Response to the review of survey methods recommendations

Department of Climate Change, Energy, the Environment and Water response to the recommendations *of Review of Kangaroo Management Programme Surveys in New South Wales*, Borchers D, Burt L, Marshall L, Oedekoven C (2023), Centre for Research into Ecological and Environmental Modelling (CREEM-2023-04)

Response to the recommendations

In April 2023, the Centre for Research into Ecological and Environmental Modelling (CREEM) was contracted to review the current kangaroo survey design and analysis methods and advise on areas for improvement.

The CREEM reported, 'Overall, we found the KMP [NSW Kangaroo Management Program] to be very thorough in its approach, to have considered all relevant aspects of the surveys and to be willing to make improvements and consider new technologies to ensure that the abundance estimates are as reliable as possible'.

CREEM made 27 recommendations. A summary of these and the department's response to each is provided below. Some recommendations involve minor adjustments to analysis methods with little or no resourcing impact, while others will require additional resources and further consideration before proceeding.

No.	CREEM recommendation	Response
1	We recommend small modifications to the survey design in the tablelands regions based on the coverage assessment obtained using the recently available distance sampling survey design package in R (dssd; Marshall 2021). These will achieve more uniform coverage, ensuring that the surveyed area is a more representative sample from the study region.	**Accept recommendation.**

No.	CREEM recommendation	Response
2	Increase the number of samplers (small areas, or blocks, containing zigzag transects) in the Western Plains and consider a randomised, systematic placement of blocks.	**Accept recommendation.** Undertake analysis of alternative designs during 2024 with a view to implementing changes in 2025 surveys.
3	Either include the areas of national parks in the survey design for the Western Plains or exclude them entirely (i.e., exclude the area when calculating the abundance estimates). Providing there are no constraints to surveying over national parks, transects falling within national parks could be surveyed, and then the analyses later completed, both excluding and including the data from the national parks. Alternatively, the national park data could be analysed separately.	**Accept recommendation.** Exclude national park estate from the surveys and also exclude the area of national park estate from the calculation of populations.
4	Continue to explore observer-specific detection functions to investigate potential differences in search behaviour between observers, such as guarding the line.	**Accept recommendation.** Continue to use observer-specific detection functions as a training tool with observers.
5	Probabilistic approaches for matching duplicate detections could be explored for mark–recapture distance sampling (MRDS) analyses of Western Plains detection data.	**Accept recommendation.** Assess the use of probabilistic approach to matching duplicates during 2024 with a view to implementing changes in 2025 surveys.
6	For analysis of the Western Plains data, consider a wider pool of component models to choose from in model selection.	**Accept recommendation.**
7	Include uncertainty associated with any adjustment factors into the uncertainty of the density/abundance estimates to better reflect the uncertainty associated with the total abundance or density estimate. This will require estimates of variances (or coefficients of variation) for the adjustment factors.	**Accept recommendation.**
8	Consider updating the adjustment factors because these were based on data from surveys that took place over 20 years ago, and the factors may have changed in this time.	**Accept recommendation subject to funding.**

No.	CREEM recommendation	Response
9	Continue to trial new technologies to evaluate their potential to deliver accurate and cost-effective abundance estimates. For example, the use of digital, visible light and infrared cameras could be trialled at the same time as conducting a helicopter survey to obtain a comparison. Long-range drones also have considerable advantages in terms of safety and cost compared to aircraft.	**Accept recommendation.** Options to use drone, plane or helicopter-mounted cameras will be investigated.

Survey design -tablelands

No.	CREEM recommendation	Response
10	The segmented grid design should be considered generally preferable to the segmented trackline design; the latter can cause less uniform coverage in complex areas. The exception to this is when regularly spaced landscape features are present (e.g., fields of regular size) and the spacing of the segmented grid is similar to the regular pattern, but this is not thought to be the case in the tablelands kangaroo management zones (KMZ).	**Accept recommendation.** This is consistent with the current methods used for tablelands surveys. This recommendation will be superseded by the response to recommendation #1.
11	Continue to use the same spacing between the segment ends and between each row of segments to ensure that each segment can be treated as an independent sampler.	**Accept recommendation.**
12	Use a design with equal coverage across strata within kangaroo management zones, i.e., use the same segment lengths and spacings. Keeping the coverage, the same across strata will ensure that when detections are pooled across strata for estimating the detection function, pooling robustness applies, and the detection function is representative of the kangaroo management zone as a whole (Buckland et al. 2001). See Appendix A for further discussion.	**Accept recommendation.**
13	To obtain a more uniform design coverage, it is recommended to generate the survey across the whole management zone and then later divide the samplers by stratum. This will remove the areas of lower coverage on the internal stratum boundaries. It is also recommended to consider a lower threshold for retaining segments; for example, retaining all segments more than 50% inside the study area will greatly improve the coverage, see Appendix A. It is anticipated that the costs of implementing these changes will be minimal since only minor changes are recommended, but it may add to the cost of post-processing the data for analysis.	**Accept recommendation.**

No.	CREEM recommendation	Response
Survey design - Western Plains		
14	If abundance estimates are to include areas of national parks, then these regions should also be included in the survey design. Otherwise, the abundance estimates should be calculated with the areas of national park excluded from the total area.	**Accept recommendation.** Exclude national park estate from surveys and the area of national parks from the population calculations for Western Plains surveys. This approach is already taken for tablelands surveys.
15	Consideration should be given to increasing the number of blocks sampled in each kangaroo management zone to achieve a more reliable estimate of encounter rate variability. This change could involve sampling a greater number of smaller blocks This approach will also increase the chances of obtaining a representative sample. With more samplers per kangaroo management zone, the sampled habitat may stand a greater chance of being more representative of the habitat throughout the kangaroo management zone. It would, however, increase the time and cost of the surveys. If sampling blocks are to be redefined, a systematic design across the kangaroo management zone will generally increase the chances of obtaining a more representative sample.	**Accept recommendation.** Undertake analysis of alternative designs during 2024 with a view to implementing changes in 2025 surveys.
16	To better preserve uniform coverage, consider clipping the zigzag transects around areas that cannot be covered rather than adjusting the angles of the zigzag lines, see Appendix A.	**Accept recommendation.** Implement by considering hazards and excluded properties in the future survey design (referred to in the response to recommendation #2).
Data collection		
17	To reduce the possibility of responsive movement, a suggestion is to reconfigure the digital data entry to allow observers to record distance bin as the first entry. The benefits of this would need to be weighed up with the ease of implementing the change and changing established data entry routines for returning observers.	**Not supported.** Preference is to work on the training of the observers to improve their data entry speed, species ID and search pattern.

No.	CREEM recommendation	Response
Analysis		
18	In Western Plains surveys, use block, rather than each zigzag transect, as the sampler to estimate encounter rate variance. Increasing the number of blocks is recommended above.	**Accept recommendation.** Will be addressed through response to recommendation #2.
19	In tablelands surveys investigate the use of the systematic variance estimators (e.g., Fewster et al. 2009).	**Accept recommendation.**
20	In the Western Plains surveys report, provide a summary of survey data e.g., number of groups, number of duplicates, by kangaroo management zone. This would allow readers to assess sample sizes.	**Accept recommendation.**
21	Consider expanding the list of component models for model selection. Model selection can be done separately for DS and MR models.	**Accept recommendation.**
22	Evaluate how a probabilistic approach to duplicate matching according to Hamilton et al. (2018) compares to the fixed tolerance approach currently used. Several challenges would need to be overcome. The component for calculating the score in Hamilton et al. (2018) pertaining to downward angle would need to be replaced with an equivalent term pertaining to distance bin. Furthermore, common dolphins investigated by Hamilton et al. (2018) have very different grouping behaviour compared to kangaroos or other species of interest here. Hence, it is uncertain if the method would work similarly well.	**Accept recommendation.** Assess the use of probabilistic approached to matching duplicates during 2024 with a view to implementing changes in 2025 surveys.
Correction factors		
23	Update, or review the applicability, of the correction factors as these are based on surveys which took place over 20 years ago and the proportions may have changed during this period. This would provide confidence that appropriate correction factors were being applied but require substantial investment, hence, more detailed knowledge is required.	**Accept recommendation subject to funding.**
24	Include uncertainty of correction factors into uncertainty of density/abundance estimates to better reflect the uncertainty of the density/abundance estimates.	**Accept recommendation.**

No.	CREEM recommendation	Response
New technologies		
25	To investigate digital surveys further, we recommend conducting a trial survey comparing visual surveys simultaneously conducted with digital imagery and thermal imaging of the same survey strip. Combining these 3 approaches in a trial survey might allow assessment of what percentage of animals were missed by each method.	**Accept recommendation.**
26	We suggest investigating the detection efficiency of automated detection before committing to large surveys using digital cameras, and to inform design decisions about such surveys.	**Accept recommendation.**
27	We suggest investigating the feasibility of analytic methods for drone-borne camera surveys. These have important advantages in terms of pilot and observer safety but would require substantial investment to evaluate.	**Accept recommendation.**