Appendix 18

Distribution and abundance of the Northern quoll (*Dasyurus hallucatus*) in far north Queensland

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Executive Summary

- This study used a combination of existing quoll presence records, capture-recapture data derived from camera trapping, and habitat modelling to enumerate the distribution and size of the far north Queensland quoll population within National, State and Local contexts.
- The Mt Emerald quoll population forms part of a far north Queensland quoll metapopulation which occurs from around Ravenshoe in the south to Cooktown in the north. This is one of 10 known quoll metapopulations that occur across Australia, and one of six metapopulations within Queensland.
- Based on extent of occurrence, current and anticipated threats, and the consistency of quoll records coming from the region, it is likely that the far north Queensland metapopulation is one of the most secure and important for the survival of *D. hallucatus* in Queensland and Australia.
- MaxEnt habitat modelling showed a robust discrimination of current and potentially suitable habitat areas of *D. hallucatus*. Habitat was categorised into one of five habitat suitability categories (low, medium, high and very high) across far north Queensland.
- This modelling reveals a band of high and very high quality habitat hugging the western edge of the Wet Tropics bioregion boundary and running from about Ingham north to Kuranda. A belt of high and very high quality habitat runs from Ravenshoe to Kuranda and includes Mt Emerald.
- More than 72% of predicted high and very highly suitable habitat in far north Queensland is found within a 55km radius of Mt. Emerald, suggesting the region including Mt. Emerald local area could be a significant reservoir of quolls for the region.
- This modelling reveals that Mt. Emerald is mostly composed of high and very high

quality quoll habitat.

- Quoll population density was estimated using individual recognition from camera trap photos to provide information on the number of quolls, and the ½ mean maximum distance statistic to calculate the sampling area from which those quolls were counted.
- This approach led to density estimates of 1.09 quolls/100ha in flat or near flat suitable habitat and of 2.25 quolls/100ha in moderately to extremely rugged, suitable habitat.
- The above density statistics, coupled with the extent of potential habitat—as as modelled by MaxEnt—s uggest that the far north Queensland quoll metapopulation numbers approximately 9466 individual quolls. This approach provides an estimate of 53 individual quolls on Mt Emerald. Closed population capture-recapture also provides an estimate of 53 individual quolls on Mt Emerald. This constitutes approximately 0.5% of all quolls estimated to occupy the far north Queensland metapopulation.
- This study is confounded by a lack of data in some areas. Future studies which ground truth the MaxEnt habitat model, and which aim to develop density estimations arising from camera trapping throughout the range of habitats within the far north Qld area, would significantly bolster the results of this study.
- The combination of high and very high quality quoll habitat on the Mt Emerald massif (Fig. 6) and its location adjacent to an area of discontinuous habitat suggests Mt Emerald may be critically important for maintaining connectivity and dispersal of *D. hallucatus* between the Walsh/ Herbert River catchment areas and the Barron/Mitchell catchment areas.
- Notwithstanding uncertainties in the data, this study suggests that the far north Queensland quoll population is highly significant at a State and National level.
- The Mt Emerald population of quolls—although not numerically significant within the overall far northern context—are present in an area that is critical for the far northern

metapopulation. Genetic analyses of *D. hallucatus* confirm the importance of Mt. Emerald for maintaining the genetic flow between northern and southern populations of far north Queensland quolls (Conroy and Lamont 2013).

- Although the extent of the impact of the MEWF project on quolls at Mt Emerald is unknown, the small contribution that this population makes to the far northern metapopulation indicate that it is unlikely that the development will negatively impact quolls at the state or regional scale in the short-term. It is unknown how the quoll population at the site will be affected over subsequent years as we lack any data or way of predicting changes to ecosystems carrying capacity that might occur as a result of construction and operation of the MEWF site.

Introduction

The northern quoll *Dasyurus hallucatus,* is a poorly known, endangered dasyurid marsupial. The species occurs in coastal and subcoastal habitats in tropical Australia (Van Dyck *et al.* 2013). Although a distinctive-looking and active predator, gaps exist in our knowledge of the distribution of this species at the regional and local scales. This is particularly true of Queensland populations of the species which have never been comprehensively surveyed or mapped. Likewise no published studies have attempted to calculate the numerical size of any naturally occurring northern quoll population. These data are essential in order to assess the potential impact on this species.

Therefore in this study we aim to investigate the distribution and numerical population size of northern quolls in far north Queensland in order to ascertain the significance of the Mt Emerald site within that spatial context. We achieve this using photo-based individual recognition, population density estimation and closed capture-recapture modeling to estimate the size of the Northern quoll (*Dasyurus hallucatus*) metapopulation in far North Queensland, and Mt Emerald.

Methods

The distribution of northern quolls

The distribution of northern quolls in far north Queensland was mapped using 274 species presence records obtained from a variety of sources including Wildlife Online, Quoll Seekers Network, unpublished data of wildlife scientists, and records obtained during this study (Appendix A).

Quoll distribution at the Queensland and National scales has been illustrated by Hill and Ward (2010) and Van Dyck *et al* (2013). This is used to contextualize the far north Queensland quoll metapopulation.

Extent of quoll habitat in far north Queensland

A species distribution model of *D. hallucatus* incorporating environmental predictor variables and species occurrence data was created using MaxEnt version 3.3.3k (Phillips et al., 2004).

Model settings

The MaxEnt Model was run at a spatial resolution of 80m with five-fold cross validation, and background predictions files were generated in each fold for additional model validation to be conducted. The remaining settings were left as default, with 500 iterations and the logistic output format, which represents the probability of occurrence of the target species within the range of 0 to 1 for each grid cell in the model (Phillips and Dudik, 2008). The final model output was masked using the vegetation layer to exclude unsuitable habitat types from the output (i.e. rainforest, non-remnant vegetation, urban and agricultural, and open water).

Model performance was evaluated by the area under the curve (AUC) in receiver operating characteristic analysis (ROC) of the cross validated model output. An AUC score of 1.0 indicate a statistically valid, perfect model fitting, while AUC value of <0.5 indicates a model performing poor and no better than random (Phillips et al., 2004). The true skill statistic (TSS) was also used in conjunction with AUC (Allouche et al., 2006). This measure is similar to the commonly used Cohen's Kappa index but correcting Kappa's dependency on species prevalence (Allouche et al., 2006; Jones, 2012; Lu et al., 2012). TSS score ranges from −1 to 1: A TSS values >0.6 indicate good predictions, 0.2 – 0.6 indicate fair, and values <0.2 indicate poor or no better than random predictions (Landis and Koch, 1977).

Model input data

Two-hundred and seventy-one presence records of *D. hallucatus* were obtained from a variety of sources including the Qld Museum, Queensland Government Wildlife Online Wildlife online, researchers, unpublished observations of researchers and those records obtained during this study (Appendix A). Only northern quoll presence records which could be located with a precision of 500m and which had originated since 1970 were used in the model.

Environmental data

We selected nine environmental variables as potential predictor variables of *D. hallucatus* distribution for this study, based on their biological and ecological relevance to species distributions. These included: elevation, aspect, slope, vegetation, geology, annual precipitation, precipitation seasonality, precipitation of wettest quarter, and precipitation of driest quarter. Climatic variables were especially considered to be highly biologically meaningful to define eco-physiological tolerances of a species within its distribution range (Kumar and Stohlgren, 2009).

The 80m Digital Elevation Model dataset of far north Queensland (Accad 1999) was used to generate slope and aspect parameters. The Queensland Government Regional ecosystem dataset provide vegetation parameters A geology dataset of Queensland contains mapped polygons classified by dominant substrate rock classes. Both vegetation and geology dataset were converted to a raster map layer for later analysis. For climatic data, BIOCLIM dataset, which consist of 19 statistically downscaled, high-resolution climatic variables representing current climatic conditions, were derived from the WorldClim database (Hijmans et al., 2005). A set of four BIOLCIM variable layers were selected for the model: bio12 = annual precipitation, bio15 = precipitation seasonality, bio16 = precipitation of wettest quarter, and bio17 = precipitation of driest quarter.

Model output

The default MaxEnt output is a continuous prediction of habitat suitability for a species. In this study, a classified, binary distribution map was created by applying thresholds to the default output. We defined habitat suitability as follows;

- probability of occurrence values <0.1; unsuitable habitat;
- probability of occurrence values 0.1 – 0.25; low habitat suitability
- probability of occurrence values 0.25 – 0.50; medium habitat suitability
- probability of occurrence values 0.50 – 0.75; high habitat suitability
- probability of occurrence values 0.75 – 1.0; very high habitat suitability.

The abundance of northern quolls in far north Queensland

The abundance of northern quolls was estimated by calculating the density of quolls in a subset of the study area and multiplying this by the amount of potential quoll habitat within the area (as per MaxEnt model output below). Density was calculated by tallying the number of quolls captured each of 379 survey points within a 55km radius of Mt Emerald. This was achieved using camera traps, which provided the photographic record of presence and movements of individual quolls required for these calculations (see below for details).

Camera trapping

Camera trapping entailed setting a Reconnyx 550V trail camera (www.reconyx.com) and a chicken lure, at each of up to 50 camera sites surveyed at any one time. Three-hundred and seventy-nine camera trap sites were spread across 11 districts, all within a 55km radius of the MEWF site (Fig. 1). These were operated between August and October 2012. Individual quolls were identified by their spot patterns. The usefulness of the photos for spot-pattern recognition was optimized by consistent placement of the cameras, 1m directly above the lure and facing down at right angles to the ground. We thereby obtained consistently oriented photos of the dorsum of each quoll which decreased ambiguity in individual identification. The lure consisted of three chicken necks, secured within a pegged down, 2" capped poly-pipe foot valve unit sold by irrigation suppliers.

Fig. 1. The location of 379 camera-trap sites (white squares) surveyed during this study.

Given the aim of estimating quoll density was to provide a basis for calculating quoll population size across the entire far north Queensland area, an effort was made to stratify camera trapping effort across a range of habitats within the study area. To do this, Broad Vegetation Group (BVG) and Terrain digital layers were dissolved to create a single layer of 63 BVG x Terrain habitat types. 1:2 000 000 scale BVG data (http://www.ehp.qld.gov.au/ecosystems/biodiversity/regional-ecosystems/bvg.html#12_million_descriptions) were used. The terrain data layer was created using the 80m DEM for the study area and applying Riley's Terrain Ruggedness Index (TRI) algorithm (Riley *et al.*, 1999) at a 360m spatial resolution. This spatial resolution was chosen as the nearest multiple of 80m (the base DEM resolution) to the putative home range radius of quolls (see below for details of 1/2MMDM calculations). The six ruggedness levels thus produced were further combined and reclassified into 3 levels;

- level and nearly level (Rileys TRI<116m),
- slightly to intermediately rugged (Rileys TRI 117 - 239m),
- moderately to extremely rugged (Rileys TRI<240-4367m).

Estimating the area sampled and the density of quolls at each camera trap array

Area sampled by each camera trap

The area sampled by the camera traps was estimated using the half maximum mean distance moved (1/2MMDM)(Wilson and Anderson 1985) statistic for each individual quoll. This statistic is used to estimate the mean sampling area for each camera trap, i.e. a circular area with a radius which equals the estimate of 1/2MMDM. Forty movement events made by 25 individual northern quolls were recorded during camera trapping resulting in a 1/2MMDM value of 334.6m. This translates to a circular sampling area of each camera trap of approximately 35ha.

Density of quolls at each camera trap site

Mark-recapture modelling

In addition to the density/area of habitat approach used to estimate quoll population size, a closed population mark-recapture model was also used to estimate the size of the MEWF site quoll population. This was achieved using Program Mark (White and Burnham 1999). The basic model (M0)(which assumes equal capture probability for all individuals on all days) proved the most parsimonious (AIC 24.6644).

Mark-recapture modelling of other camera-trapped populations was undertaken but models performed poorly, returning nonsensically large Confidence Intervals.

Estimating the size of the far north Queensland northern quoll metapopulation

The size of the northern quoll metapopulation was estimated by applying the average density of quolls discovered at 11 disparate districts to the extent of quoll habitat throughout far north Queensland. Camera trapping sampled 22 BVG x Terrain habitat polygons within that area, however due to the spatial ecology of northern quolls (which was revealed as this project progressed), it was decided in hindsight that it would be invalid to refer the density of quolls obtained from each camera site purely to the BVG x Terrain habitat in which the camera was sited, i.e. quolls could have been lured to the camera from any one of several BVG x Terrain habitats within the 35ha effective sampling area of each camera. We thus collapsed all BVG x Terrain habitat types into one of three Terrain levels (see above), without reference to BVG (but continuing to exclude vine-forest, agricultural and urban land). Even at this scale, it was necessary to further collapse the TRI levels 2 and 3 into a single level, due to the scale over which quolls potentially roam. Ultimately, two separate quoll density estimations were calculated; one for Flat habitats (TRI level 1 above), and another covering the slightly to highly rugged landscape (TRI levels 2 and 3 above).

These density estimates were applied to the extent of each of the above two habitat classes which overlapped with the MaxEnt habitat model.

Results and Discussion

Distribution

At the National scale, populations of the northern quoll are highly fragmented into 10 known metapopulations (Van Dyck *et al.* 2013, Hill and Ward 2010, Burnett unpublished data). Six of these metapopulations occur in Queensland, ranging from south-east Queensland in the south to Weipa in the north (Fig. 2).

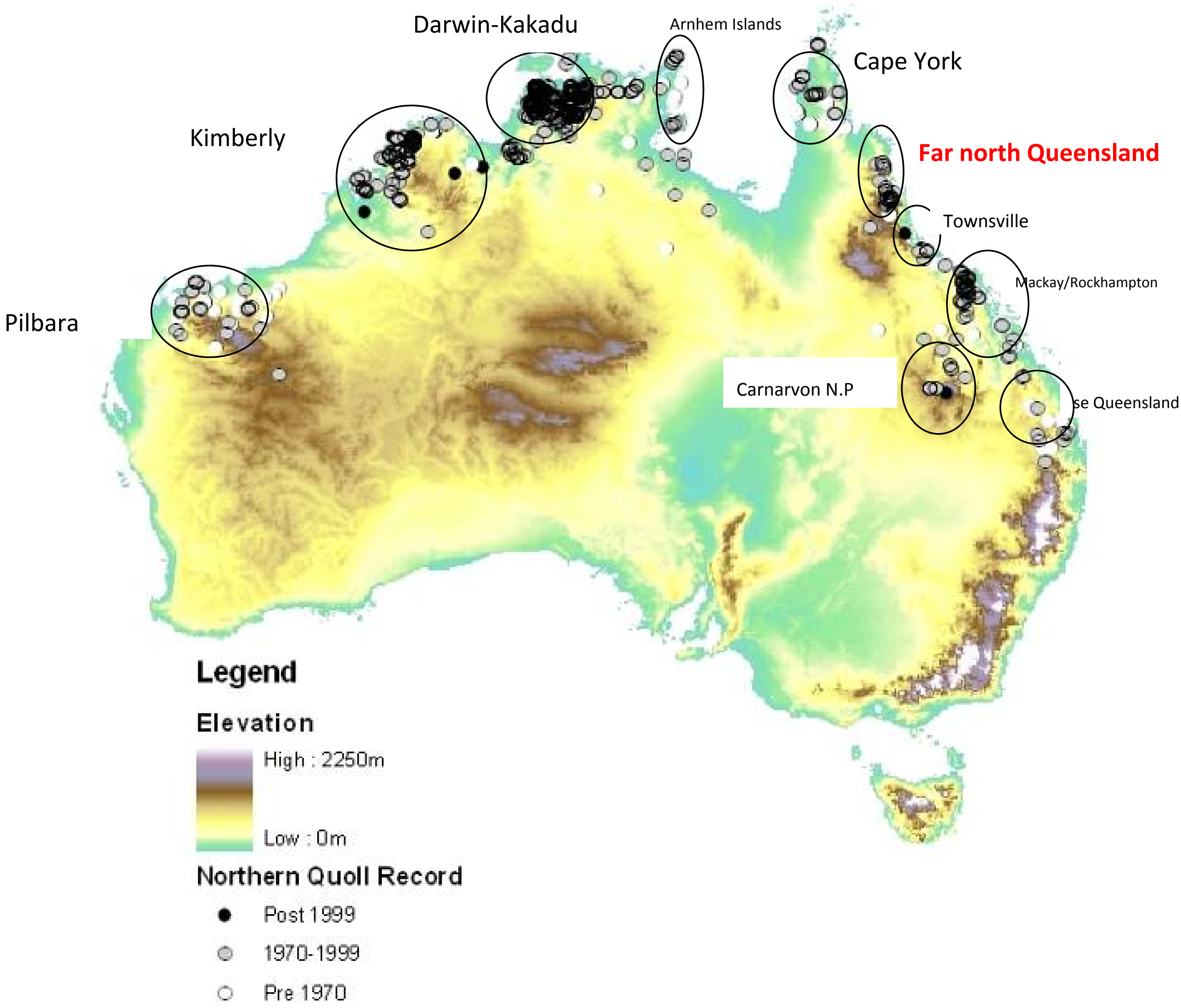

Fig. 2. Broad-scale distribution of the northern quoll across Australia (from Hill and Ward 2010). Putative metapopulation boundaries designated as part of the current study are labelled. Boundaries are indicative only.

Two-hundred and seventy-four presence records in combination with habitat modelling (as above), indicate that the Mt Emerald population of quolls forms part of a contiguous far north

Queensland quoll metapopulation which stretches from approximately Ravenshoe in the south to Cooktown in the north (Fig. 3).

The far north Queensland quoll metapopulation is significant at a state and national level. Within Queensland, it is one of only three metapopulations that are represented by more than 6 contemporary records (i.e.since 1999). The south-east Queensland, Carnarvon and Cape York metapopulations are known from either less than 6 contemporary records and/or from a spatial extent less than 25km^2. This suggests that quoll populations in these areas are not secure. On the other hand, and in common with the Mackay/Rockhampton and Townsville metapopulations, the far north Queensland metapopulation occurs over a reasonably large spatial extent and is represented by numerous records recorded over numerous years, suggesting that these are numerically robust and stable metapopulations. The status of all non-Queensland metapopulations is not secure. These metapopulations have either recently suffered massive declines as cane toads *Rhinella marina* (Hill and Ward 2010) invade their habitat, are restricted to off-shore islands where population sizes are limited by carrying capacity and which may be vulnerable to invasion by cane toads, or are in the path of the cane toad invasion front.

There is insufficient data to map the boundaries of these metapopulations with certainty. It is possible that those areas mapped as metapopulations really only represent a single cohesive population, multiple metapopulations or that additional unmapped metapopulations and populations also exist. Even in this far north Queensland metapopulation under study, we have only habitat modelling to confirm the metapopulation boundary, with limited field data to verify its accuracy.

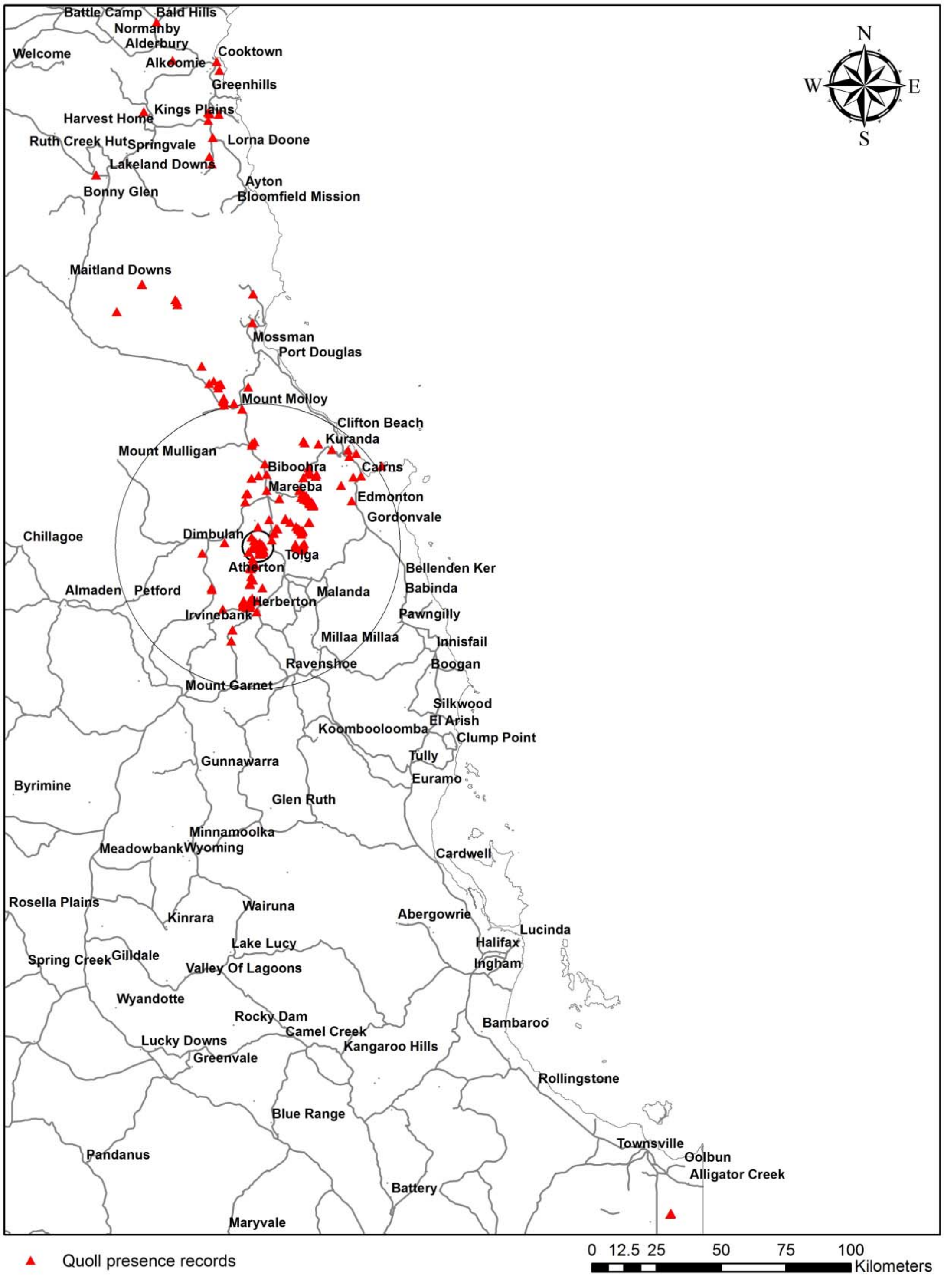

Fig. 3. The contemporary (since 1980) extent of occurrence of *D. hallucatus* in far north Queensland.

Extent of quoll habitat

The current distributions of *D. hallucatus* were modeled successfully. The results of AUC and TSS indicated that, on average, the MaxEnt model proved to be statistically valid (Mean AUC = 0.945, Mean TSS = 0.758) and have high discrimination ability (Table 1).

Table 1. Mean, minimum and maximum cross-validated AUC values and TSS values obtained for the *D. hallucatus* Maxent model. Mean value gives the average probability of AUC and TSS scores across cross-validated models.

	Value	AUC	TSS
Dasyurus hallucatus Maxent model	Mean	0.945	0.758
	Minimum	0.920	0.701
	Maximum	0.965	0.856

Relative contributions of each predictor variable

The MaxEnt model estimates the relative contribution of environmental variables (%) to model development. According to our model output results, climatic predictors made a greater contribution to the final model output than substrate related variables (Table 2). The most powerful predictors were precipitation of the driest quarter (bio17; 39.7%), followed by precipitation seasonality (bio15; 16.4%), and annual precipitation (bio_12; 11.5%). The contribution of the substrate related variables relatively low overall (<10.1%).

Table 2. Environmental predictor variables of *Dasyurus hallucatus* as grid layers across the study areas at a pixel resolution of 80m and mean percent contribution of the predictor variables to the final Maxent model. Mean % contribution of each predictor variable across cross-validated MaxEnt models.

Code	Description	Unit	Mean % contribution
bio17	BIOCLIM: Precipitation of driest quarter	Mm	39.70
bio15	BIOCLIM: Precipitation Seasonality	Mm	16.4
bio12	BIOCLIM: Annual precipitation	Mm	11.5
re55	Vegetation	RE classes	10.1
bio16	BIOCLIM: Precipitation of wettest quarter	Mm	9.7
elev55	Elevation	M	8.6
geo55	Geology	Rock classes	2.6
aspect55	Aspect	Degrees	0.8
slope55	Slope	Degrees	0.7

Predicted species distribution and area of extent

Habitat modelling revealed an almost continuous band of potential quoll habitat stretching from near Ingham in the south to Cooktown in the north (Fig. 4). This model suggests that the main discontinuity in quoll habitat occurs to the east and north of Mt Emerald (Fig. 5). The combination of high and very high quality quoll habitat on the Mt Emerald massif (Fig. 6) and the location of Mt Emerald adjacent to this discontinuity in habitat suggest that Mt Emerald may be of critical importance for maintaining connectivity and dispersal of *D. hallucatus* between the Walsh and Herbert River catchments to the Barron and Mitchell catchments to the north. Genetic analyses of *D. hallucatus* confirm the importance of Mt. Emerald for maintaining the genetic flow between northern and southern populations of far north Queensland quolls (Conroy and Lamont 2013).

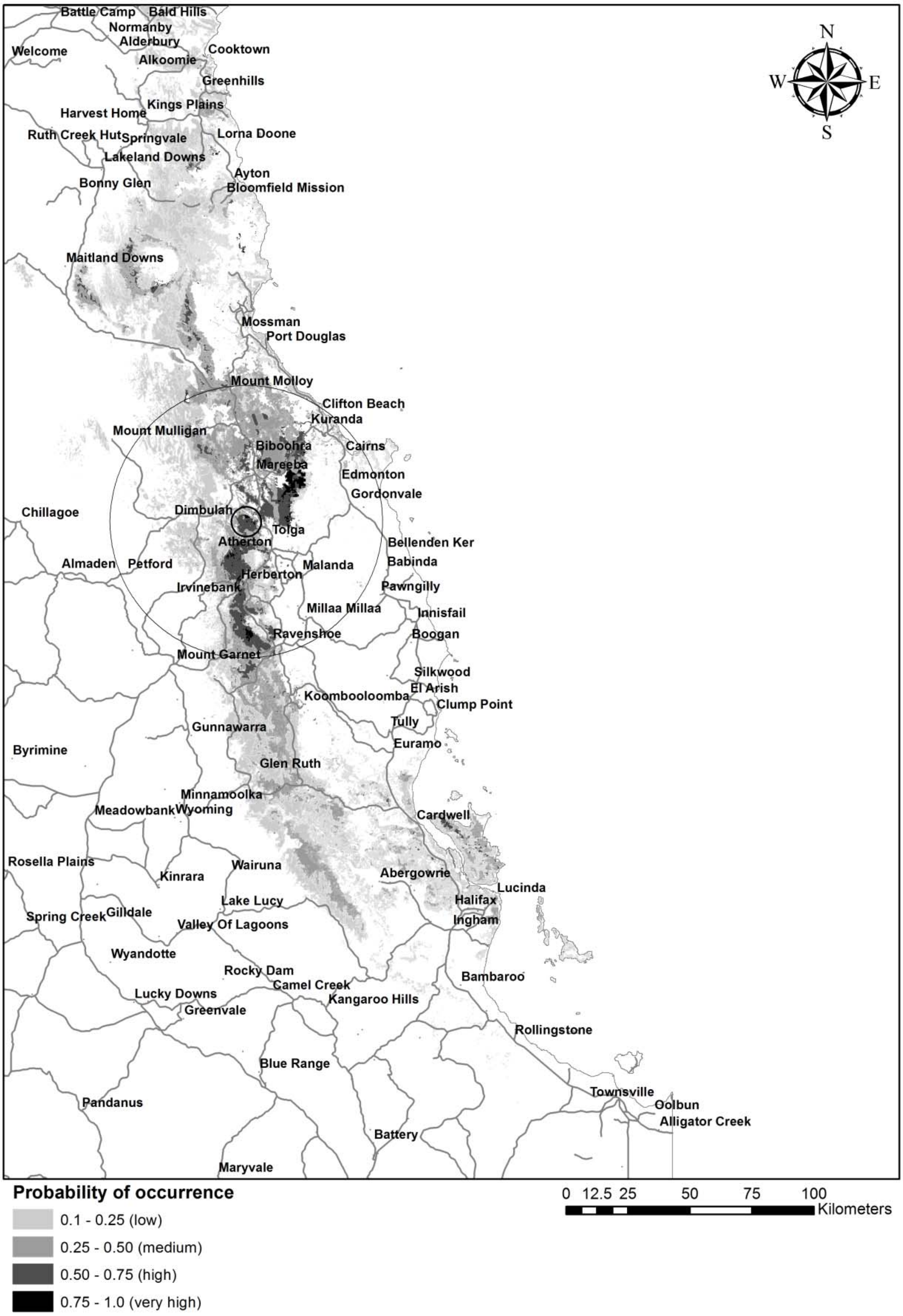

Fig. 4. Quoll habitat suitability within the far north Queensland region, modelled with MaxEnt.

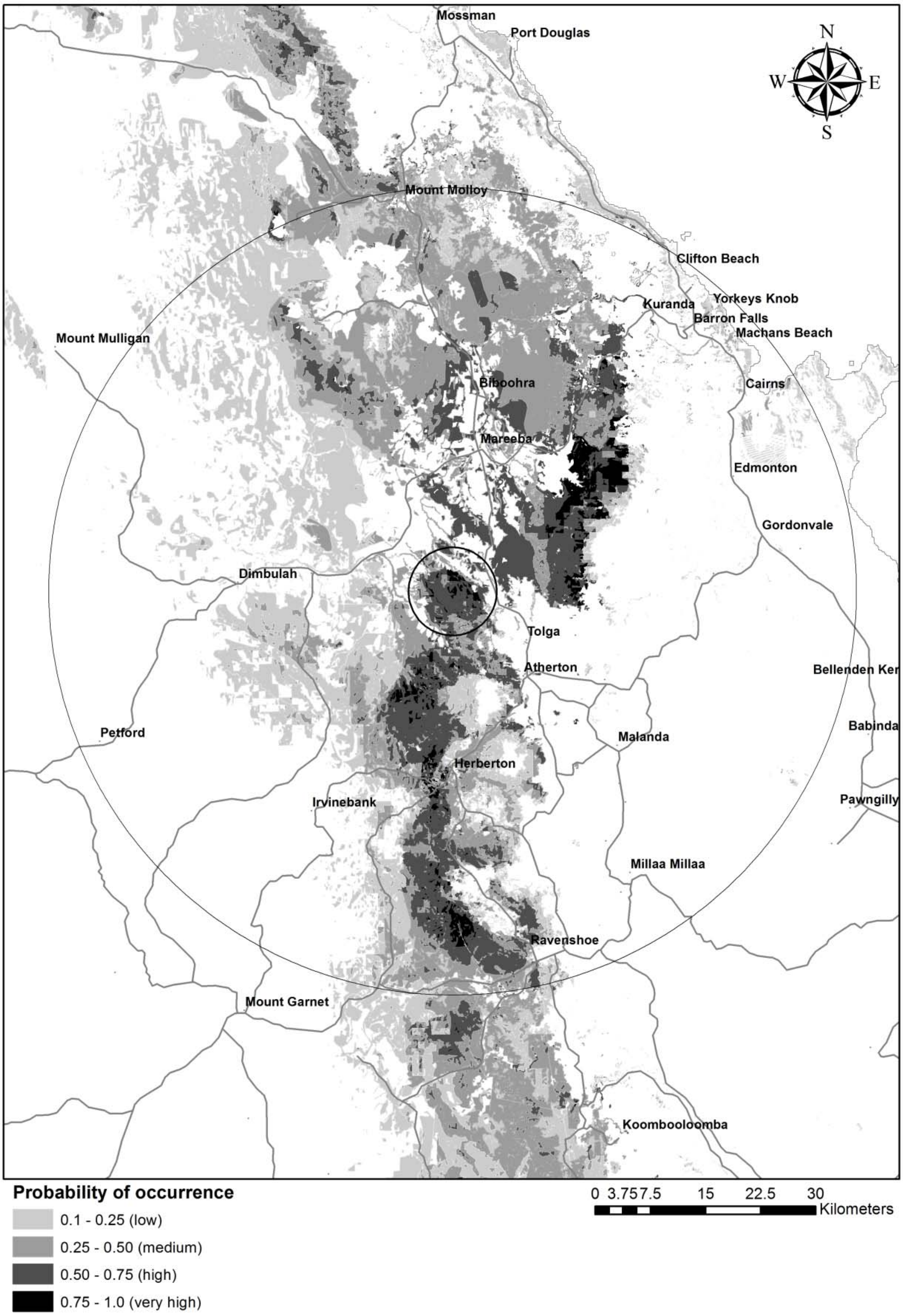

Fig. 5. Quoll habitat suitability within the northern Atherton Tablelands region, modelled with MaxEnt. Note that this is a magnified view of the above output (Fig. 4).

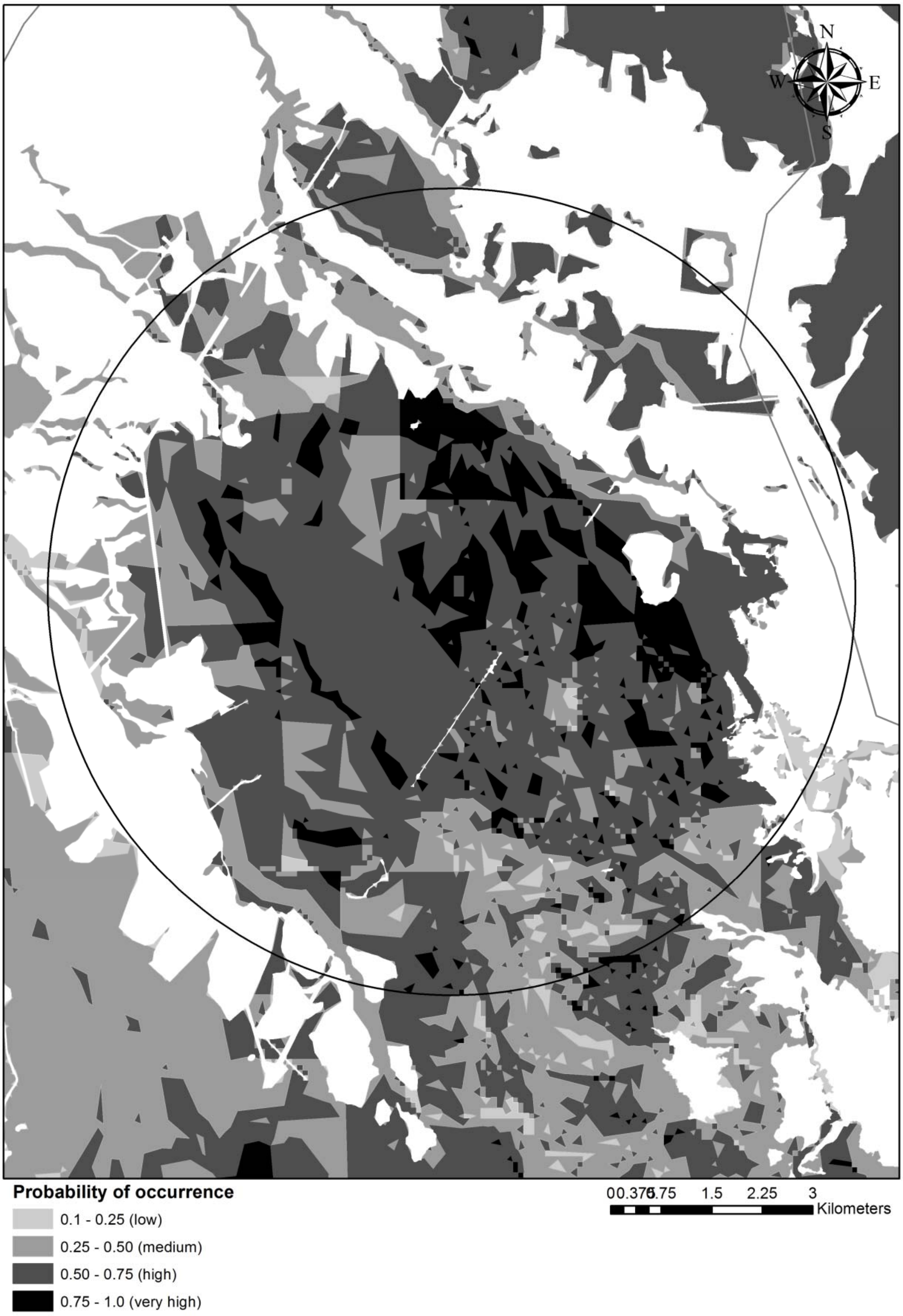

Fig. 6. Quoll habitat suitability within the Mt Emerald area, modelled with MaxEnt.

Note that this is a magnified view of the above output (Fig. 4).

Quality of quoll habitat in far north Queensland

MaxEnt modelling suggests that a band of high and very high quality quoll habitat makes up a core, stretching from Ravenshoe to Kuranda (Fig 3) implying that this central area of the far north Queensland region is particularly important to quolls. Mt Emerald sits within this area, forms part of this high quality habitat zone, and 72% of all predicted high and very high quality habitat occurs within a 55km radius of Mt Emerald (Table3, Fig 3, 4). Thus suggesting this central portion of the far north Queensland area is more important for quolls than other areas within the metapopulation. Mt Emerald itself consists largely of high and very high quality habitat, and makes up 4.5% of all such habitat in the far north Queensland. Mt. Emerald and the habitats contained within a 55km radius around Mt Emerald are very important for ensuring the persistence of *D. hallucatus* populations in far north Queensland (Table 3; Fig. 5).

This statistic has not been ground truthed and therefore should be interpreted with some caution. In particular it is noted the quoll presence samples used to build the MaxEnt model were not collected randomly and many of these records are anecdotal in origin—consequently the apparent density of quoll records in this area (which contributes to model output identifying this as high and very high quality habitat), could be biased by the fact this is also an area of high exposure and hence reporting rates. This uncertainty could be removed by ground-truthing the model output with randomly assigned survey locations across the far north Queensland range.

Density and abundance of quolls in far north Queensland

102 individual quolls were captured 130 times at 109 (28.8%) camera sites during this study. The overall camera trap success rate was approximately 29%. The density of quolls at each camera trap site ranged from 0 – 8.5 quolls/100ha (Mean 0.44 quolls/ha, SD 0.0124, n= 109).

The density of quolls differed between the two terrain classes into which all camera trap sites were categorized. The estimated density of quolls in flat and nearly flat terrain was approximately 1.09 quolls/100ha, compared to quoll density in moderately to extremely rugged terrain which averaged 2.25 quolls/100ha.

Table 3. Spatial extent of habitats of *D. hallucatus* within five suitability thresholds resulting from MaxEnt models.

Maxent Probability range	Habitat Category	Area within entire FNQ Area (Ha)	Area within 55km radius of Mt Emerald (Ha)	Area within Mt Emerald (Ha)	Proportion of each habitat class within FNQ area	Proportion of each habitat class within 55km radius of Mt Emerald	Proportion of each habitat class within Mt Emerald	Area of each habitat class within FNQ area as a proportion of total extent of that habitat class	Area of each habitat class within 55km radius of Mt Emerald as a proportion of total extent of that habitat class	Area of each habitat class within Mt Emerald as a proportion of total extent of that habitat class
<0.1	Unsuitable	6227420.9	650847.9	0.0	0.805	0.556	0.0	0.895	0.105	0.0
0.1 - 0.25	Low	885915.0	202458.1	932.3	0.115	0.173	0.061	0.77	0.229	0.001
0.25 - 0.5	Medium	484684.7	218178.1	8031.0	0.063	0.186	0.529	0.533	0.45	0.017
0.5 - 0.75	High	123251.8	87212.0	5283.2	0.016	0.074	0.348	0.25	0.708	0.043
0.75 - 1.0	Very high	14246.6	12254.1	931.1	0.002	0.01	0.061	0.075	0.86	0.065
TOTAL		7735519.12	1170950.13	15177.60						

Applying the density/unit area potential habitat approach, the entire far north Queensland quoll population is estimated at approximately 9466 individual northern quolls of which approximately 4299 quolls inhabit 394611.4ha of flat or near flat terrain and 5167 individuals inhabit 229264.18ha of moderately to extremely rugged terrain.

Application of the density method to estimate the size of the Mt Emerald quoll population suggests that 53 individual quolls potentially inhabit the site. Closed capture-recapture modelling using data from a 750-m camera trap grid which covered most of the site, also suggests a population size of 53 individuals (95%CI 34 – 109 individuals). This equates to between 0.35% and 1.2% of the entire estimated far northern quoll population.

Uncertainty in the estimate of quoll population size

This population estimate developed above must be viewed in the context of the data that were available for this. A number of factors suggest that this could be an overestimate of quoll abundance. Firstly, the estimate of extent of available habitat (MaxEnt modelling) is likely to overestimate the area of occupied quoll habitat. The model used a range of abiotic and biotic parameters to model the distribution of quoll habitat, but it cannot fully take into account other possible influences on quoll presence such as anthropogenic activities, ecological interactions, natural catastrophes or other threats, which may prevent *D. hallucatus* from fully occupying/accessing all potential habitat areas. It was not possible to ground-truth the model output during this project.

It is also possible that the habitat model is biased towards habitats in which human activity (and this encounters with quolls) is greatest, as mentioned above.

Further uncertainty arises from the density estimates which were applied to the modelled extent of quoll habitat to produce a total quoll population count. All camera trapping, from which density data were derived, was carried out within a 55km radius of Mt Emerald. The extrapolation of these density data to the entire far north Queensland quoll habitat area may therefore over- or underestimate the true size far northern quoll metapopulation.

The implications of these uncertainties are that the relative importance of the Mt Emerald site in the context of the far northern population could be underestimated if density data from Mt Emerald and surrounds are higher than elsewhere within the species range. This requires an extensive program of camera trapping throughout the far northern region in order to validate the density data.

Conclusions

The far north Queensland metapopulation of northern quolls is highly significant at the National and State scale. Unlike all mapped extant Northern Territory and Western Australian populations the far north Queensland metapopulation is not threatened by cane toads or in known decline, having endured and apparently recovered from that impact (Woinarski *et al.* 2008). Within a Queensland context, the far north Queensland population is significant in that it is a highly visible and persistent population. There are no data concerning the density or area of extant of northern quolls in any other metapopulation area so no conclusions can be drawn as to the relative abundance of quolls between the far north Queensland metapopulation and other metapopulations or populations.

Although the Mt Emerald quoll population represents only 0.5% of the overall northern quoll metapopulation—the importance of a population of any number in this location is unknown.

Given that a small total area is to be cleared (approx. 45ha) during the construction phase of this project, it is unlikely that many quoll fatalities will eventuate. Importantly, we don't know the medium- and long-term impacts of the development on carrying capacity of the site. Potential impacts on carrying capacity could arise from weed invasion associated with the movement of vehicles through the site, importation and expansion of weeds due to disturbance of the native ground covers and soil, and changes in fire regime.

Notwithstanding uncertainties in the data, this study suggests that the far north Queensland quoll population is highly significant at a State and National level. Genetic analyses of *D. hallucatus* confirm the importance of Mt. Emerald for maintaining the genetic flow between northern and southern populations of far north Queensland quolls (Conroy and Lamont 2013). The Mt Emerald population of quolls—although not numerically significant within the overall far northern context—are present in an area that is critical for the far northern metapopulation. Although the extent of the impact of the MEWF project on quolls at Mt Emerald is unknown, the small contribution that this population makes to the far northern metapopulation indicates that it is unlikely that the development will negatively impact quolls at the state or regional scale in the short-term. It is unknown how the quoll population at the site will be affected over subsequent years as we lack any data or way of predicting changes to the carrying capacity of the site that might occur as a result of construction and operation of the MEWF site.

Knowledge gaps and research needs

The following knowledge gaps impede a full and proper assessment of the significance of the far northern and Mt Emerald quoll populations, and of the impacts of the MEWF project.

1. Quoll population and metapopulation boundaries are poorly known, and represent estimates at best. There has been insufficient recent or historical survey for quolls to have high confidence that the species only occurs in mapped metapopulation areas.

2. It was not possible to ground-truth the MaxEnt model output during this project. This leads to uncertainty in the accuracy of habitat model output. An assessment of the accuracy of this output entails stratified sampling of quolls within the modelled extent in far north Queensland.

3. The applicability to the rest of the far northern metapopulation area of the quoll density estimates derived for the Mt Emerald and surrounds is untested. This requires an extensive program of camera trapping stratified by habitat-type and covering the entire far northern region in order to validate the density data.

4. There are no data concerning the density or area of extant of northern quolls in any other metapopulation area so no conclusions can be drawn as to the relative abundance of quolls between the far north Queensland metapopulation and other metapopulations or populations. This requires a program of quollpopulation survey and enumeration, using the same methods as those used in this study, in other metapopulation areas.

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Appendices

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Appendix A. Presence records used to map the contemporary extent of occurrence of *D. hallucatus* and to model habitat suitability in far north Queensland.

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
2	-17.49155	145.2824	Wildlife online	50	?	21/02/2012	21/02/2012	Dry River, 0.3 km SE of Rock Bar
3	-17.49155	145.2824	Wildlife online	50	?	12/05/2012	12/05/2012	Dry River, 0.3 km SE of Rock Bar
4	-17.45259	145.28733	Wildlife online	100	?	31/07/2010	31/07/2010	Silver Valley Road, between Lancelot battery & rockart rock
5	-17.4523	145.28795	Wildlife online	100	?	7/10/2009	7/10/2009	Silver Valley Road, Dry River "Rock Art site"
7	-17.371674	145.32822	Scott Burnett fauna records	10	WGS84	19/06/2000	19/06/2000	Upper Walsh River, upper Bussy Ck
8	-17.370898	145.349261	This study	15	GDA94	14/09/2012	18/09/2012	Upper Walsh
9	-17.37033	145.346925	This study	15	GDA94	14/09/2012	18/09/2012	Upper Walsh
10	-17.368571	145.348569	This study	15	GDA94	14/09/2012	18/09/2012	Upper Walsh
11	-17.36781	145.35292	Scott Burnett fauna records	100	WGS84	1/01/2003	30/05/2003	Watsonville Range, under powerline
12	-17.366915	145.350127	This study	15	GDA94	14/09/2012	18/09/2012	Upper Walsh

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
13	-17.366738	145.326863	Scott Burnett fauna records	10	WGS84	19/06/2000	19/06/2000	Upper Walsh River
14	-17.366682	145.326704	Scott Burnett fauna records	15	WGS84	19/06/2000	19/06/2000	Upper Walsh River
15	-17.366583	145.326799	Scott Burnett fauna records	15	WGS84	19/06/2000	19/06/2000	Upper Walsh River
16	-17.36518	145.351813	This study	15	GDA94	14/09/2012	18/09/2012	Upper Walsh
17	-17.359276	145.326543	Scott Burnett fauna records	15	WGS84	23/02/2003	23/02/2003	Picnic Rock, Watsonville
18	-17.359622	145.3279	Scott Burnett fauna records	50	WGS84	1/01/2000	31/12/2000	154 Walsh River Road, Watsonville QLD
19	-17.359309	145.326714	Scott Burnett fauna records	10	WGS84	19/06/2000	19/06/2000	Upper Walsh River
20	-17.354706	145.351284	This study	15	GDA94	13/09/2012	17/09/2012	Upper Walsh
21	-17.352441	145.351611	This study	15	GDA94	13/09/2012	17/09/2012	Upper Walsh
22	-17.352176	145.377335	This study	15	GDA94	14/09/2012	18/09/2012	Upper Walsh
23	-17.351458	145.35378	This study	15	GDA94	13/09/2012	17/09/2012	Upper Walsh
24	-17.350638	145.355919	This study	15	GDA94	13/09/2012	17/09/2012	Upper Walsh
25	-17.343214	145.359701	This study	15	GDA94	13/09/2012	17/09/2012	Upper Walsh
26	-17.3117	145.21423	This study	15	GDA94	13/09/2012	17/09/2012	Stannery Hills

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
27	-17.30692	145.39798	Wildlife online	400		17/12/1994	18/12/1994	Mt Baldy SF, Walsh River and adjacent slopes
28	-17.30513	145.21249	This study	15	GDA94	13/09/2012	17/09/2012	Stannery Hills
29	-17.2952	145.3529	Wildlife online	500		28/02/2001	28/02/2001	Mt Baldy - Lower I site
30	-17.29167	145.35306	Wildlife online	300		1/03/2001	1/03/2001	Mt Baldy - Lower I site
31	-17.2916	145.35214	This study	15	GDA94	9/10/2012	15/10/2012	UPPER WALSH NORTH
32	-17.27979	145.36359	This study	15	GDA94	9/10/2012	15/10/2012	UPPER WALSH NORTH
33	-17.2682	145.3578	Wildlife online	500		28/02/2001	28/02/2001	Mt Baldy - Upper I site
34	-17.26667	145.3575	Wildlife online	300		3/03/2001	3/03/2001	Mt Baldy - Upper I site
36	-17.24151	145.35629	This study	15	GDA94	9/10/2012	15/10/2012	UPPER WALSH NORTH
37	-17.23948	145.35516	This study	15	GDA94	9/10/2012	15/10/2012	UPPER WALSH NORTH
38	-17.23739	145.354	This study	15	GDA94	9/10/2012	15/10/2012	UPPER WALSH NORTH
39	-17.23575	145.3602	This study	15	GDA94	9/10/2012	15/10/2012	UPPER WALSH NORTH
40	-17.23494	145.35316	This study	15	GDA94	9/10/2012	15/10/2012	UPPER WALSH NORTH
41	-17.23022	145.37395	Wildlife online	20		12/01/2012	12/01/2012	Oakey Creek, 11 km W of Tolga

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
42	-17.22904	145.36159	This study	15	GDA94	9/10/2012	15/10/2012	UPPER WALSH NORTH
43	-17.20651	145.36192	Wildlife online	50		5/01/2012	5/01/2012	Oakey Creek, Arriga, 8 km W of Walkamin
44	-17.20651	145.36192	Wildlife online	50		5/01/2012	5/01/2012	Oakey Creek, Arriga, 8 km W of Walkamin
45	-17.20651	145.36192	Wildlife online	50		18/01/2012	18/01/2012	Oakey Creek, Arriga, 8 km W of Walkamin
46	-17.20651	145.36192	Wildlife online	50		23/01/2012	23/01/2012	Oakey Creek, Arriga, 8 km W of Walkamin
47	-17.189778	145.395937	This study	15	GDA94	2012		Mt Emerald 750
48	-17.189708	145.388997	This study	15	GDA94	2012		Mt Emerald 750
49	-17.18465	145.18033	This study	15	GDA94	20/09/2012	24/09/2012	Mutchilba
50	-17.182983	145.403194	This study	15	GDA94	21/08/2012	27/08/2012	Mt Emerald 750
51	-17.182947	145.389078	This study	15	GDA94	2012		Mt Emerald 750
52	-17.18245	145.34784	This study	15	GDA94	24/10/2012	31/10/2012	Oakvale
53	-17.176207	145.403252	This study	15	GDA94	21/08/2012	27/08/2012	Mt Emerald 750
54	-17.176094	145.389152	This study	15	GDA94	21/08/2012	27/08/2012	Mt Emerald 750
55	-17.175785	145.396263	This study	15	GDA94	21/08/2012	27/08/2012	Mt Emerald 750

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
56	-17.169205	145.375112	This study	15	GDA94	20/08/2012	24/08/2012	Mt Emerald 750
57	-17.169191	145.368158	This study	15	GDA94	2012		Mt Emerald 750
58	-17.16819	145.52253	Wildlife online	300		1/09/1995	30/09/1995	Tinaroo Dam-G, 640m asl
59	-17.16554	145.54051	Wildlife online	300		1/09/1995	30/09/1995	Tinaroo Dam-D, 650m asl
60	-17.16496	145.51828	Wildlife online	300		1/09/1995	30/09/1995	Tinaroo Dam-H, 670m asl
61	-17.162859	145.39666	This study	15	GDA94	2012		Mt Emerald 750
62	-17.162653	145.403368	This study	15	GDA94	21/08/2012	27/08/2012	Mt Emerald 750
63	-17.162541	145.389269	This study	15	GDA94	20/08/2012	24/08/2012	Mt Emerald 750
64	-17.162484	145.38222	This study	15	GDA94	20/08/2012	24/08/2012	Mt Emerald 750
65	-17.162371	145.368122	This study	15	GDA94	20/08/2012	24/08/2012	Mt Emerald 750
66	-17.161711	145.545236	Quoll Seekers FNQ	100				Tinaroo Dam wall (200M EAST)
67	-17.15928	145.54718	Wildlife online	300		1/09/1995	30/09/1995	Tinaroo Dam-C, 670m asl
68	-17.15632	145.51902	Wildlife online	300		1/09/1995	30/09/1995	Tinaroo Dam-I, 690m asl
69	-17.155809	145.396464	This study	15	GDA94	2012		Mt Emerald 750

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
70	-17.155764	145.389328	This study	15	GDA94	20/08/2012	24/08/2012	Mt Emerald 750
71	-17.155708	145.382279	This study	15	GDA94	20/08/2012	24/08/2012	Mt Emerald 750
72	-17.155633	145.368205	This study	15	GDA94	2012		Mt Emerald 750
73	-17.1537	145.55073	Wildlife online	200		10/09/2000		1.4km northeast of Tinaroo Dam wall
74	-17.149091	145.389174	This study	15	GDA94	2012		Mt Emerald 750
75	-17.148894	145.262003	Quoll Seekers FNQ	50				1 Lemonside Road (off Dimbulah Road), Mareeba
76	-17.148874	145.375289	This study	15	GDA94	20/08/2012	24/08/2012	Mt Emerald 750
77	-17.142098	145.368162	This study	15	GDA94	2012		Mt Emerald 750
78	-17.12078	145.54162	Wildlife online	300		1/12/1995	31/12/1995	Tinaroo Creek retrapping-G
79	-17.11794	145.44048	This study	15	GDA94	27/09/2012	1/10/2012	HENRY HANNAM RD
80	-17.11501	145.44086	This study	15	GDA94	27/09/2012	1/10/2012	HENRY HANNAM RD
81	-17.109642	145.538949	This study	15	GDA94	2012		Lamb Range
82	-17.109064	145.541125	This study	15	GDA94	2012		Lamb Range

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
83	-17.108221	145.543591	This study	15	GDA94	2012		Lamb Range
84	-17.10386	145.53174	Wildlife online	300		1/04/1994	30/04/1994	Tinaroo Creek-H, 645m asl
85	-17.10065	145.44958	This study	15	GDA94	27/09/2012	1/10/2012	HENRY HANNAM RD
86	-17.09488	145.52143	Wildlife online	300		1/04/1994	30/04/1994	Tinaroo Creek-J, 640m asl
87	-17.094808	145.383019	Quoll Seekers FNQ	50		1/06/2010	1/06/2010	17░ 5'41.31"S 145░22'58.87"E Chewko Road QLD
88	-17.080996	145.570913	This study	15	GDA94	2012		Lamb Range
89	-17.080511	145.568052	This study	15	GDA94	2012		Lamb Range
90	-17.079859	145.500792	Quoll Seekers FNQ	50		29/12/2012	29/12/2012	S 17.079859 áEá145.500792á. 4)
91	-17.069806	145.483394	Quoll Seekers FNQ	50		29/12/2012	29/12/2012	S 17 04.113 E 145 29.022
92	-17.023062	145.585253	This study	15	GDA94	2012		Lamb Range
93	-17.022736	145.583454	This study	15	GDA94	2012		Lamb Range
94	-17.022061	145.578514	This study	15	GDA94	2012		Lamb Range
95	-17.01974	145.5842	Wildlife online	300		1/05/1994	31/05/1994	Davies Creek-S, 600m asl

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
96	-17.01973	145.58431	Wildlife online	100		9/08/2004		Davies Creek monitoring sites
97	-17.01873	145.5838	Wildlife online	100		5/12/2004	5/12/2004	Davies Creek monitoring sites
98	-17.01867	145.58532	Wildlife online	300		1/11/1995	30/11/1995	Davies Creek II-Q2, 650m asl
99	-17.01709	145.583933	This study	15	GDA94	2012		Lamb Range
100	-17.01704	145.58158	Wildlife online	100		16/07/2002	16/07/2002	Davies Creek monitoring sites
101	-17.01696	145.58498	Wildlife online	100		30/08/2005		Davies Creek monitoring sites
102	-17.01647	145.58344	Wildlife online	250		18/06/1990	18/06/1990	Davies Creek Rd, Lamb Range, 2.4 km NNE Mt Turtle
103	-17.015471	145.571727	This study	15	GDA94	2012		Lamb Range
104	-17.01486	145.58187	Wildlife online	100		12/09/2000		Davies Creek monitoring sites
105	-17.0148	145.57857	Wildlife online	100		2/12/2004	2/12/2004	Davies Creek monitoring sites
106	-17.01477	145.57767	Wildlife online	100		30/08/2005		Davies Creek monitoring sites
107	-17.01466	145.58103	Wildlife online	100		13/09/2000		Davies Creek monitoring sites
108	-17.01466	145.58103	Wildlife online	100		4/06/2003	4/06/2003	Davies Creek monitoring sites

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
109	-17.01466	145.58103	Wildlife online	100		5/06/2003	5/06/2003	Davies Creek monitoring sites
110	-17.01466	145.58251	Wildlife online	250		20/06/1990	20/06/1990	Davies Creek Rd, Lamb Range, 2.6 km NNE Mt Turtle
111	-17.01465	145.58157	Wildlife online	450		19/06/1990	19/06/1990	Davies Creek, Lamb Range, 2.5 km N Mt Turtle
112	-17.01431	145.58016	Wildlife online	100		31/08/2005		Davies Creek monitoring sites
113	-17.012826	145.571156	This study	15	GDA94	2012		Lamb Range
114	-17.01206	145.5789	Wildlife online	300		1/05/1994	31/05/1994	Davies Creek-T, 600m asl
115	-17.010795	145.57081	This study	15	GDA94	2012		Lamb Range
116	-17.00972	145.57806	Wildlife online	100		8/01/2012		Davies Creek NP nr Mareeba
117	-17.00825	145.57035	Wildlife online	250		20/06/1990	20/06/1990	Davies Creek Rd, Lamb Range, 3.4 km NNW Mt Turtle
118	-17.006497	145.338311	Quoll Seekers FNQ	50		20/01/2009	20/01/2009	94 Ivicevic Road, Paddys Green, Mareeba
119	-17.00371	145.56757	Wildlife online	250		16/06/1990	16/06/1990	Davies Creek Rd, Lamb Range, 3.8km NNW Mt Turtle
120	-17.002457	145.56202	This study	15	GDA94	2012		Lamb Range

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
121	-17.000208	145.563071	This study	15	GDA94	2012		Lamb Range
122	-16.99834	145.55104	This study	15	GDA94	28/09/2012	2/10/2012	Kay Rd
123	-16.998283	145.564188	This study	15	GDA94	2012		Lamb Range
124	-16.996766	145.56605	This study	15	GDA94	2012		Lamb Range
125	-16.993689	145.548716	This study	15	GDA94	2012		Lamb Range
126	-16.993409	145.545995	This study	15	GDA94	2012		Lamb Range
127	-16.993036	145.541565	This study	15	GDA94	2012		Lamb Range
128	-16.99167	145.55373	This study	15	GDA94	28/09/2012	2/10/2012	Kay Rd
129	-16.990752	145.5428	This study	15	GDA94	2012		Lamb Range
130	-16.989133	145.544627	This study	15	GDA94	2012		Lamb Range
131	-16.98694	145.55855	This study	15	GDA94	28/09/2012	2/10/2012	Kay Rd
132	-16.981539	145.550008	This study	15	GDA94	2012		Lamb Range
133	-16.98059	145.34102	This study	15	GDA94	27/09/2012	1/10/2012	Southedge Research Station
134	-16.980019	145.54553	This study	15	GDA94	2012		Lamb Range

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
135	-16.97761	145.34685	This study	15	GDA94	27/09/2012	1/10/2012	Southedge Research Station
136	-16.967502	145.415999	Quoll Seekers FNQ	50		1/01/2002	31/12/2012	-16.967502, 145.415999. 52 McGrath Road. Mareeba
137	-16.952069	145.686825	Quoll Seekers FNQ	50		11/05/2011	11/05/2011	16 57' 07.45"S 145 41' 12.57"E
140	-16.919165	145.594237	Scott Burnett fauna records	15	WGS84	18/06/2003	18/06/2003	Clohesy R Rd, 1000m e first ford
141	-16.916472	145.386922	Quoll Seekers FNQ	50				Pickford Rd, Biboohra QLD 4880
142	-16.913031	145.597453	Quoll Seekers FNQ	50		1/06/2008	30/06/2008	Cedar park Rd, Koah QLD
143	-16.912894	145.576731	Quoll Seekers FNQ	50				Clohesy River Road, Kuranda, QLD 4881
144	-16.890313	145.567816	Scott Burnett fauna records	15	WGS84	23/07/2001	23/07/2001	Cnr of Kennedy Highway and Palm Valley Rd, just north of Koah Roadhouse.
146	-16.829003	145.712022	Quoll Seekers FNQ	50		1/01/2005	31/12/2011	Dunne Rd at Yorkeys Knob
147	-16.809942	145.364043	Scott Burnett fauna records	15	WGS84	15/06/2000	15/06/2000	Big Mitchell Reserve
148	-16.807714	145.604567	Quoll Seekers FNQ	50				Myola Road, Kuranda QLD
150	-16.80292	145.55559	This study	15	GDA94	27/09/2012	1/10/2012	Private Property of Petra Lovey

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
151	-16.80248	145.36455	Wildlife online	200		12/03/2000	12/03/2000	100m north of Big Mitchell Creek, Peninsula Development Rd
152	-16.79782	145.373782	Scott Burnett fauna records	15	WGS84	14/06/2000	14/06/2000	Big Mitchell reserve
153	-16.797106	145.549978	Quoll Seekers FNQ	50				Armstrong Road, Kuranda.
158	-16.6068	145.35194	Wildlife online	200		10/05/2000	10/05/2000	Eulama Creek Rd, Julatten
159	-16.382919	145.36913	Quoll Seekers FNQ	50		23/07/2008	23/07/2008	Zone 55K (DATUM WGS 84) Easting 326229 Northing 8138625
160	-16.317182	145.09875	Scott Burnett fauna records	15	WGS84	28/05/2011	2/06/2011	Windsor Tableland
161	-16.307845	145.097047	Scott Burnett fauna records	15	WGS84	28/05/2011	2/06/2011	Windsor Tableland
162	-16.300264	145.090837	Scott Burnett fauna records	15	WGS84	28/05/2011	2/06/2011	Windsor Tableland
164	-16.246891	144.970892	Scott Burnett fauna records	15	WGS84	28/05/2011	2/06/2011	Windsor Tableland
165	-16.244297	144.971198	Scott Burnett fauna records	15	WGS84	28/05/2011	2/06/2011	Windsor Tableland
166	-15.86368	144.80962	Wildlife online	20		24/02/2009	24/02/2009	Lily Creek homestead, Lakeland Downs
167	-15.8027	145.219422	Quoll Seekers FNQ	50		27/09/2009	27/09/2009	S 15 48.972. E 145 13.992

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
176	-15.67711	145.21619	Wildlife online	450		28/07/1989	28/07/1989	Helenvale-Cooktown road junctio, 1.5 km WSW Black Mt
179	-15.656156	145.253889	Quoll Seekers FNQ	50		13/10/2011	13/10/2011	Mt Atmos Valley -15.39'22.16" 145.15'.14"
180	-15.65389	145.22167	Wildlife online	100		28/11/2004		Black Mountain N.P.
181	-15.65	145.216667	Quoll Seekers FNQ	50				Mount Simon,Rossville QLD 4895 (Black Mountian NP)
182	-15.64387	144.9839	Wildlife online	50		28/06/1996	29/06/1996	Northern limestone outcrop, above side tributary of East Normandy River, Kings Plains Station
183	-15.467167	145.089203	Quoll Seekers FNQ	50				Wilton access road 15 km north west of Cooktown
184	-15.332803	145.032889	Quoll Seekers FNQ	50		30/06/2009	31/12/2006	Endeavour Valley Rd, Cooktown QLD 4895
185	-16.920136	145.758744	Quoll Seekers FNQ	50				Parramatta Park, Severin St QLD
186	-16.885556	145.833889	Quoll Seekers FNQ	50				2240 Yarrabah Road, East Trinity
187	-16.34099	144.87802	Peter Buosi - Ecologist	50	GDA94	6/06/2006	6/06/2006	Palmer River

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
188	-16.34076	144.87968	Peter Buosi - Ecologist	50	GDA94	8/06/2006	8/06/2006	Palmer River
189	-16.34076	144.87968	Peter Buosi - Ecologist	50	GDA94	9/06/2006	9/06/2006	Palmer River
190	-17.39057	145.37621	Saeed De Ridder - Naturalist	100		24/03/2000	24/03/2000	Rifle Range, Herberton
191	-17.16972	145.54694	Andrew Dennis -Ecologist	100	AGD84	14/01/2000	14/01/2000	Pensini's Restaurant, Lake Tinaroo
197	-16.68445	145.32979	Scott Burnett fauna records	15	WGS84	2/12/1999	2/12/1999	on Mareeba Rd, 1km south of Mt Molloy
200	345428.6051	8101964.3	John Winter –Ecologist	15	WGS84	17/01/2007	17/01/2007	Tinaroo Falls
201	345434	8107800	John Winter –Ecologist	15	WGS84	11/03/2007	11/03/2007	Tinaroo Ck Rd, Emu Ck
202	338615.3609	8112512.9	John Winter –Ecologist	15	WGS84	12/03/2007	12/03/2007	Tinaroo Ck Rd, Douglas Ck
203	335616.8084	8108436.3	John Winter –Ecologist	15	WGS84	23/03/2007	23/03/2007	Tolga, Vollert's
204	310222.9681	8249120.4	John Winter –Ecologist	15	WGS84	2/06/2007	2/06/2007	Mt Poverty
205	-16.64538	145.26272	Australian Wildlife Conservancy	15	GDA94	25/05/2006	25/05/2006	Brookyn Sanctuary

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
206	-16.59740	145.25391	Australian Wildlife Conservancy	15	GDA94	25/05/2006	25/05/2006	Brookyn Sanctuary
207	-16.64538	145.26272	Australian Wildlife Conservancy	15	GDA94	15/11/2006	15/11/2006	Brookyn Sanctuary
208	-16.64881	145.26180	Australian Wildlife Conservancy	15	GDA94	15/11/2006	15/11/2006	Brookyn Sanctuary
209	-16.59740	145.25391	Australian Wildlife Conservancy	15	GDA94	15/11/2006	15/11/2006	Brookyn Sanctuary
210	-16.59942	145.24281	Australian Wildlife Conservancy	15	GDA94	15/11/2006	15/11/2006	Brookyn Sanctuary
211	-16.65802	145.26262	Australian Wildlife Conservancy	15	GDA94	18/04/2007	18/04/2007	Brookyn Sanctuary
212	-16.59813	145.24796	Australian Wildlife Conservancy	15	GDA94	18/04/2007	18/04/2007	Brookyn Sanctuary
213	-16.59813	145.24796	Australian Wildlife Conservancy	15	GDA94	18/04/2007	18/04/2007	Brookyn Sanctuary
214	-16.59813	145.24796	Australian Wildlife Conservancy	15	GDA94	18/04/2007	18/04/2007	Brookyn Sanctuary
215	-16.59813	145.24796	Australian Wildlife Conservancy	15	GDA94	18/04/2007	18/04/2007	Brookyn Sanctuary
216	-16.59942	145.24281	Australian Wildlife Conservancy	15	GDA94	18/04/2007	18/04/2007	Brookyn Sanctuary
217	-16.59942	145.24281	Australian Wildlife Conservancy	15	GDA94	18/04/2007	18/04/2007	Brookyn Sanctuary
218	-16.64538	145.26272	Australian Wildlife Conservancy	15	GDA94	10/11/2007	10/11/2007	Brookyn Sanctuary
219	-16.64538	145.26272	Australian Wildlife Conservancy	15	GDA94	10/11/2007	10/11/2007	Brookyn Sanctuary

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
220	-16.59740	145.25391	Australian Wildlife Conservancy	15	GDA94	10/11/2007	10/11/2007	Brookyn Sanctuary
221	-16.59730	145.25209	Australian Wildlife Conservancy	15	GDA94	10/11/2007	10/11/2007	Brookyn Sanctuary
222	-16.59813	145.24796	Australian Wildlife Conservancy	15	GDA94	10/11/2007	10/11/2007	Brookyn Sanctuary
223	-16.59942	145.24281	Australian Wildlife Conservancy	15	GDA94	10/11/2007	10/11/2007	Brookyn Sanctuary
224	-16.64538	145.26272	Australian Wildlife Conservancy	15	GDA94	6/10/2009	6/10/2009	Brookyn Sanctuary
225	-16.64881	145.26180	Australian Wildlife Conservancy	15	GDA94	6/10/2009	6/10/2009	Brookyn Sanctuary
226	-16.59348	145.21141	Australian Wildlife Conservancy	15	GDA94	19/04/2010	19/04/2010	Brookyn Sanctuary
227	-16.64538	145.26272	Australian Wildlife Conservancy	15	GDA94	7/11/2010	7/11/2010	Brookyn Sanctuary
228	-16.64538	145.26272	Australian Wildlife Conservancy	15	GDA94	7/11/2010	7/11/2010	Brookyn Sanctuary
229	-16.53234	145.18409	Australian Wildlife Conservancy	15	GDA94	26/09/2011	26/09/2011	Bottle tree
230	-16.53234	145.18409	Australian Wildlife Conservancy	15	GDA94	26/09/2011	26/09/2011	Bottle tree
231	-16.60963	145.24374	Australian Wildlife Conservancy	15	GDA94	26/09/2011	26/09/2011	Station Ck
232	-16.65503	145.25923	Australian Wildlife Conservancy	15	GDA94	26/09/2011	26/09/2011	Pom Pom track
233	-16.65174	145.26103	Australian Wildlife Conservancy	15	GDA94	26/09/2011	26/09/2011	Pom Pom track

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
234	-16.66896	145.26387	Australian Wildlife Conservancy	15	GDA94	15/03/2013	15/03/2013	Mulligan Highway
235	-16.64538	145.26272	Australian Wildlife Conservancy	15	GDA94	16/05/2013	16/05/2013	Brookyn Sanctuary
236	-16.65802	145.26262	Australian Wildlife Conservancy	15	GDA94	16/05/2013	16/05/2013	Brookyn Sanctuary
237	-16.58472	145.22794	Australian Wildlife Conservancy	15	GDA94	18/05/2013	18/05/2013	Brookyn Sanctuary
238	-16.66415	145.30062	Australian Wildlife Conservancy	15	GDA94	20/05/2013	20/05/2013	Mulligan Highway
239	-17.37556	145.3433	Scott Burnett fauna records	15	GDA94	19/05/2010	23/05/2010	Toy Creek, upper Walsh River
240	-17.37519	145.34869	Scott Burnett fauna records	15	GDA94	19/05/2010	23/05/2010	Toy Creek, upper Walsh River
241	-17.37512	145.34506	Scott Burnett fauna records	15	GDA94	19/05/2010	23/05/2010	Toy Creek, upper Walsh River
242	-17.37469	145.3521	Scott Burnett fauna records	15	GDA94	19/05/2010	23/05/2010	Toy Creek, upper Walsh River
243	-17.3743	145.34249	Scott Burnett fauna records	15	GDA94	19/05/2010	23/05/2010	Toy Creek, upper Walsh River
244	-17.37417	145.35023	Scott Burnett fauna records	15	GDA94	19/05/2010	23/05/2010	Toy Creek, upper Walsh River
245	-17.3673	145.35273	Scott Burnett fauna records	15	GDA94	20/05/2010	24/05/2010	Toy Creek, upper Walsh River
246	-17.36515	145.35244	Scott Burnett fauna records	15	GDA94	20/05/2010	24/05/2010	Toy Creek, upper Walsh River
247	-17.36366	145.35083	Scott Burnett fauna records	15	GDA94	20/05/2010	24/05/2010	Toy Creek, upper Walsh River

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
248	-17.36347	145.35288	Scott Burnett fauna records	15	GDA94	20/05/2010	24/05/2010	Toy Creek, upper Walsh River
249	-17.35598	145.35615	Scott Burnett fauna records	15	GDA94	20/05/2010	24/05/2010	Toy Creek, upper Walsh River
251	-17.17749	145.540223	Quoll Seekers FNQ	50		28/04/2012	28/04/2012	Main road into Tinaroo, not far from Tinaroo. Co-ordinates - 17.17749 145.540223
252	-17.14079062	145.433236	Quoll Seekers FNQ	50		21/04/2013	21/04/2013	Walkamin area Coordinates -17.14079061783959;145.43323554345704
253	-17.113107	-17.113107	Quoll Seekers FNQ	50				-17.113107 145.363305. Walkamin near Mareeba (address of the prison is 729 Chettle Rd, Arriga
254	-17.11281667	145.544667	Quoll Seekers FNQ	50		28/12/2012	28/12/2012	Co-ordinates S 17 06.769 E 145 32.682 Alt 869m. Steep south facing rocky slope with open woodland and grassy understorey
255	-17.09480833	145.383019	Quoll Seekers FNQ	50		1/06/2010 13:20	1/06/2010 13:20	17° 5'41.31"S 145°22'58.87"E (Google it) base of Mount Uncle and Mount Aunt, Chewko Road.

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
256	-17.079859	145.500792	Quoll Seekers FNQ	50		29/12/2012	29/12/2012	Co-ordinates S 17.079859 E 145.500792 . 4)
257	-17.069339	145.423751	Quoll Seekers FNQ	50		Within a week of this date	matthewweinert@westnet.com.au	Near the Mareeba Airport - 17.069339,145.423751
258	-17.006209	145.724593	Quoll Seekers FNQ	50		1/5/11	30/11/2011	276 Robert Road, Bentley Park - 17.006209 145.724593
259	-16.907487	145.566101	Quoll Seekers FNQ	50		14/03/2012	14/03/2012	Kennedy Highway near the servo/davies ck bridge. - 16.907487, 145.566101
260	-16.87544444	145.410028	Quoll Seekers FNQ	50		8/06/2012 11.30pm	8/06/2012 11.30pm	Co-ordinates 16°52'31.6" S 145°24'36.1" E
261	-16.85134	145.716981	Quoll Seekers FNQ	50		10/04/2013	10/04/2013	Northern approach to Thomatis Creek Bridge on the Highway. Co-ords -- 16.851349,145.716981
262	-16.841214	145.741743	Quoll Seekers FNQ	50		6/05/2013	6/05/2013	Hibiscus Lane, Holloways Beach Co-ordinates -16.841214, 145.741743
264	-16.282283	145.372214	Quoll Seekers FNQ	50		1/01/2009	31/12/2009	Mossman-Daintree Road, adjacent to golf course

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
265	-16.282283	145.372214	Quoll Seekers FNQ	50		1/01/2010	31/12/2010	Mossman-Daintree Road, adjacent to golf course
266	-15.73675	145.231861	Quoll Seekers FNQ	50		3/06/2010 8AM	3/06/2010 8AM	Cooktown Road between Rossville and the Shiptons Flat Turn off, South of Cooktown. s 15 44' 12.3", e 145 13' 54.7" (Lat and Long) or 55L 0310553 8259389 (UTM UPS)
267	-15.5033	145.2574	Quoll Seekers FNQ	50		7/11/10	7/11/10	Just south of Cooktown, on the road to Quarantine Bay - about 15.5033S 145.2574E
268	-15.47186111	145.2482	Quoll Seekers FNQ	50		9/01/2012	9/01/2012	Charlotte Street, Cooktown 15°28'18.70"S 145°14'53.52"E
269	-14.25685278	144.461847	Quoll Seekers FNQ	50		25/09/11	25/09/11	Cape Melville - top of Camp Creek. 14°15'24.67"S 144°27'42.65"E
270	-17.1300	145.3600	Alex Kutt - Ecologist	50	WGS84	1/01/1992	31/12/1992	Walkamin
271	-17.11350	145.54415	Scott Burnett unpublished	15	WGS84	10/06/2004	10/06/2004	Tinaroo Creek Rd, Lamb Range

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
			records					
272	-17.11020	145.53684	Scott Burnett unpublished records	15	WGS84	10/06/2004	10/06/2004	Tinaroo Creek Rd, Lamb Range
273	-17.10388	145.53413	Burnett	15	WGS84	10/06/2004	10/06/2004	Tinaroo Creek Rd, Lamb Range
274	-17.10119	145.52767	Scott Burnett unpublished records	15	WGS84	10/06/2004	10/06/2004	Tinaroo Creek Rd, Lamb Range
275	-17.0187	145.5838	Far Northern Threatened Species	50	WGS84	2004		
276	-17.0170	145.5816	Far Northern Threatened Species	50	WGS84	2002		
277	-17.0170	145.5850	Far Northern Threatened Species	50	WGS84	2005		
278	-17.0149	145.5819	Far Northern Threatened Species	50	WGS84	2000		
279	-17.0148	145.5786	Far Northern Threatened Species	50	WGS84	2004		
280	-17.0148	145.5777	Far Northern Threatened	50	WGS84	2005		

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
			Species					
281	-17.0147	145.5810	Far Northern Threatened Species	50	WGS84	2000		
282	-17.0147	145.5810	Far Northern Threatened Species	50	WGS84	2003		
283	-17.0143	145.5802	Far Northern Threatened Species	50	WGS84	2005		
284	-16.924972	145.361497	Quoll Seekers FNQ	100	WGS84	30-Oct-08	30-Oct-08	ceiling of Jabiru Safari Lodge at Mareeba Wetlands
285	-16.924972	145.361497	Quoll Seekers FNQ	100	WGS84	6/07/2008	6/07/2008	Marreba wetlands
286	-16.826663	145.653584	Quoll Seekers FNQ	100	WGS84	7/08/2011	7/08/2011	By siide of Kennedy Highway, 400m east of Rainforestation .
287	233449	233449	Quoll Seekers FNQ	50	WGS84	6 July 2010	6 July 2010	**near Lakeland NP GPS 0233449 – 8389906**
288	55 336300 8120100		Lloyd Jones – QPWS	15	WGS84	6/06/2001	2000	South of Emerald Ck on Kennedy Highway.
289	55 343934		Mark Newton - QPWS	15	WGS84	29/09/2001	2000	Tichum Creek Bridge on Kennedy Highway

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
	8123320							7kms NW of Emerald Ck.
290	55 345461 8128183		Mark Newton- QPWS	15	WGS84	9/10/2001	2000	400m south of Kanervo Rd and Kennedy Highway, SW of Koah.
291	55 347452 8132025		Gary Wilson & Ian Fox-QPWS	15	WGS84	23/07/2001	2000	Cnr of Kennedy Highway and Palm Valley Rd, just north of Koah Roadhouse.
292	-16.923623	145.730832	Quoll Seekers FNQ	100	GDA94	1/01/2008	31/12/2008	Moody creek, Marino quarry forest
293	-16.912065	145.417056	Quoll Seekers FNQ	100	GDA94	1/02/2010	28/02/2010	Bibhoora, north of Mareeba on the Mulligan Highway.
294	-15.863476	144.809804	Quoll Seekers FNQ	100	GDA94	1/01/2007	31/12/2009	Lakeland
295	-17.359276	145.326543	Scott Burnett fauna records	50	GDA94	1/11/1998	30/11/1998	154 Walsh River Road, Watsonville QLD
297	-17.354384	145.326851	Scott Burnett fauna records	50	GDA94	1/05/2001	30/05/2001	Walsh R Rd/Toy Creek crossing
298	-17.356725	145.330933	Scott Burnett fauna records	50	GDA94	1/05/2011	30/05/2011	Toy Creek, upper Walsh River
299	-17.357352	145.329718	Scott Burnett fauna records	50	GDA94	1/02/1999	28/02/1999	The Castle, elliot trapped on track to Toy Creek, 2/3 of the way there
300	-17.35107	145.329506	Scott Burnett fauna records	50	GDA94	15/06/2001	15/06/2001	Totorooby, Walsh River

Record No.	LATITUDE	LONGITUDE	Project_source	PRECISION (m)	Datum	START_DATE	END_DATE	LOCALITY
301	-17.380269	145.252565	Scott Burnett fauna records	50	GDA94	1/01/2010	15/06/2013	Buckley residence, Bakerville
302	55k 487580	7844579	Townsville QSN project_Burnett	15	GDA94	30/05/2010	4/06/2010	211 Mt View Rd, Toonpan
303	55k 487412	7844337	Townsville QSN project_Burnett	15	GDA94	30/05/2010	4/06/2010	211 Mt View Rd, Toonpan
304	55k 487417	7844275	Townsville QSN project_Burnett	15	GDA94	30/05/2010	4/06/2010	211 Mt View Rd, Toonpan
305	55k 487431	7844384	Townsville QSN project_Burnett	15	GDA94	30/05/2010	4/06/2010	211 Mt View Rd, Toonpan
306	55k 487514	7844493	Townsville QSN project_Burnett	15	GDA94	30/05/2010	4/06/2010	211 Mt View Rd, Toonpan