1. PURPOSE

The purpose of this procedure is to outline the steps required to undertake targeted fauna surveys for threatened and priority listed species that may be present within areas of pure and mixed karri forest. Outcomes from these surveys will be used to further validate and update the Fauna Information Distribution System (FDIS). In coupes where the surveys are carried out, the surveys will complement FDIS as a tool for informing forest management decisions. In addition, introduced pest animals such as foxes and cats can be identified and management actions implemented as appropriate.

2. PROCEDURE

Targeted flora surveys are already undertaken in areas that will result in permanent or semi-permanent disturbance, for example, road construction and log landings. However, limited fauna monitoring has previously been carried out within the karri forest. Targeted surveys commenced in April 2015. They currently consist of:

a) camera surveys for terrestrial and arboreal species;

b) indirect monitoring techniques for species that are less-detectable by cameras; and

c) call-based surveys for threatened bird species.

Camera surveys are established to detect threatened and priority listed species present within selected areas about to be harvested. Data recorded by camera surveys typically consist of an image or series of images of individuals or groups of animals within the area of detection covered by the camera. As most individuals can be identified to species, the camera essentially records the presence of that species at that place and time. This can be a useful tool for informing management action, but also provides opportunities for short and long-term assessment of occupancy patterns by threatened species in these areas.

Camera surveys are complemented by surveys for skeletal remains, feathers, sloughed skin, feeding signs, faecal material, runnels, tracks, scratches, wallows, nests, dens, mounds, burrows, roosts and hollows. These activity indicators can provide indirect evidence of a species' presence, especially if the sign is species-specific.

To detect the presence of threatened bird species of interest, e.g. threatened cockatoo and owl species, call-based surveys are undertaken to detect individuals, mating pairs and flocks. Data recorded during these surveys can be useful for identifying important nesting hollows and trees for retention as part of the FPC's habitat and legacy element retention procedures. These surveys will also allow determination of how threatened birds are using the harvest areas over time.

The surveys and assessment of data are undertaken by trained FPC staff with support from experienced wildlife ecologists. In 2015 FPC engaged a contract ecologist to assist with the implementation of this procedure and to provide advice. Department of Parks and Wildlife (Parks and Wildlife) staff with specific expertise in the identification and management of vertebrate fauna are responsible for validating survey results and for approving any management actions proposed to reduce species-level impacts. The two agencies will work together to review and improve the survey methods.

2.1 Targeted fauna surveys

The rationale for the use of camera surveys, indirect survey techniques and call-based surveys is outlined in Appendix 2.

2.1.1 Camera survey

Camera surveys are undertaken in the following karri forest strata, which represent the range of strata available for timber harvesting:

a) Young karri regrowth, approximately 30 years old, receiving first thinning operation.

b) Pre-1950's regrowth karri forest, receiving a regeneration, clearfall or second thinning operation.

c) Mature two-tiered karri forest receiving a regeneration or clearfall operation.

The coupes surveyed are representative of the sub-regions, landforms and forest types that are scheduled for harvest over the following 12 month period and include those most likely to have threatened species present. The number of coupes to be surveyed over any 12 month period is informed by the outcomes of previous surveys and also consideration of feedback from stakeholders.

The number and configuration of cameras to be deployed in each coupe is dependent on: coupe size, topography, variation in vegetation structure and habitat type, and known movement and behavioral patterns of threatened species likely to be present in the survey area.

For each camera survey, FPC staff undertake the following:

1) GPS referencing (on a map and in field) of each camera deployed.
2) Retrieval of cameras after a minimum of 20 days has elapsed.
3) Download of camera photo captures and identification of fauna (a Parks and Wildlife approved ecologist will assist with identification and verification).
4) Record identified fauna and provide a report to Parks and Wildlife with the planning checklist for disturbance activities (Form DPaWFEM 019). This coupe approval package will facilitate advice on any required management actions.

2.1.2 Indirect monitoring techniques

Indirect monitoring of activity indicators such as faecal material, tracks, diggings, runnels, burrows, nests, nesting hollows, dens and scratches on trees is undertaken. This monitoring is not intended to be a detailed search of the entire coupe area, but rather opportunistic observations. Observations by FPC staff may occur at any stage of the coupe planning process as well as during the establishment and retrieval of cameras. FPC staff undertake the following:

1) GPS referencing of the search area (track) and any evidence observed (point).
2) Physical marking of trees containing hollows for retention. These are marked with white flagging tape by the field ecologist and then with white paint by the coupe OIC.
3) Completion of data collection forms that document the type and freshness of observed activity indices, the species likely to be responsible, and confidence of identification. If there is an opportunity to record images, this is encouraged and where the quality is acceptable, are added as an attachment to the recording form.
4) Spatial maps of recorded activity indices (fresh only) are provided to Parks and Wildlife as a part of the fauna survey report accompanying the planning checklist for disturbance activities (Form DPaWFEM 019).

2.1.3 Call-based surveys for threatened bird species

Short-term surveys for the presence of threatened birds such as cockatoos and owls are unlikely to give a true representation of habitat use, due to the mobile nature of these species and their reliance on different areas of habitat at different times of the year and between years. For this reason, the primary aim of call-based surveys is to determine the likelihood of breeding activity occurring within coupe areas and locate important nesting hollows, for protection as part of the habitat and element retention processes. Roosts and feeding habitat are also documented to allow assessment of habitat use over time and to allow management responses to reduce impacts. Roosts for most of these species are usually located in or near riparian environments or permanent water. These areas are already protected in informal reserve systems and buffer zones.

The call-based surveys are undertaken as follows:

1) Selection of karri coupes for survey, based on the same selection process described for the camera surveys.
2) Identification of bird(s) of interest, Baudin's Cockatoo (*Calyptorhynchus baudinii*), Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*), barking owl (*Ninox connivens*), and/or masked owl (*Tyto novaehollandiae novaehollandiae*) at a coupe level.
3) In conjunction with an experienced ecologist, identification of a suitable road network or call point locations for survey work.
4) Determination of the number of sample points required to achieve effective coverage of the coupe area, taking into account different forest densities, coupe sizes, listening conditions and species being monitored.
5) At each sample point call based surveys are undertaken using listening or play back techniques relevant to the species of interest.

6) Where calls are heard, species are identified from calls and visual observations of the birds, feeding debris and/or feathers. Particular attention is paid to individual birds or contact calls occurring between pairs.

7) Where calls of pairs occur from within the coupe, GPS and bearing data are collected to enable triangulation for field assessment of potential breeding hollows or roosting sites.

8) Opportunistic call-based surveys are undertaken from within the coupe during camera set up, removal and surveys for fauna activity indices. These activities are also planned around triangulated locations of calling pairs to allow field location of active breeding hollows.

9) To maximise detection of breeding birds and hollows, surveys are undertaken during breeding, nesting and/ or young rearing season. For cockatoos, active nests are located most easily mid-morning or at dusk, when the male returns to the nest with food for the incubating or brooding female. Female birds may be flushed from the nest during diurnal surveys if the trunk of the tree is rubbed with a stick. For owls, birds are most easily detected just before sunset and in the first half hour after sunlight has completely faded. The first evening call is often made from or near the roost or nest.

10) Surveys are undertaken in the same coupe over at least two separate days in calm, fine weather, when ambient noise is low. For coupes that are operational over more than one year, cockatoo surveys are undertaken annually, during the relevant breeding seasons.

11) Data collection forms are completed to document species heard, locations, and confidence of identification. The form includes a categorised assessment of the number of individuals e.g. single individual, pair, small flock or large flock, numbers of birds where possible, genders if individuals or pairs are observed. Calls or visuals allow this level of differentiation. The presence of individual males may indicate there is a nest nearby. If there is an opportunity to record images or call/s, this is encouraged. If the quality of the images is acceptable, these are added as an attachment to the recording form.

12) Results are included with the FDIS report, and provided to Parks and Wildlife with the DPaWFEM 019 coupe approval package, to facilitate advice on required management actions.

13) Relevant FPC coupe managers and treemarkers are also informed of results and requirements.

2.2 Recordkeeping

All survey findings are recorded within the relevant harvest coupe planning file attached to the FDIS report. A simple spatial data set is also maintained for planning and longer-term coupe level and harvest plan evaluation purposes. A summary of the outcomes from camera surveys, indirect monitoring techniques and call-based surveys is produced, and a template example is shown in Appendix 3. In addition, completed fauna survey results with Parks and Wildlife endorsed management actions are provided to Parks and Wildlife's Species and Communities Branch. This ensures that Species and Communities Branch have noted any confirmed sightings of threatened or priority listed fauna and that this data contributes to state level datasets.

2.3 Management actions

Modified management actions are carried out as a result of survey outcomes where necessary, following consultation with Parks and Wildlife. These surveys are also used to further validate the FDIS and to complement FDIS as a tool for informing forest management decisions. In addition, introduced pest animals such as foxes and cats can be identified and management actions implemented as appropriate.

3. RESPONSIBILITIES

Selected operations staff undertake training in fauna monitoring and implement surveys under the direction of a Parks and Wildlife approved ecologist. FPC staff are responsible for recordkeeping and reporting confirmed sightings to Parks and Wildlife's Species and Communities Branch, as well as providing the complete fauna survey data.

The Manager Planning and Native Forest Silviculture helps to facilitate surveys on an annual basis and works with Parks and Wildlife to refine fauna monitoring procedures as required.

FPC recommends appropriate management actions based on the results of the surveys. Parks and Wildlife approves the management actions via the DPaWFEM 019 coupe approval package. FPC treemarkers and coupe managers are responsible for ensuring the appropriate implementation of these recommendations.

The Senior Coordinator, Forest Management Systems coordinates stakeholder consultation in regards to the intensity and implementation of targeted fauna surveys.

4. RESOURCES

- DPaWFEM 019 – Planning checklist for disturbance activities

5. APPENDICES

- Appendix 1 – Background on the Fauna Distribution Information System (FDIS)
- Appendix 2 – Method justification for camera surveys and call-based surveys
- Appendix 3 – Example fauna survey report

Appendix 1 – Background on the Fauna Distribution Information System (FDIS)

As described in the Forest Products Commission's (FPC's) management plan for the karri forest, the Fauna Distribution Information System (FDIS) is checked during pre-disturbance (including harvesting) activities. FDIS was developed based on scientific knowledge available on vertebrate species in the South West of Western Australia and validated against fauna occurrence records. FDIS provides a precautionary survey tool to assess likely fauna presence, as for example, where there is a moderate possibility that a threatened fauna species will be present in a given area (the potential for the presence of threatened species), management strategies are implemented in accordance with Department of Parks and Wildlife's (Parks and Wildlife's) instructions. The following excerpt of the FDIS manual (Christensen *et al*. 2005) further explains FDIS.

Excerpt of the FDIS manual (Christensen *et al.* 2005) [1]:

FDIS is a computerized system for predicting the occurrence of vertebrate fauna species in any given area of forest prior to timber harvesting or prescribed burning operations. The system allows 'sensitive' species to be taken account of prior to planned disturbance events thereby obviating the need for expensive biological surveys. As a predictive system FDIS has a number of advantages over the biological survey method that is generally used to discover what species are present within an area.

Commenced in 1996, FDIS developed from a system of field inspections of forest blocks containing proposed harvesting coupes by the two senior authors. The likelihood of the presence of fauna species in the block was assessed in the field by using a list of 279 vertebrate forest species and listing them against major vegetation associations found by field inspection to be present within the block. Species were listed and scored on a scale of 0-3, scores being allocated using the combined accumulated knowledge and experience of the two senior authors (total of more than 60 years) together with information contained in standard texts on fauna. The system was later refined, the Havel/Mattiske RFA Vegetation Complexes map, replacing the field trips as a basis for the fauna predictions. Over a period of 2 years various combinations of the more than 300 Vegetation Complexes were assessed against fauna distributions. Using trial and error it was found that a combination of the major forest formations together with moisture and temperature gradients, both dictated largely by latitude and distance from the sea, gave the most reliable Vegetation Complexes combinations for predicting fauna. As a result 54 'Fauna Habitats' were developed for use in predicting fauna distribution within the forested area.

A Fauna Habitats/Vertebrate species table, (54 habitats/306 species), comprising a total of 16,524 possible combinations, forms the basis of the predictions which can now be made readily on the computer for any given area within the forest. The use of the Havel/Mattiske maps eliminates the need for field visits to each coupe and every proposed prescribed burn area each year.

The system has been validated using the more recent and most accurate WA Museum and CALM [now Parks and Wildlife] fauna records.

Species schedules, that give details of relevant biology as well as recommendations for management, have been developed for each 'sensitive' species. The system also contains tables with extra information on fauna succession following timber harvesting and regeneration and prescribed fire.

1 This extract has been taken from the Executive summary (pg. 6-7) and Timber harvesting (pg. 21-22).

The object of the assessment procedure is to identify what vertebrate fauna are likely to occur within felling coupes prior to any timber harvesting and regeneration operations taking place. This allows measures to be taken to further protect any species that might need to be given special attention, over and above the routine precautions built into the current silvicultural prescriptions.

The FDIS procedure is an indirect method based on predictions of fauna occurrences in mapped vegetation complexes. Christensen and Liddelow [1997] consider that this indirect method of assessment is superior to carrying out actual biological surveys in each coupe, for the following reasons:

- *standard biological survey, unless repeated over several years, can only provide a 'point in time' snapshot of the fauna that inhabits any habitat;*
- *the 'rare' and restricted species, the species of most interest to managers, are often not recorded during biological surveys because these species are usually uncommon and few in number;*
- *the activity of many species, in particular reptiles and birds, is strongly regulated by seasonal factors, which means that a 'once off' biological survey is unlikely to locate all the species that occur in an area; and*
- *surveys on small areas, such as a felling coupe, will inevitably underestimate the species that may be present in the general area and which utilize the coupe but are not necessarily present on the coupe all of the time.*

It is suggested that biological surveys in these situations can in fact be counter-productive, managers may be 'lulled into a false sense of security' by the fact that an area has been actually 'checked on the ground.' In reality it is almost certain the list of fauna produced as a result of a biological survey of a coupe or an area in preparation for prescribed burning, will be incomplete. Worst of all, the species that are missed during biological surveys are likely to be the less obvious and less common species, the very species managers need to know about.

The indirect predictive technique on the other hand allows attention to be focussed on the species sensitive to timber harvest and regeneration and prescribed fire in the most practical and cost effective manner. Thus in cases where predictions indicate probable presence, follow-up field assessment and confirmation of a species presence can be undertaken using targeted survey techniques if this is deemed to be necessary. In practice we have found that this usually only applies to a limited number of coupes. Biological surveys are nevertheless a very useful mechanism for improving our knowledge of species distribution and every opportunity should be taken to carry out biological surveys in areas of forest not previously surveyed or where FDIS information needs to be improved.

FDIS is a precautionary tool that is used to ensure the protection of threatened and priority fauna, and any targeted surveys undertaken by FPC will complement and help to further validate and improve this existing system. Targeted surveys will consider survey limitations associated with the detection probability of some species (e.g. those that are impacted by seasonal factors, in low abundance or rare and so less likely to be located). However, notwithstanding this, targeted fauna surveys can potentially add value to the FDIS system and provide information on habitat that may be 'point in time' utilised by threatened and priority fauna. This will be achieved through the provision of high precision spatial data to Parks and Wildlife that can be uploaded into FDIS to improve the predictive capacity and accuracy of the system.

This spatial data will also contribute to the 'Threatened and Priority Fauna database', a dataset maintained by Parks and Wildlife that contains locational data for threatened and priority listed fauna throughout the State. This data is available to the public in 'NatureMap', a data portal created in collaboration with the Western Australian Museum. Each year, the most up-to-date records of confirmed fauna sightings are obtained from Parks and Wildlife Species and Communities branch, following a search in the karri forest management unit (FMU). This data is compared with FDIS data, as well as other research and knowledge on species habitat requirements to improve our understanding of what species can reasonably be considered present in the FMU and areas immediately adjoining the FMU. Multiple sources of information are considered important in making this assessment.

In cases where the search data from the Threatened and Priority Fauna database return very low (e.g. one sighting) numbers of a threatened species within the karri FMU and surrounds, some validation could be employed via knowledge about distribution, habitat, using the FDIS system and also via results of the targeted fauna surveys.

In addition, in the future, Parks and Wildlife may extend the current FORESTCHECK program into the karri forest (it is currently in jarrah forest). Further background information about FORESTCHECK, and how the results of this long-term research program have helped inform the approach taken to targeted fauna surveys can be found at: http://www.dpaw.wa.gov.au/about-us/science-and-research/landscape-conservation-research/183-forestcheck. The approach taken to targeted fauna surveys has also been developed in consideration of how the results could contribute towards the extension of FORESTCHECK into karri forest.

Overall, FPC hopes to implement targeted fauna surveys that will contribute to more effective management outcomes in the long-term and contribute to improved locational and habitat knowledge for threatened and priority fauna occurring in the karri forests.

Appendix 2 – Method justification for camera surveys and call-based surveys

Camera surveys

Camera survey has been chosen as the best method for undertaking targeted surveys for threatened and priority fauna based on reported success in other monitoring programs within the forests of the south west (e.g. Robinson and Tunsell 2014), for threatened and difficult to survey species in other parts of Australia (e.g. De Bondi *et al*. 2010, Antos and Yuen 2014, Harley *et al*. 2014, Nelson *et al*. 2014, McDonald *et al.* 2015) and more widely (e.g. Samejima *et al*. 2012, Townsend *et al*. 2014).

There are a number of methods that can be used for on ground survey to detect presence/absence of vertebrate fauna. FORESTCHECK historically has used wire cage traps and large (20 litre) pit fall traps on predetermined survey grids. In addition, this is augmented by spot light surveys and road surveys. In 2013 remote camera monitoring was trialled for the first time (Robinson and Tunsell 2014). The trial was based on work undertaken by Smith and Coulson (2012), investigating camera survey applications for the detection of potoroos and bandicoots. The use of camera surveys in FORESTCHECK was successful, with the cameras capturing most of the species that were captured in the wire cage traps, as well as additional species that were not otherwise trapped such as small birds, western grey kangaroos, western brush wallabies and echidnas. Other studies have also identified that camera surveys compare favourably with live-trapping surveys, and are more cost effective than live trapping for survey of cryptic species, especially where population densities are low (e.g. De Bondi *et al*. 2010, Nelson *et al*. 2014).

Camera surveys are being increasingly used around the world to study elusive fauna species. Cameras are appealing for several reasons, including: (1)They are relatively unobtrusive and avoid the need to physically catch and handle wildlife; (2) they can be left in the field for extended periods; (3) multiple cameras can be deployed simultaneously, allowing large areas to be surveyed; (4) they improve detection rates for cryptic fauna, as previously mentioned; (5) they are robust to inclement weather conditions and unexpected events that would disrupt a cage and pitfall trapping program; (6) the level of training associated with use of cameras is not as high as that required for animal handling; (7) ethics constraints are not as considerable as live trapping; and (8) there are potential applications for the survey of arboreal species as well as ground dwelling species (Drury 2014, Harley *et al.* 2014).

There are a number of potential limitations that need to be considered when using camera surveys, particularly in relation to operator training, camera model, camera placement and orientation, triggering and recovery, camera settings, temperature differentials, species identification and behavioural responses of the animals to the cameras (Antos and Yuen 2014, Meeks *et al*. 2015). These limitations can be largely overcome with training, field protocols and the use of complementary survey methods such as indirect monitoring techniques.

FPC's primary target fauna species for the surveys are ones that have the highest probability of being present in the areas where timber harvesting occurs. Therefore, surveys will not target threatened fauna that are known to be present solely within riparian areas of the FMU, such as Carter's fresh water mussel (*Westralunio carteri*) and the sunset frog (*Spicospina flammocaerulea*) (Burbidge and Roberts 2002, Klunzinger *et al*. 2015). The potential impact of timber harvesting on such species is likely to be less direct, as shown by monitoring carried out since the 1980s that investigates the broader effects of forest management on aquatic invertebrates (Pennifold and Pinder 2011).

Camera survey will provide information regarding the presence of threatened species and the utilisation of habitat elements within areas proposed to be harvested. Table 1 provides information on each of the threatened fauna species that are being targeted for these surveys.

Table 1: Species targeted by camera and indirect surveys in the karri forest management unit

Common name	Ranking*	Scientific name	Probability of occurrence*	Details on survey method suitability
Chuditch	VU	*Dasyurus geoffroii*	1	This is a medium sized ground dwelling animal that is likely to be detected by camera survey and indirect surveys for faecal material and dens.
Mallee fowl	VU	*Leipoa ocellata*	3	This is a medium sized bird mostly active on the ground. Therefore, camera surveys are likely to detect this species. The species also builds very distinctive mounds that are likely to be detected during indirect monitoring techniques. Although historically recorded in the karri FMU there are no recent verified sightings.
Numbat	EN	*Myrmecobius fasciatus*	3	This is a small-medium sized ground dwelling animal that is more likely to be detected by camera survey than by cage trapping. Indirect survey techniques will also search for faecal material, feeding patterns in termite mounds and den logs. There are few records of this species in the karri FMU (Peacock 2006). This species is most likely to occur in mixed karri-jarrah forest on the boundaries of the FMU
Quenda (Southern Brown Bandicoot)	P5	*Isoodon obesulus fusciventer*	1	Previously detected by camera survey (Robinson and Tunsell 2014). Indirect monitoring techniques will also be able to detect diggings and runnels.

Table 1: continued

Common name	Ranking*	Scientific name	Probability of occurrence*	Details on survey method suitability
Quokka	VU	*Setonix brachyurus*	1	Previously detected by camera survey (Robinson and Tunsell 2014). Indirect monitoring techniques will also be able to detect faecal material and runnels.
South-western Brush-tailed Phascogale	CD	*Phascogale tapoatafa wambenger*	1	This is a small arboreal mammal that spends 80-90% of its time among the tree canopy (Scarff and Bradley 2006). Probability of detection on the ground is likely to be lower than for ground dwelling fauna; however use of cameras for arboreal survey will increase detection probability, particularly where this is combined with indirect monitoring techniques.
Western Pygmy Trapdoor Spider	P3	*Bertmainius opimus*	1	Burrows of this species in Karri bark, while cryptic, can be readily used to identify the presence of this species. Burrow searches are included in indirect monitoring techniques.
Tammar Wallaby (Western Australian subspecies)	P5	*Macropus eugenii derbianus*	3	Camera surveys have been found to be effective at detecting wallabies (Robinson and Tunsell 2014). Indirect monitoring techniques will also be able to detect faecal material.
Water Rat	P4	*Hydromys chrysogaster*	1	This is a small-medium sized ground dwelling animal that is likely to be readily detected by camera survey, where suitable habitat is targeted. Indirect monitoring techniques will also be able to detect evidence of feeding where this species is present.
Western Brush Wallaby	P4	*Macropus irma*	1	Previously detected by camera survey (Robinson and Tunsell 2014). Indirect monitoring techniques will also be able to detect faecal material and pads.

Table 1: continued

Common name	Ranking*	Scientific name	Probability of occurrence*	Details on survey method suitability
Western Ringtail Possum	CR	*Pseudocheirus occidentalis*	1	This is a medium sized arboreal mammal that forages almost exclusively among the tree canopy. Probability of detection on the ground is likely to be low; however use of cameras for arboreal survey will increase detection probability, particularly where this is combined with indirect monitoring techniques such as hollow searches, tree scratches and faecal material.
Woylie	CR	*Bettongia penicillata ogilbyi*	1	Previously detected by camera survey (Robinson and Tunsell 2014). Indirect monitoring techniques will also be able to detect faecal material.

* Both ranking and probability of occurrence are explained in the FPC's management plan for the karri forest.

Some priority listed species are not being targeted in these surveys because they are either very unlikely to be present or they are not threatened by forest management activities. For example:

- Abbott et al. (2007) reported on the scorpion fly and indicated that '*Information collected from monitoring sites in Jarrah Eucalyptus marginata forest provides no strong indication that this species shows a preference for, or aversion to, a particular silvicultural treatment or period since the most recent fire*' (page 97).
- In regards to the Western False Pipistrelle, which is found throughout the South West, Christensen et al. (2005), considers that the extensive reserve system, fauna habitat zones, and retention of mature habitat elements within harvest coupes, caters adequately for this species.

Camera-trapping can also provide a useful method for detecting and monitoring pest animal activity, e.g. feral cats and foxes (Bengsen *et al*. 2011), as well as other feral animals including goat, deer and pigs. Information about the activity levels of these species will allow development of appropriate management responses.

It is recognised that camera survey will not be appropriate for gathering pre harvest information on presence/absence for threatened and iconic bird species, such as cockatoos and owls. It is therefore proposed that the camera survey will be augmented by call-based survey within and adjacent to coupes as part of pre harvesting planning requirements.

Call-based surveys for threatened bird species

Of the threatened bird species that have been identified as being present in the karri FMU, the Forest Red-tailed Black Cockatoo and Baudin's Cockatoo have been identified as the most dependent on the karri forest for habitat. Both species are relatively mobile and their reliance on different areas for foraging at different times of the year and between years makes protection of feeding resources during forestry operations impractical. Roosts for these species are usually located in or near riparian environments or permanent water (Johnstone and Kirkby 2008). These areas are already protected in informal reserve systems and buffer zones. In addition, these birds have a relatively large breeding home range of between 116 and 187 hectares (Abbott 1998) and so have access to undisturbed breeding hollows in areas of old-growth forest that are also protected within formal and informal reserve systems. However, because these species exhibit an obligate dependence on hollows in standing trees, one of the main threats remains the loss of breeding hollows as a result of clearing, fire damage and nest competition (Abbott 1998, Chapman 2008, Johnstone *et al*. 2013a).

Call-based surveys along the road networks and opportunistic surveys within the coupes during pre-harvest planning operations have been deemed the most suitable method for surveying for cockatoos, in conjunction with indirect monitoring techniques from the ground that search for hollows in standing trees and signs of feeding and roosting. The call-based surveys and indirect monitoring techniques aim to identify any breeding activity occurring within coupe areas and to locate important nesting hollows. Trees containing suitable hollows then become priorities for protection. Feeding and roosting habitat will also be surveyed, however as previously mentioned is unlikely that roosting habitat will be located within the harvest areas. Where roosting areas or high quality feeding habitat is located within the coupe, management responses will be considered to reduce potential impacts on the species arising from the harvesting of this resource. For example, this could include temporal separation of harvesting of these areas or offset of harvest times from human-cockatoo conflicts arising from feeding in orchards. The protection of hollows however is likely to be the most effective management strategy for threatened bird protection in the long-term and the remainder of this section focuses on this aspect.

Johnstone and Kirkby (2015) have reported differences in the male and female contact calls for Baudin's Cockatoo, and have also previously noted that both Baudin's Cockatoo and the Forest Red-tailed Black Cockatoo have a mating call that can be useful when trying to locate nests (Johnstone *et al.* 2013*b*, Johnstone *pers. com.* 2015). This may enable the differentiation of flock-based contact calls from mating calls or male-female breeding pairs in the field. In addition, where the birds are within the coupe area and out of sight, the differentiation of flocks from pairs or individuals can be made from a distance by listening to contact calls. The location of individuals, pairs or flocks can then be determined using a combination of GPS and bearing data from the road network.

Road based call surveys have been designed following Lee *et al*. (2013 *a, b*). They conducted observations from a vehicle, which involved driving a pre-determined route and looking and listening for cockatoos at pre-defined survey points. Observations at each survey point were for durations of two to five minutes and included visual sightings and contact calls, as well as estimates of bird numbers.

To maximise detection of breeding birds and hollows, surveys need to be completed when birds are breeding, nesting and/or rearing young. For Baudin's Cockatoo, peak breeding season occurs in October to December and active nests are located most easily at dusk, when the male returns to the nest with food for the incubating or brooding female (DEWHA 2010). Breeding birds tend to forage near the nest during the breeding season and the presence of droppings and feathers, or 'chewed' marri nuts, can help to locate nesting trees. Incubation lasts for about 29 days and chicks remain in the nest for up to 16 weeks (Bohner 1984, Johnstone and Kirkby 2008).

For the Forest Red-tailed Black Cockatoo, breeding has been recorded in every month with peaks in April to June and August to October (Johnstone et al. 2013*b*). Breeding occurs when the Jarrah and/or Marri are fruiting, as these are principal food trees. The female incubates for about 29 days and chicks remain in the nest for about 48 days (Johnstone et al. 2013*b*). Female birds may be flushed from the nest during diurnal surveys if the trunk of the tree is rubbed with a stick (DoE 2015).

Other species targeted by the call-based surveys may include the priority listed masked owl and barking owl. These species are potentially vulnerable to land management practices that reduce the availability of large hollows (Kavanagh 1996, McNabb *et al.* 2003, Clemann and Loyn 2003, Schedvin *et al.* 2003). The objective of surveys is to locate tree hollows within harvesting coupes that are important for these species for nesting and roosting. The approach to survey for these species is almost identical to that for the cockatoos, with some variation in the timing of surveys and the active use of playback to elicit call response.

During call playback, pre-recorded territorial calls are broadcast to elicit an audible or visual response. Listening is continued after playback and once an owl is detected, a compass bearing is taken and distance is estimated to plot the location of the owl, following procedures outlined in Loyn *et al.* (2011). Observations of these birds suggest that they respond most intensely to playback near nest trees and early in the breeding season (Loyn *et al.* 2011).

Owls are most easily detected just before sunset and in the first half hour after sunlight has completely faded. The first evening call is often made from or near the roost or nest (Loyn *et al*. 2011). Breeding behaviour for both species is poorly known from Western Australia. For the masked owl, autumn and winter are the favoured seasons in New South Wales and spring breeding has been recorded in Victoria (Kavanagh 1996, Schedvin et al. 2003). Most frequently recorded breeding for this species has been documented in March to October with chicks hatching after an incubation of 35 to 42 days (Kavanagh 1996). For the barking owl, nesting occurs between July and October with chicks hatching after 36 days (Clemann and Loyn 2003).

Recent technological advances in automated recording systems (e.g. song meters) may also prove useful in the future for assessing the use of specific sites by threatened cockatoos and priority listed owls, allowing data to be collected efficiently over many days/nights.

Appendix 3 – Example fauna survey report

Forest Products Commission WESTERN AUSTRALIA	**Fauna survey report**
Coupe	BigBrook 0215
District/ Region	Donnelly/ Warren
Location	Approximately 10 kilometres north west of Pemberton
Area (hectares)	186 hectares
Mature forest type	Karri
Silvicultural application	Clearfell/thinning with habitat tree retention
Aspect	Generally south facing slope
Number of cameras deployed	20
Period of deployment and dates	30 days, between 28 April 2015 and 28 May 2015
Total fauna photo detections	26
Fauna species detected	Feral cat, western grey kangaroo, quenda, brush tail possum, mardo, grey shrike thrush, bush rat
Camera and capture locations	See attached map for detail
Indirect survey distance	6 km (see attached map for detail)
Fauna species detected	Feral cat, western grey kangaroo, quenda, brush tail possum, bush rat, quokka
Threatened bird survey layout	See Appendix 1
Threatened birds recorded	Nil
Threatened bird survey results	See Appendix 3
Have any threatened or priority species been identified in the fauna monitoring?	**Yes**. Quenda is a priority 5 species.
Any other notes (example, evidence of threated fauna)	A quokka runnel (level 1) and scats were observed adjacent to one camera location.
Forest Products Commision comment and recommended management actions	Quenda were primarily located near the riparian systems and their core habitat will be protected in stream zone buffers. Harvesting activities are unlikely to significantly affect this species at a landscape scale. No additional management actions required.
Name of Forest Products Commission Officer	

Approved by Department Parks and Wildlife

Name _____ Signature _____

Comments _____

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