea turtles emerge as hatchlings to disappear into the ocean and when the females reappear on beaches to lay eggs of their own. Learning about this phase of a sea turtle's life cycle is extremely challenging and scientists have long been searching for new ways to improve their understanding of this life stage (see also 'Thevenard Island: Turtle stronghold', *LANDSCOPE*, Winter 2017).

University of Alabama Birmingham PhD student Elizabeth Bevan spent time in WA in August 2017 working with department staff Scott Whiting, Tony Tucker and Ryan Douglas, Adrian Lane (Dambimangari ranger), Danny Barrow and Ben Corey to investigate the possible use of RPAs for turtle research and monitoring. As part of the trial for future surveys and behavioural studies, the team used RPAs to record turtles at sea. By observing turtles from the sky, researchers hoped to eliminate potential impacts on the turtles' behaviour caused by boat traffic or water-based operations. Another aim of the trial was to determine the usefulness of RPAs to view turtles across multiple habitats, such as beaches, reefs and the open ocean, and to quantify if a turtle's behaviour is altered when approached by a RPA.

The team also tested RPAs as an alternative to traditional beach surveys to check for turtle tracks and nesting turtles, which are typically carried out on foot. Until now, dedicated volunteers and scientists walk, often in very difficult conditions in extreme heat and at night, to record the number and activity of hatchlings and females by counting their tracks. The trial showed that using RPAs to survey beaches and the ocean saved staff and volunteer time in the field, helped cover a greater survey area, provided a safer survey alternative for some hazardous sites – such as those that may be inhabited by crocodiles – and enabled turtle behaviour to be viewed without the impacts of the observers themselves. RPAs also provided the opportunity to



Above Data derived from the RPA imagery in the spinifex meadows at Millstream Chichester National Park. The small clouds floating above the hummocks are seed heads.
Photo – Paul Rampant/DBCA

Right Patch burn pattern of spinifex.
Photo – Jiri Lochman

Far right RPAs are used in a variety of landscapes.
Photo – DBCA

view the turtles in the context of the entire landscape, which cannot be done at ground-level.

Staff from the department's Marine Science Program have teamed up with Murdoch University colleagues to follow humpback dolphins (*Sousa sahulensis*) using small quadcopters to determine how much time dolphins spend submerged, versus how long they can be seen from the air. This information will be applied to more accurately estimate the sizes of dolphin populations from the series of traditional surveys conducted from planes during the past three years. These aerial surveys provide a population census, but it's a minimum count, given that the dolphins can't be counted when they're underwater and not visible from the sky. Researchers can attach tags to the dolphins to quantify dive times, or use helicopters to follow them from the air, but both operations are more expensive and invasive.

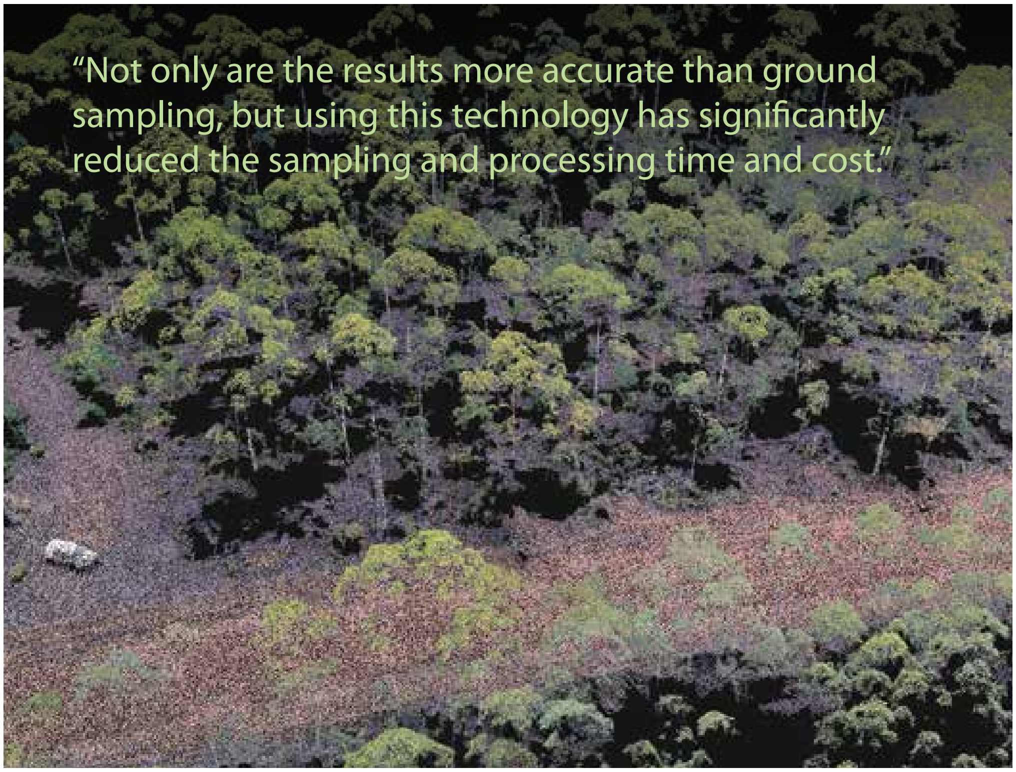
Another collaboration between the department and Murdoch University has used an RPA, which takes off and lands vertically like a quadcopter but then flies a survey pattern as a fixed-wing aircraft, to survey dugongs. Murdoch University started trialling the unmanned survey approach for dugongs in 2012 in Shark Bay. This information is being married with a study into the density and condition of seagrass, which is being undertaken by Edith Cowan University. One of the main advantages of using RPAs for this type of research is that it eliminates the risk for people flying at low altitude over water to record dugongs.

'DRONES' IN THE DESERT

In yet another application, the department has been using RPAs to better understand WA's spinifex deserts, where each year lightning-caused mega-fires sweep through. These fires, clearly detectable on satellite imagery, can burn as much as 100,000 square kilometres of the desert in some years, but are barely noticed by people other than those who live there. WA's deserts are sparsely populated, so unlike the south-west of the State, the bushfire threat to human life is relatively low. However, the desert megafires can threaten remote communities, Aboriginal cultural values, visitors to the region and infrastructure associated with mining, pastoralism and tourism. They also contribute to wildlife losses and are a significant contribution to Australia's greenhouse gas emissions. Given the remoteness, the vast expanses and limited resources, most of these fires are not able to be suppressed and eventually burn themselves out by running in to recently burnt country, or extinguish when weather conditions abate.

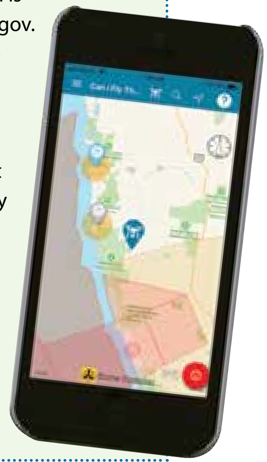
It was not always like this. For thousands of years before European settlement, Aboriginal people used fire regularly and skillfully for a myriad of reasons. This resulted in a fine grain patchwork of vegetation at different growth stages. Most of the landscape was made up of patches of young spinifex, which were a buffer to the development and spread of megafires. With the departure of traditional Aboriginal burning across much of the desert following European settlement, the fire pattern changed dramatically and quickly. The small, cool patchy fires lit by Aboriginal people gave way to large, hot lightning-caused fires. This changed fire pattern has been implicated in the decline of mammals and some bird species, as well as fire-sensitive plants such as cypress pine (*Callitris* spp.) and mulga (*Acacia aneura*).

Concerned by the damage caused by hot megafires, Aboriginal and non-Aboriginal landholders are looking to reintroduce cool patch burning. To safely plan and implement this form of



Did you know?

All RPA users need to obtain authority to operate RPAs on the lands and waters the department manages. More information is available at www.dpaw.wa.gov.au/management/remotely-piloted-aircraft. CASA has developed an easy-to-use app – *Can I fly there,* which provides information about where you are allowed to fly RPAs and which areas are no-fly zones. It is available from the Apple App store, Google play and as a web app. More information about CASA is available from www.casa.gov.au.



prescribed burning on lands managed by the department, a firm knowledge of spinifex fire behaviour is essential. We need to know the weather and fuel conditions under which spinifex fires will ignite and spread, and when they won't. And when conditions are right for fire to spread, we need to know how fast it will spread so we can predict where it might go and what values it might threaten. To this end, scientists have been studying the characteristics of spinifex as a fuel for bushfires, and setting experimental fires to understand how they behave under different fuel and weather conditions. The aim is to provide fire and land managers with guidelines on how to forecast the fire danger rating and predict the behaviour of spinifex fires.

The cover of spinifex, together with wind speed, are important for determining whether fires will spread. The proportion of the ground that is covered by spinifex is largely dependent on the age of the spinifex (how long since the last fire), the soil conditions, and the amount of rain since the last fire. Historically, researchers have used slow and tedious methods of assessing spinifex cover using ground-based sampling techniques. But, in 2016, senior principal research scientist Neil Burrows and his team used an RPA to take aerial photographs over different spinifex communities and then used a computer-automated process to calculate spinifex cover and the area of bare ground from the photos. Not only are the results more accurate than ground sampling, but using this technology has significantly reduced the sampling and processing time and cost. What would normally take several people a whole day, can now be done in under an hour using the RPA and computer technology.

SEEING THE TREES AND THE FOREST

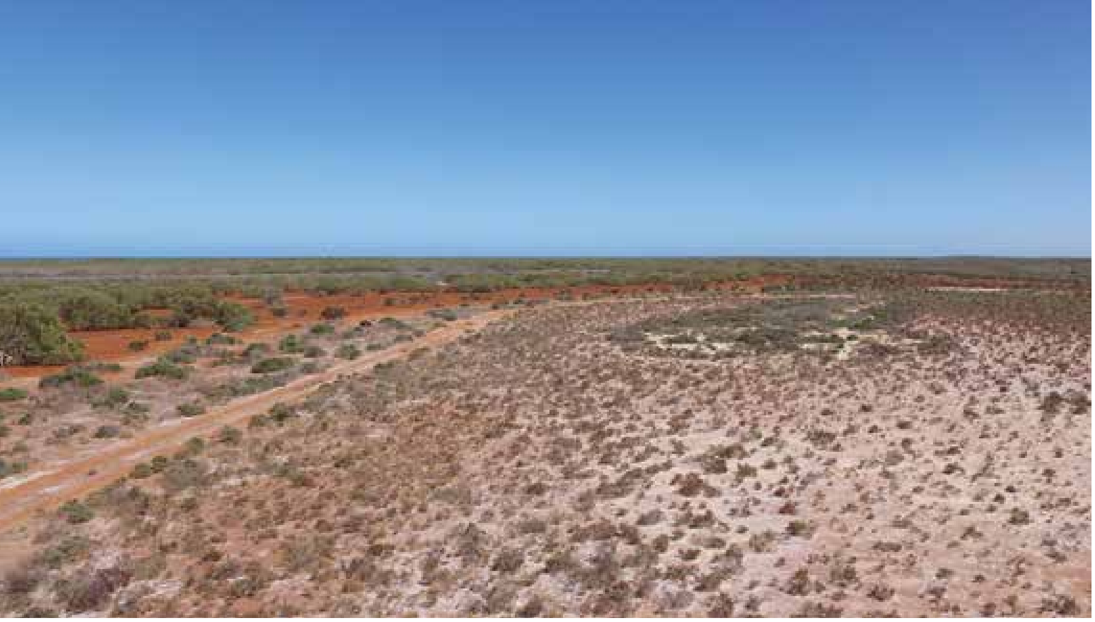
The department has long used aerial surveying to map vegetation to inform silvicultural management, carry out assessments on old-growth forest, dieback mapping and assessment, and to help inform reserve planning in the south-west. Traditionally, they mounted a camera to a Cessna 172 that they used to take aerial photographs, which were interpreted as a single frame, viewed in stereo or combined to create a photo mosaic.

Recent advances in technology and photogrammetric software is enabling the department to create datasets from aerial photographs that have been captured by RPAs for use in photo interpretation, photogrammetric measurement and statistical analysis.

A significant development in this work is the processing of RPA-captured aerial images into photogrammetric 'point cloud data', which can construct spatially accurate three-dimensional images of the forest based on a very large number of points. Point cloud data can also be used to carry out accurate tree measurements, including height and crown cover.

Going forward, RPAs are set to also play a role in the way the department manages forest fires. The ability to use thermal imaging to detect hotspots on the perimeter of a fire will help fire managers predict weak containment lines and areas of vulnerability. Using RPAs to survey the fire perimeter will lessen the current dependence on the favourable weather conditions needed to fly over the boundary and will provide more accurate

Above left Point cloud data is used to construct an impression of the forest, which enables the department to carry out tree measurements and other assessments.
Photo – DBCA



Left An RPA provides an aerial view of the diminished mangrove forests of Shark Bay.

Above View of The Gap, Albany from above.
Photos – Peter Nicholas/DBCA

information on the location and security of the fire boundaries and hot spots. They will also enable surveillance to be carried out at night, when conventional aviation activities are limited by operation factors and visability.

Department researchers have also been using RPAs to survey the 'forests' of Shark Bay along the Carnarvon Coast, which few people know is the southern-most substantial area of mangrove in WA. The current method for surveying this area, which supports rich and diverse fauna, including birds and invertebrates, is to use satellite imagery which generates 15-metre pixels. These images are then verified with ground-truthing of individual tree canopy cover at a number of locations with various densities.

Using RPAs to survey mangrove communities enables researchers to carry out targeted investigations of tree and canopy densities and facilitates quick data collection. Avoiding the need for ground-truthing also eliminates the risks associated with entering areas that are populated by midges, mosquitoes, flies, snakes and, in particular, crocodiles in the Kimberley; avoids hazards associated with travelling in a muddy substrate such as getting bogged; reduces the potential for personal injury; and negates the challenges associated with changing tides and currents.

In 2016 a team investigated the substantial loss of mangroves in the Carnarvon Coast in Shark Bay Marine Park and World Heritage Area. The RPAs used as part of this study provided substantial verification imagery of this loss, which researchers suspect was caused by a combination of environmental pressures such as increasing seawater temperature, air temperature and sediment salinity, and decreasing rainfall. There are also future plans to use RPAs to provide ground truth data at numerous sites in the 140,000 hectares of mangroves in the Kimberley.

THE SKY'S THE LIMIT – OR IS IT?

As with any rapidly emerging technology, the common and widespread use of RPAs has led to the development of associated regulations. These ensure that RPAs do not impact on the safety or security of individuals, infrastructure or the natural environment and the department operates within the perimeters outlined by the Civil Aviation Safety Authority.

When used in parks and reserves by visitors, RPAs can pose a potential threat to other visitors, other air users and operators if they crash. They can affect vegetation and wildlife and, in some cases, they may even pose a fire risk. They may also detract from other visitors' experiences, places of cultural significance as well as impact on visitor privacy. Traditional owners have also raised concerns over the impact of RPAs on cultural values.

So, while the benefits of RPAs in a range of applications are numerous, and the department continues to use the technology in research projects and as part of its other management responsibilities, there is much to consider when it comes to their use. However, we can be sure that as the battery power, technology and supporting software continues to improve, RPAs will be incorporated into an increasing number of departmental projects in the future, and the impact they will make on our ability to carry out science and conservation, which may not have otherwise been possible, will undoubtedly increase.

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