



The Impacts of the 2019–20 Bushfires on Eastern Grey Kangaroos in the North East and Gippsland Kangaroo Harvest Zones

D.S.L. Ramsey

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Front cover photo: Eastern Grey Kangaroo in burned bushland near Cobargo NSW, January 2020 (Source: Reuters).

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Summary

Context:

Victoria's commercial kangaroo harvesting program commenced on 1 October 2019 with the commercial take limited by quotas set across seven harvest zones. Following the recent bushfires during the 2019–20 summer, quota allocation was suspended in the North East and Gippsland harvest zones due to the severity of the fires in these regions.

Aims:

To assess the extent of the probable impacts of the bushfires on the kangaroo populations in the North East and Gippsland harvest zones to determine whether commercial harvesting can recommence in these zones and if so, whether revision of the quota allocation is required.

Methods:

The extent of the overlap between the areas burnt by the bushfires and the areas where commercial harvesting is permitted (i.e. the kangaroo survey area) was used as a proxy for direct impacts. Indirect impacts were assessed by examining the likely flux of kangaroos from burnt to unburnt areas of the kangaroo survey area due to bushfire-related dispersal. Impacts (both direct and indirect) were then assessed for individual local government areas (LGAs) within each zone. Recommendations were then made about the risk of recommencing harvest in each LGA. Allowable offtake for the affected zones was revised on a *pro rata* basis, under an assumption that harvesting would not recommence where impacts were likely to be significant.

Results:

The bushfires had the greatest impacts in the Towong, East Gippsland and Alpine LGAs, burning an estimated 31%, 11% and 5%, of their respective kangaroo survey areas. The likely flux of kangaroos into the unburnt kangaroo survey areas due to the bushfires were also highest for these LGAs. Direct and indirect impacts in other LGAs were trivial by comparison.

Conclusions and implications:

Recommencing commercial harvesting in the North East and Gippsland harvest zones is considered to be a low risk, except for areas within the Towong, Alpine and East Gippsland LGAs. Due to high predicted impacts from the bushfires, recommencing commercial harvesting within the Towong, Alpine and East Gippsland LGAs for the remainder of 2020 is considered to have a high risk of impeding the recovery of these local kangaroo populations. If commercial harvesting in these LGAs is accordingly not permitted for the remainder of 2020, the maximum allowable offtake of kangaroos in the North East and Gippsland harvest zones would be reduced by 10% and 23%, respectively.

Recommendations:

- If the Towong, Alpine and East Gippsland LGAs are excluded from harvesting, commercial harvest quotas in the North East and Gippsland harvest zone should be revised accordingly to 11 300 and 3 100 kangaroos respectively and harvesting can be undertaken in the remaining LGAs in each zone for the 2020 calendar year.
- Management of Authorities to Control Wildlife (ATCWs) should also be considered carefully in the three most significantly impacted LGAs (Towong, Alpine and East Gippsland). A total revised allocation of 25 900 and 7 000 kangaroos are recommended as the maximum sustainable offtake for the North East and Gippsland harvest zones, respectively, which can be undertaken in the remaining LGAs in each zone for the 2020 calendar year. This includes kangaroos taken by both commercial harvest and the ATCW permit process.
- Careful management of ATCW permit applications is required for the North East harvest zone in particular, to ensure that numbers do not exceed the maximum allowable offtake.

1 Introduction

Victoria's commercial kangaroo harvesting program commenced on 1 October 2019, underpinned by the regulatory guidelines detailed in the *Victorian Kangaroo Harvest Management Plan* (DELWP 2020). The program enables authorised harvesters to take kangaroos for commercial purposes in designated areas of Victoria. The commercial take is limited by quotas, set across seven commercial harvesting zones, that are based on ecologically sustainable criteria (Scroggie and Ramsey 2019). The total allowable offtake of kangaroos in each harvest zone includes the commercial harvest quota and any kangaroos taken under Authority to Control Wildlife (ATCW) permits.

In response to the severity and extent of the recent bushfires across much of eastern and north-eastern Victoria in late 2019 and early 2020, quota allocations were suspended in all seven harvest zones. However, in early February 2020 harvesting resumed in all but the two worst-affected harvest zones (the North East and Gippsland zones), because a continued suspension of the entire commercial harvesting program was no longer considered necessary. This approach was consistent with the intent behind the creation of commercial harvesting zones, which was to manage the quota allocation in each zone individually in response to local conditions and circumstances. An important consideration was the fact that commercial harvesting and control occurs predominantly on private land, which may not have been affected by the fires to the same extent as more heavily forested areas of public land.

By February 2020, the bushfires in eastern and north-eastern Victoria were largely contained. An assessment of the extent of the Victorian bushfires is now required to assess whether commercial kangaroo harvesting can recommence in the North East and Gippsland harvest zones without posing an unacceptable risk to kangaroo populations in those zones. In addition, if a recommencement of commercial harvesting is recommended, then an assessment of whether commercial quotas should be revised will be required, to ensure ecological sustainability of the harvest for the remainder of 2020.

This report details the assessment of the potential impacts of the bushfires on the kangaroo populations in the North East and Gippsland harvest zones, in order to make recommendations on the recommencement of the harvest and any revision of the commercial quota.

1.1 Aims

- Using existing aerial survey data and fire extent maps, assess the potential impact of the 2019–20 bushfires in the North East and Gippsland harvest zones on kangaroo populations in those areas.
- Using 2019 kangaroo harvesting data from the Kangaroo Harvesting Program and Authority to Control Wildlife (ATCW) data, assess the extent to which harvesting activity and ATCW control overlaps with fire-affected areas.
- Using known information about kangaroo dispersal, consider how far and where kangaroos may have dispersed from fire-affected areas.
- Using existing aerial survey data and the outcomes from the first three aims, analyse risks to kangaroo populations of recommencing harvest in the North East and Gippsland zones, or parts thereof.
- Recommend any qualifying conditions that may need to be imposed if harvest recommences in the North East and Gippsland harvest zones; for example, reduced harvest areas, adjustments to quotas, or timing considerations.

2 Methods

2.1 Direct impacts of bushfires on the kangaroo population

A method similar to that detailed in Heard and Ramsey (2020) was used for estimating the potential direct impacts of the bushfires on the kangaroo population. This method examines the extent of the overlap between the fire regions and the region of interest as a simple proxy of the direct impacts of the bushfires. Polygons of the extent of the 2019–20 bushfires in the North East and Gippsland kangaroo harvest zones were obtained from DELWP's Biodiversity Division (version dated 11 February 2020). These bushfires occurred predominantly in heavily forested areas of public land in East Gippsland and the Alpine National Park (Figure 1). However, current aerial survey estimates of kangaroo abundance only consider habitat that is outside the densely forested parts of the state (Scroggie *et al.* 2017), called here the kangaroo survey area, and it is this portion of the population that is subject to commercial harvesting. Thus, the fire extent map was intersected with the map of the kangaroo survey area to estimate the fraction of the kangaroo survey area affected by the bushfires. This was undertaken separately for each local government area (LGA) in the North East and Gippsland harvest zones (Figure 2).

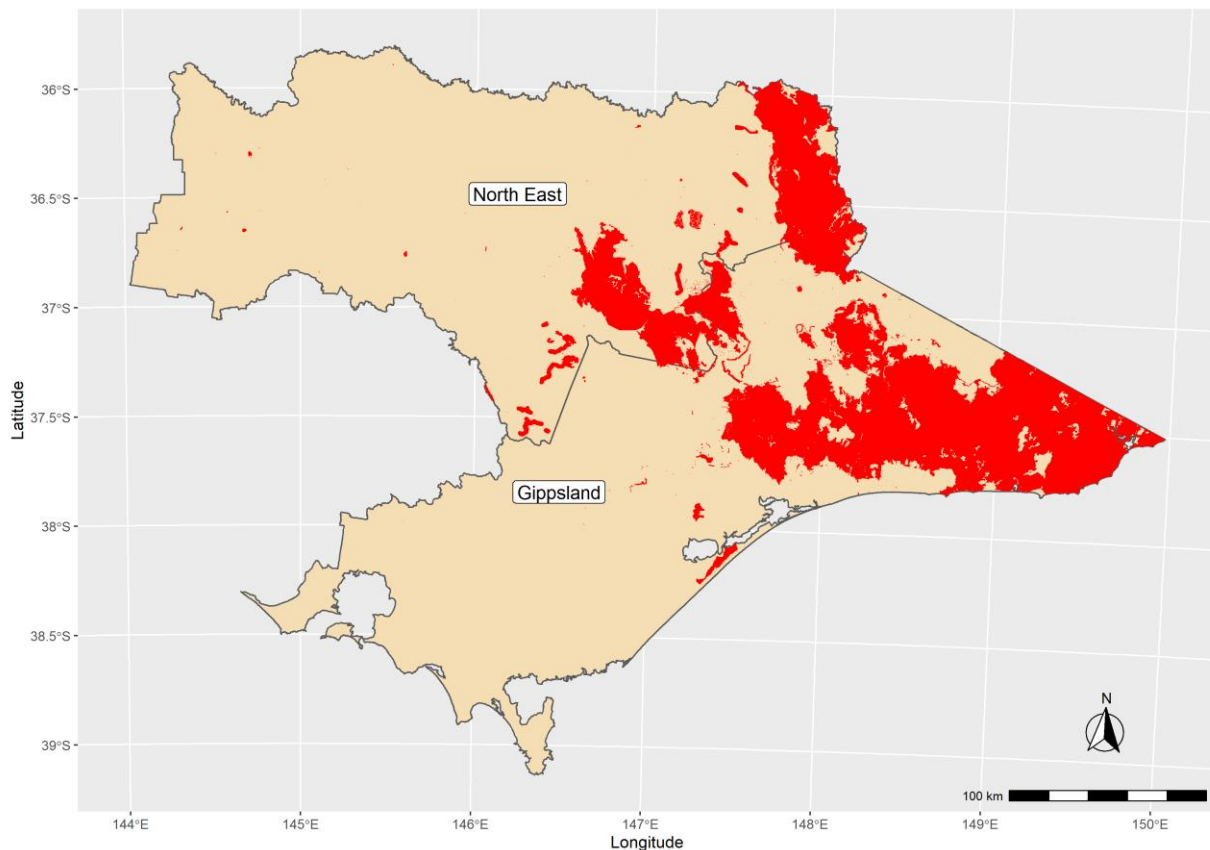


Figure 1. Extent of the 2019–20 bushfires (red shading) within the North East and Gippsland kangaroo harvest zones.

This affected fraction was then simply multiplied by the kangaroo abundance within each LGA, estimated from the last aerial survey in November 2018 (Moloney *et al.* 2019), to estimate the proportion of the kangaroo population that was potentially impacted by fires. This assumes that kangaroos are uniformly distributed within the kangaroo survey region within each LGA. Overall impacts for each harvest zone were estimated by summing the impacts for each individual LGA.

Potential impacts within each LGA were also assessed by examining previous records of the locations of harvested kangaroos, as well as kangaroos authorised for control under ATCW permits. Harvest data from 2019 (1st October – 31st December) as well as the number of kangaroos approved for control under ATCW permits during 2019 were obtained from Biodiversity Division and collated. A large proportion of the harvest locations were available only to the nearest street address, so the midpoint of the street location was used as the harvest location. Locations of kangaroos authorised for control under ATCW permits were only resolved to the level of the LGA. Locations of these activities were then mapped and compared with the predicted fire impacts.

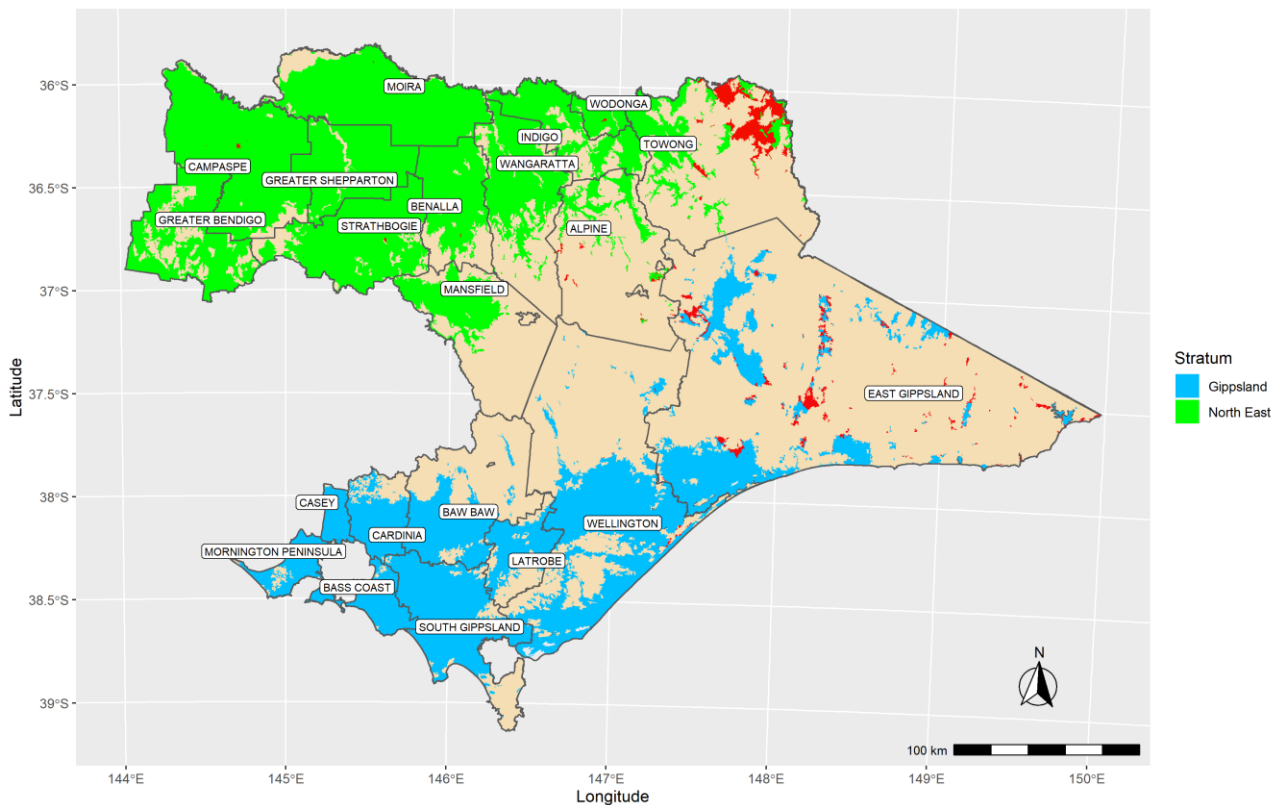


Figure 2. Kangaroo survey areas within the North East and Gippsland harvest zones (blue and green shading) and the amount of this area affected by the 2019–20 bushfires (red shading). The remaining areas represent densely forested areas of public land, which are not considered during kangaroo aerial surveys. Polygons show the boundaries of Local Government Areas (LGA) within each zone.

2.2 Indirect impacts of bushfires on the kangaroo population

Indirect impacts of the bushfires on the kangaroo population were also assessed by examining the likely movements of kangaroos dispersing from fire affected areas into adjacent unburnt areas. The rationale for examining dispersal from the bushfire zone was that areas considered to have a relatively high level of flux due to immigration of kangaroos may need consideration with respect to additional disturbances from harvesting or control. For example, recolonisation of the bushfire regions is likely to depend on those areas that received high levels of kangaroo immigration due to the fires. Hence, allowances might need to be made for this recolonisation to occur without disturbance from harvesting or control.

Although observations of Eastern Grey Kangaroos fleeing bushfires are relatively common, no information exists about how far individuals might travel from the bushfire front. In addition, limited published information exists on patterns of dispersal in Eastern Grey Kangaroos, and information that does exist depends heavily on the methods used for measuring dispersal. Studies using radiotracking of kangaroos have suggested that limited (breeding) dispersal occurs in established populations, with evidence of some mature individuals dispersing up to 20 km from their breeding sites (Jarman and Taylor 1983; Johnson 1989). In contrast, studies measuring the amount of genetic differentiation (a measure of gene flow) occurring among

populations separated by various distances have shown that (generational) dispersal occurred over much larger distances, up to 230 km (Zenger *et al.* 2003). Unfortunately, these studies shed little light on the potential movements of kangaroos responding to bushfires. Indeed, the pattern of bushfire-related movements are likely to be highly context-specific, dependent on the proximity of nearby suitable unburnt habitat and other sources of shelter (Nimmo *et al.* 2019).

In the absence of any information on the expected pattern of movements of kangaroos in relation to bushfires, an *ad hoc* approach was adopted to gauge the likelihood of unburnt regions of the kangaroo survey area receiving dispersing kangaroos. Hence, it was assumed that kangaroos dispersed directly away from an active bushfire front, and dispersal distances were drawn from a half-normal distribution with a standard deviation of 20 km. Using this method, the majority of movements (66%) were within 20 km of the bushfire region and 95% were within 39 km. No assumptions were made about the directions of movements, so that any direction was equally likely. The probability of bushfire-related movement of kangaroos into the kangaroo survey area within each LGA was then calculated using the dispersal kernel defined above, emanating from the edge of each of the bushfire polygons and calculated over a 1 km grid of the kangaroo survey area. The net effect of these movements was then estimated by calculating the proportion of these 1 km cells in the kangaroo survey area with a probability of movement greater than 0.20, separately for each LGA. The proportion of cells meeting this criterion thus represents the proportion of the survey area within each LGA potentially subject to bushfire related kangaroo movement.

2.3 Revision of harvest quotas

Based on the above analyses, recommendations were formulated as to whether a revision of the harvest quotas for the North East and Gippsland harvest zones would be required. This was undertaken by considering the impacts of the bushfires on the kangaroo survey areas within individual LGAs, either directly due to loss of habitat from burning, or indirectly due to dispersal from fire-affected areas. If impacts were considered high (i.e. >25% of an LGA area subject to either direct or indirect impacts), then it was assumed a decision may be made to close that LGA to further harvesting for the duration of the 2020 calendar year. An expected decision to close an LGA from any offtake then reduced the estimated number of kangaroos potentially available for harvest in that harvest zone on a *pro rata* basis, and the corresponding harvest quota was revised in proportion to this new abundance estimate.

3 Results

3.1 Direct impacts of bushfires on the kangaroo population

The 2019–20 bushfires had the greatest impacts in the Towong, East Gippsland and Alpine LGAs, burning an estimated 31%, 11% and 5% of their respective kangaroo survey areas (Tables 1, 2). Bushfire impacts on the remaining LGAs were all trivial (< 1%) (Tables 1 & 2). Overall, the bushfires burnt 2.7% and 2.5% of the kangaroo survey area in the Gippsland and North East harvest zones, potentially impacting around 2 400 and 7 300 individual kangaroos in those two harvest zones respectively (Tables 1, 2).

Commercial harvesting activity was highest in the North East harvest zone, occurring predominantly in the Greater Bendigo, Strathbogie, Benalla and Mansfield LGAs while harvesting activity in the Gippsland region occurred primarily in the South Gippsland LGA (Figure 3). Overall 1 730 and 157 kangaroos were harvested between 1 October and 31 December 2019 in the North East and Gippsland harvest zones, respectively. Very little harvesting activity (< 15 kangaroos) occurred in those LGAs most impacted by the bushfires (Figure 3).

The number of kangaroos authorised for control under ATCW permits during 2019 was also higher in the North East compared with the Gippsland harvest zone (Figure 4). In the North East the highest number of authorisations occurred in the Strathbogie, Mansfield, Benalla, Wangaratta and Greater Bendigo LGAs (> 4 000 kangaroos authorised in total in each of these LGAs) while the highest number of authorisations in the

Gippsland harvest zone occurred in the East Gippsland LGA (2 507 kangaroos authorised), which was the LGA most affected by the bushfires in this harvest zone (Figure 4).

Overall, the number of kangaroos authorised for ATCW control in the North East harvest zone during 2019 (37 633) was higher than the maximum recommended offtake for 2020 (28 800) (Scroggie and Ramsey 2019). Hence, ATCW numbers for the North East harvest zone should be closely managed during 2020 to ensure the total take does not exceed the recommended maximum.

Table 1. Estimates of abundance for Eastern Grey kangaroos for each LGA in the Gippsland Harvest Zone, the percentage of the survey area that was burnt (% Burnt), the number of potentially impacted kangaroos (Impacted), and the percentage of the survey area potentially subject to bushfire-related kangaroo dispersal (% Dispersal).

LGA	Abundance	Area	% Burnt	Impacted	% Dispersal
Bass Coast	4845	846	0	0	0.0
Baw Baw	8763	1530	0	0	0.0
Cardinia	5538	967	0	0	0.0
Casey	2239	391	0	0	0.0
East Gippsland	20716	3617	11.3	2341	79.4
Latrobe	5040	880	0	0	0.0
Mornington Peninsula	3688	644	0	0	0.0
South Gippsland	15384	2686	0	0	0.0
Wellington	24496	4277	0.3	73	2.3
Total	90711	15838	2.7	2414	18.7

Table 2. Estimates of abundance for Eastern Grey kangaroos for each LGA in the North East Harvest Zone, the percentage of the survey area that was burnt (% Burnt), the number of potentially impacted kangaroos (Impacted), and the percentage of the survey area potentially subject to bushfire-related kangaroo dispersal (% Dispersal).

LGA	Abundance	Area	% Burnt	Impacted	% Dispersal
Alpine	7079	607	5.0	354	96.3
Benalla	20140	1727	0.1	20	0.1
Campaspe	49761	4267	0.2	100	0.2
Greater Bendigo	26449	2268	0.1	26	0.1
Greater Shepparton	27021	2317	0	0	0.0
Indigo	16572	1421	0	0	2.8
Mansfield	14053	1205	0	0	0.0
Moira	42578	3651	0	0	0.0
Strathbogie	33831	2901	0.1	34	0.1
Towong	21819	1871	30.9	6742	65.3
Wangaratta	24012	2059	0.1	24	8.9
Wodonga	4700	403	0.6	28	0.8
Total	288014	24697	2.5	7328	8.2

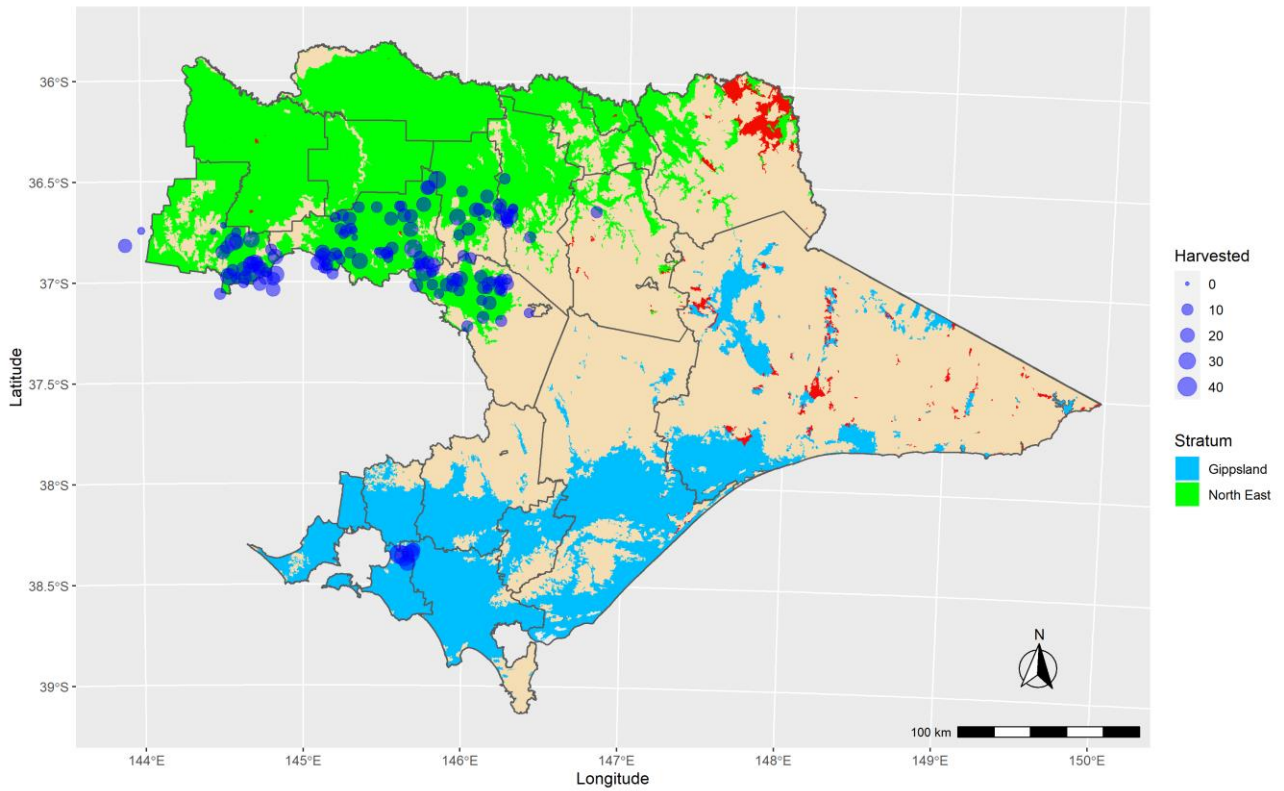


Figure 3. Numbers of kangaroos harvested in the North East and Gippsland harvest zones, 1 October – 31 December 2019.

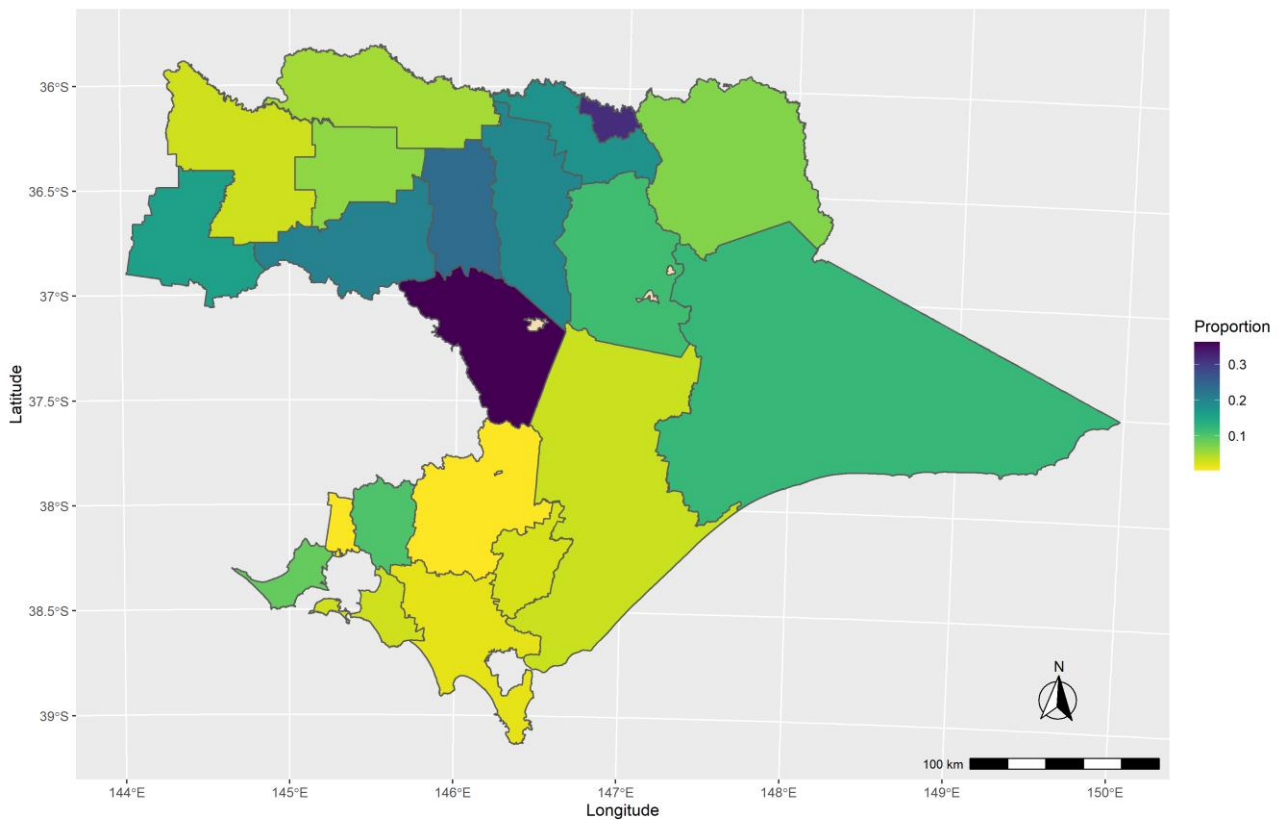


Figure 4. Number of kangaroos authorised for control (expressed as a proportion of the estimated kangaroo abundance) under the ATCW permit process in the North East and Gippsland harvest zones during 2019.

3.2 Indirect impacts of bushfires on the kangaroo population

Based on the assumed dispersal kernel, the Alpine, East Gippsland and Towong LGAs were relatively more likely to have a high flux of kangaroos, with 96%, 79% and 65% of their respective survey areas potentially subject to bushfire-related kangaroo dispersal (i.e. relative flux > 0.2) (Figure 5). In the remaining LGAs, the estimated proportion of the survey area potentially subject to bushfire-related kangaroo dispersal was low (< 10%) (Tables 1, 2) (Figure 5). Overall, 19% and 8% of the kangaroo survey areas in the Gippsland and North East harvest zones, respectively, were potentially subject to bushfire-related kangaroo dispersal (Tables 1, 2).

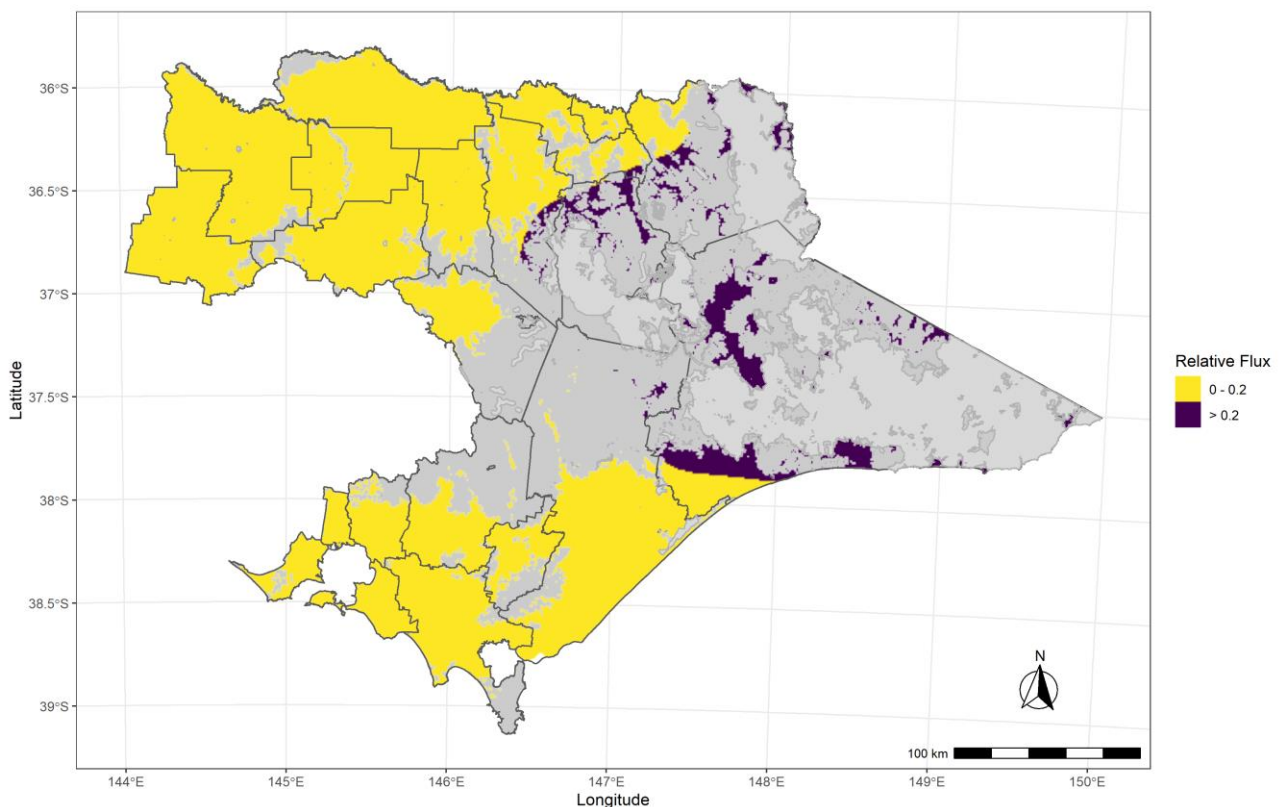


Figure 5. Potential relative flux in kangaroo abundance expected into unburnt regions of the kangaroo survey area due to bushfire-related movements. Grey regions represent densely forested parts of each zone. The pale grey region indicates the extent of the 2019–20 Victorian bushfires.

3.3 Revision of harvest quotas

The impact of the 2019–20 bushfires in Victoria in three local government areas (the Alpine and Towong LGAs in the North East harvest zone and the East Gippsland LGA in the Gippsland harvest zone) was predicted to be high enough to warrant a management response. This is because these LGAs were extensively burnt, or were relatively more likely to have a high flux of kangaroos due to bushfire-related dispersal. If these LGAs are closed from further commercial harvesting of kangaroos for the remainder of 2020, the total revised offtake for 2020 in the North East and Gippsland harvest zones should be reduced by 10% and 23%, respectively, representing the *pro rata* contribution of these LGAs to kangaroo abundance in the two harvest zones. Hence, commercial harvest could continue in the remaining LGAs in both zones, using the revised allocations in Table 3.

Table 3. Recommended revised commercial harvest quota and total allowable offtake for Eastern Grey Kangaroos (rounded to the nearest 100) for the Gippsland and North East harvest zones for the period 1 January to 31 December 2020.

Harvest zone	Current commercial quota	Current total offtake	Revised commercial quota	Revised total offtake
Gippsland	4 000	9 100	3 100	7 000
North East	12 550	28 800	11 300	25 900

4 Discussion

The extensive bushfires in Victoria during the 2019–20 summer were predicted to directly impact only a small proportion (< 3%) of the overall kangaroo survey area in the Gippsland and North East harvest zones. Nevertheless, impacts were predicted to be high enough to warrant intervention for three local government areas (Towong, Alpine and East Gippsland), with over 30% of the kangaroo population within the Towong LGA likely to be impacted.

Both direct impacts (kangaroo killed by the fires) and indirect impacts (kangaroos dispersing from the burnt areas into adjacent unburnt areas) on kangaroo populations were modelled. Since the scale and extent of dispersals are unknown, our simple model of movements from the bushfire regions can only provide an indication of the relative expected flux in kangaroos occurring in areas adjacent to the bushfires. As the densities (pre-fire) within the forested areas within the burnt zones are also unknown, we have little basis for estimating how many kangaroos in total may have been impacted by the bushfires, or how many are likely to have dispersed out of burnt habitat into adjacent unburnt habitat. These analyses suggest that dispersal into unburnt regions of the kangaroo survey areas were likely to be highest in the East Gippsland, Alpine and Towong LGAs. Clearly, these analyses would benefit from future research into the movements of kangaroos in response to bushfires (Nimmo *et al.* 2019).

The impacts of the bushfires on kangaroos remain speculative. While kangaroos almost certainly either fled the bushfire regions or were killed, their fate remains unknown. There is some evidence that Eastern Grey Kangaroos rapidly recolonise burnt habitat to take advantage of new regrowth (Southwell and Jarman 1987), so any movement of kangaroos out of burnt habitat may rapidly reverse. Despite this, it seems prudent to take a precautionary approach and allow the natural reorganisation and recovery of the kangaroo populations in the impacted areas to proceed without additional pressures from kangaroo harvesting.

5 Conclusions

Based on these analyses, recommending commercial harvest in the North East and Gippsland harvest zones is considered to be a low risk, except for areas within the Towong, Alpine and East Gippsland LGAs. Due to high predicted impacts from the bushfires, recommending commercial harvest within the Towong, Alpine and East Gippsland LGAs for the remainder of 2020 is considered to carry a high risk of impeding the recovery of the local kangaroo population in these areas. If commercial harvesting in these LGAs is accordingly not permitted for the remainder of 2020, the maximum allowable offtake of kangaroos in the North East and Gippsland harvest zones would be reduced by 10% and 23%, respectively. Close management of numbers of kangaroos authorised for control under ATCW permits will also be required in light of the revised offtake, especially for the North East harvest zone where ATCW authorisations were already higher than the

recommended sustainable offtake. These predicted impacts should also be re-assessed in light of future kangaroo aerial surveys, which are scheduled for late 2020.

5.1 Recommendations

- If the Towong, Alpine and East Gippsland LGAs are excluded from harvesting, commercial harvest quotas in the North East and Gippsland harvest zone should be revised accordingly to 11 300 and 3 100 kangaroos respectively and harvesting can be undertaken in the remaining LGAs in each zone for the 2020 calendar year.
- Management of Authorities to Control Wildlife (ATCWs) should also be considered carefully in the three most significantly impacted LGAs (Towong, Alpine and East Gippsland). A total revised allocation of 25 900 and 7 000 kangaroos are recommended as the maximum sustainable offtake for the North East and Gippsland harvest zones, respectively, which can be undertaken in the remaining LGAs in each zone for the 2020 calendar year. This includes kangaroos taken by both commercial harvest and the ATCW permit process.
- Careful management of ATCW permit applications is required for the North East harvest zone in particular, to ensure that numbers do not exceed the maximum allowable offtake.

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