

8 June 2021

To: [Sch4 - Personal information] Bravus Mining and Resources

From: [Sch4 - Personal information] Woongal Environmental Services

BTF Management Plan: 2-year initial population estimate.

1. Purpose

The purpose of this memo is to address the specific requirements in the Bravus Black-throated Finch Management Plan (BTFMP) to provide an initial population estimate for the Black-throated Finch (BTF) 2 years from the approval of the BTFMP (provided as Attachment 1 below).

Specific references to the development of this initial population estimate in the BTFMP include:

- Section 4.2 & 4.3, population estimates developed through research and management.
- Section 6.4.7, the development of an initial population estimate after the first two years, specifically for the 10-mile bore location.
- Section 7.1., development of a population estimate at Year 2.
- Section 7.2, improving population estimates, particularly at Ten Mile Bore.

2. Background/Context

The BTFMP notes that population estimates are to be fully developed by year 5 from the approval of the BTFMP to coincide with the conclusion of the research program (2024). The purpose of the population estimate is to inform and assist management actions broadly, and specifically at sites such as Ten Mile Bore in joint consideration of any ongoing impacts such as grazing pressure.

The population estimate is also intended to inform ongoing monitoring and survey results through repeatable data collection and suitable methods. It is however noted that this is just one of many outcomes from the BTFMP and Black-throated Finch Research Project (BTFRP).

In time, this population estimate may also inform a broader understanding of the species locally and regionally such as through the DES Bioregional BTF Management Plan.

This initial population estimate has been developed from the following work programs and associated data:

- BTFMP delivery by Woongal Environmental Services (and subconsultant BAAM) which commenced in April 2020.
- BTFRP, delivered by E2M, which commenced in March 2020.

Both population estimation methods used and described below are specific in their data requirements and are based on currently deployed field survey techniques which are not retrospectively compatible with data previously collected through BTF surveys.

Please also refer to specific survey and project reporting for consideration of site, seasonal and other factors that may have assisted or constrained the collation of data to be used for this initial population estimate.

3. Methodologies

The BTFMP does not specify the methods to be used for developing the initial population estimate. A collaborative review of potential methods was undertaken by the BTFMP and BTFRP teams and two methods were selected, applied and the results presented below.

3.1. Distance Method

3.1.1. Description

Distance sampling comprises a set of methods in which distances from a line to observations are recorded, from which the density and/or abundance of objects can be estimated. The most widely used form of distance sampling is line transect sampling. An observer travels along each transect, recording any objects detected (observations) as well as the perpendicular distance from the transect line. The distribution of these distances is used to estimate the proportion of objects in the transect that are detected, which allows the animal density and abundance to be estimated (Thomas et al, 2010). Distance sampling is particularly suitable for animals that are difficult to catch, that can be observed directly in the field but detected with any certainty only if they are close (Sutherland, 2006).

3.1.2. Scientific basis

The Black-throated Finch Research Program (BTFRP) and the Black-throated Finch Monitoring Program (BTFMP) commenced in early 2020. Both programs incorporate 1 km active search transect monitoring, stratified throughout BTF habitat within the Study Area.

The Study Area comprises the Mining Leases for the Project and the Moray Downs West Offset Area. The Study Area excludes the area of the Lignum property in the southern section of MLs 70441 and 70505.

The stratification of transects within BTF habitat was undertaken on the basis of habitat suitability categories. A Species Distribution Model (SDM) developed by E2M (2020) was used to determine critical ecological requirements for BTF and predict distribution based on environmental data (including climate, topography, vegetation, etc.) Through implementation of the SDM, BTF habitat was modelled to predict the suitability of habitat within the Study Area for BTF.

BTF habitat values predicted by the SDM were categorised into four habitat suitability categories across the Study Area: very low (40997.8 ha), low (12540.7 ha), moderate (5075.9 ha) and high (1454.7 ha) (E2M, 2020). To avoid placement of transects in habitat unsuitable for BTF, such as cleared pasture and Regional Ecosystems that do not consist of eucalypt dominated woodlands (e.g. acacia shrublands), these were removed from the SDM (E2M, 2020).

Systematic survey sites were assigned among the habitat suitability and BTF occurrence categories based on the relative proportion of BTF records within each habitat suitability class. For the Study Area, the percentage of previous records occurring within areas of high, moderate, low, and very low habitat suitability are 47%, 25%, 20% and 8% respectively (E2M, 2020). These percentages were used to stratify 87 survey sites across the four categories of habitat suitability. An additional 15 survey sites were established in proximity to water source watch sites identified within the BTFMP.

A total of 102 transects were monitored within the four habitat categories, as follows:

- Very Low (10 transects)
- Low (22 transects)
- Moderate (24 transects)
- High (46 transects)

3.1.3. Data

Three separate monitoring events were conducted during the dry season (2020), early-wet season (2020), and wet season (2021). A total of 102 transects were monitored, recording 27 BTF detections with a total of 82 BTF recorded within 16 transects, as shown in Table 1.

Table 1 Number of BTF observed during the three survey periods.

Site ID	Year	Season	BTF Quantity	BTF Activity	Distance
CWAT05	2021	Wet	2	Perching	20.00
PT06	2021	Early-wet	2	Perching	122.70
PT07	2021	Early-wet	3	Perching	9.80
PT07	2021	Wet	1	Flying	16.04
S14	2021	Wet	4	Foraging	228.09
S18	2021	Wet	1	Flying	57.53
S18	2021	Wet	2	Foraging	15.28
S20	2021	Early-wet	5	Foraging	47.84
S20	2021	Wet	2	Foraging	56.95
S21	2020	Dry	2	Foraging	14.10
S21	2020	Dry	11	Perching	39.97
S21	2021	Early-wet	1	Flying	7.67
S29	2020	Dry	2	Perching	18.37
S29	2021	Wet	2	Perching	73.64
S31	2021	Wet	2	Perching	36.01
S31	2021	Wet	2	Flying	30.52
S32	2021	Wet	6	Foraging	205.81
S36	2021	Early-wet	4	Foraging	14.69
S47	2020	Dry	1	Perching	42.22
S47	2020	Dry	2	Perching	29.47
S47	2021	Early-wet	2	Perching	1.44
S47	2021	Wet	4	Foraging	44.54
S47	2021	Wet	6	Perching	37.56
S53	2021	Wet	4	Foraging	23.44
S54	2021	Early-wet	3	Foraging	14.14

Site ID	Year	Season	BTF Quantity	BTF Activity	Distance
S55	2021	Early-wet	2	Foraging	52.68
S72	2021	Wet	4	Foraging	46.47
S72	2021	Wet	2	Foraging	101.62
S74	2021	Wet	2	Foraging	87.66

3.1.4. Data analysis

Estimation of abundance within the Survey area can be achieved using an entirely design-based framework, providing that the transects have been placed at random throughout the Study Area (Buckland S, Oedekoven C, Borchers D, 2016). Due to the stratification of transects based on BTF habitat suitability (discussed above), a model-based framework was applied to produce the population estimate, using the Program Distance (Thomas et al., 2010) Version 7.3 Release 2.

A conventional distance sampling (CDS) analysis engine was constructed within Distance to determine the detection function. Probability of detection was modelled as a function of observed distances from the line, using a combination of key functions (Uniform, Half – Normal, and Hazard Rate) and series expansions (Cosine, Simple Polynomial, and Hermite Polynomial). Models were ordered based on the goodness of fit as identified by Akaike’s Information Criterion (AIC) (McClintock, White and Pryde, 2019). The AIC identified a Uniform Cosine model as the best fit model for determining detection function. In addition, a weakly monotonically non-increasing constraint was placed on the fitted function to determine the detection function, as the data indicated that the function was not monotonic non-increasing; the result of two BTF clusters recorded greater than 200m from the transect line (S14 and S32).

The detection function, encounter rate and cluster size were stratified by the habitat suitability categories and estimated separately. The results were combined within Distance to estimate BTF abundance.

3.1.5. Results

The BTF population for the Study Area is estimated to be approximately 1,181 individuals, with a 95% confidence interval between approximately 641 and 2,202 individuals. Population estimates are provided in Table 2.

Table 2 Population size estimate derived from the distance model

Estimated BTF population	Lower 95% confidence interval	Upper 95% confidence interval
1,181	641	2,202

3.1.6. Assumptions and limitations

- If distance-based estimates are to be accurate, the assumptions must be met. If the estimates are to be precise, large numbers of animals need to be observed. Sutherland (2006) recommends that 60–80 observations are recorded as a minimum. The minimum

observations are expected to be met during the second round of transect monitoring, which will increase the accuracy of the distance-based estimate.

- The accuracy of the distance-sampling method depends on the accuracy with which the distance to each observation is measured. Two observations were recorded at greater than 200m from the transect line, potentially as a result of observers drifting from the transect line.
- The detection function assumes an observation at distance zero (i.e. on the line) is detected with certainty – 100% detection rate.
- The survey effort and resulting population estimate reflects the spatial allocation of survey sites as per the approved Black-throated Finch Management Plan and Moray Downs West Offset Area Management Plan. Survey sites have been distributed throughout the Study Area, including a random distribution of survey sites in areas of high, moderate and low BTF habitat under the BTFRP.

3.2. Mark-Resight Method

3.2.1. Description

Mark-resight methods are commonly used to estimate abundance, population size and related parameters (McClintock, White and Pryde, 2019). Mark-resight methods are typically used where a proportion of the population is marked (e.g. colour banded) and non-invasive sighting data is collected that includes marked and unmarked individuals.

3.2.2. Scientific basis

Two broad methods were assessed to estimate the population of BTF within the Study Area from the available mist-netting and re-sighting data. These were:

1. Mark-recapture model: Used for study designs where there are repeated capture events and all newly captured individuals are marked and are distinguishable in the future (Amstrup, McDonald and Manly, 2010). Repeated mist-net events follow a mark-recapture survey design, whereby the BTF were uniquely marked with colour and metal bands each capture.
2. Mark-resight model: Used for study designs where animals are marked during capture events, which are followed by 'resighting' occasions, where marked individuals are identified but are not marked (McClintock, White and Pryde, 2019). Colour-banding during mist-netting events, followed by resighting of colour banded birds through walked survey, water source watches or incidentally, follow a mark-resight model.

A mark-resight model was determined to be the most robust method to estimate population size with the data available to date. A total of 22 colour band resightings have been obtained from 46 colour banded birds since August 2020. A mark-recapture model could not be applied as the mist-netting recorded a total of 2 BTF recaptures (from 101 BTF captured in total), which is a sample size too small to give a robust population estimate (Amstrup, McDonald and Manly, 2010).

A broad range of mark-resight models are available, with the selection of model being driven by aspects of the study design and species characteristics, including if:

- The animals can immigrate/emigrate into/from the Study Area
- Marks are uniquely distinguishable
- Individuals can be sighted more than once per sampling event; and
- The number of marked individuals is known or unknown (Cooch and White, 2019).

Based on the model requirements and recommendations provided by Cooch and White (2019) and McClintock, White and Pryde (2019), a zero-inflated poisson-log normal mark-resight model was selected as the model allows for:

- Animals to immigrate/emigrate into/from the Study Area (radio telemetry data collected to date has identified individual BTF that have emigrated from the Study Area).
- Marks are uniquely distinguishable, while the model still allows input of records where a mark has been partially identified.
- Individuals to be sighted more than once per sampling event.
- The population of marked individuals to be unknown (as marked BTF may emigrate from the population).
- Is suitable for low encounter rates.

3.2.3. Data

The Black-throated Finch Research Program, which commenced in early 2020, includes a mist-netting program that allows for an analysis of BTF population size through a mark-resight methodology. To date, three mist-netting events have been conducted, including in August-September 2020, February 2021 and March 2021. During each mist-netting event, BTF were captured via mist-netting. Approximately half of the BTF were fitted with uniquely identifiable colour bands that allow resighting of known birds without recapture. The remaining BTF were fitted with a radio transmitter and a uniquely identifiable metal tag that allows identification of known birds upon recapture. The number of BTF colour-banded and resighted during each survey period are identified within Table 3.

Table 3 Number of marked BTF captured and resighted during three survey periods

Survey period	BTF capture and colour band application		BTF recapture and resighting	
	Number of BTF captured (mist-netting)	Number of BTF colour banded	Number of BTF recaptured (mist-netting)	Number of colour bands resighted
August-September 2020 (dry season)	44	22	1	3
February 2021 (early-wet season)	22	14	0	3
March 2021 (wet season)	35	10	1	16
Total	101	46	2	22

3.2.4. Data analysis

Program MARK (White and Burnham, 1999) Version 9.0 was used to construct a zero-inflated poisson-log normal mark-resight model, in accordance with the model requirements identified

within Cooch and White (2019) and McClintock, White and Pryde (2019). 16 models were constructed to test our hypotheses about population demographics. The model parameters that were adjusted included survival probability, immigration, emigration and resighting rate. The 16 models were formed by allowing each of these four model parameters to be either variable or constant across time, thus creating 16 unique combinations. Models were ordered based on the goodness of fit as identified by Akaike's Information Criterion (AIC) (McClintock, White and Pryde, 2019). Parameter estimates, including the population estimates, from the models were averaged using Program MARK's inbuilt model weighting function, which weights the best-fitting models highest (Cooch and White, 2019).

Mark-resight data from the Ten Mile Bore area (that is, the area within a 3km radius of the Ten Mile Bore Dam) was extracted as an independent dataset. A zero-inflated poisson-log normal mark-resight model was applied to the Ten Mile Bore data using the same methodology as data from the entire Study Area. However, as no BTF were colour banded in the Ten Mile Bore Area during the August-September 2020 survey (dry season), only two survey periods were included in the model (February and March 2021).

3.2.5. Results

The BTF population for the Study Area during the March 2021 BTFRP survey is estimated to be approximately 701 individuals, with a 95% confidence interval between approximately 215 and 1,188 individuals. The estimated population within the Ten Mile Bore area was approximately 292 individuals, with a 95% confidence interval between approximately 15 and 570 individuals. Population estimates are provided within Table 4.

Table 4 Population size estimate derived from the mark-resight model

Area	Estimated population size	Standard error	Lower 95% confidence interval	Upper 95% confidence interval
Study Area	701.2	248.2	214.7	1187.7
Ten Mile Bore	292.3	141.4	15.2	569.5

3.2.6. Assumptions and limitations

The poisson-log normal mark-resight model and mark-resight models in general have inherent assumptions, as well as assumptions that have been made in the analysis of survey data.

Assumptions specific to the Study Area include:

- The Study Area, for which the BTF population estimate applies is the Study Area that has been applied within the Black-throated Finch Research Program, which comprises the Mining Leases for the Project and the Moray Downs West Offset Area. The Study Area excludes the area of the Lignum property in the southern section of MLs 70441 and 70505.
- The survey effort and resulting population estimate reflects the spatial allocation of survey sites as per the approved Black-throated Finch Management Plan and Moray Downs West Offset Area Management Plan. Survey sites have been distributed throughout the Study Area, including a random distribution of survey sites in areas of high, moderate and low BTF habitat under the BTFRP.

4. Conclusion

This is an initial population estimate using data collected since the approval of the BTFMP and BTFRP using two different statistical models.

The two methodologies were selected to undertake this initial population estimate based on the current BTF monitoring and research program data. Seasonal variations such as drought and rainfall are likely to have an impact on local and regional conditions and influence the presence / absence of the BTF within the Study Area of this program which is constrained to the Mining Lease Area and Offset Area. Additionally, access has been restricted to the Lignum Station where there have been historically large numbers of BTF observed.

Method	Lower 95% confidence interval	Estimate	Upper 95% confidence interval
Mark-resight	214.7	701.2	1187.7
Distance	641	1,181	2,202

The BTFMP notes that the full population estimate is to be developed at the conclusion of the BTFRP, 5 years after BTFMP approval which is May 2024.

This initial population estimate is not intended to be a proxy for the consideration of the BTF population locally or regionally.

References

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- Buckland S., Oedekoven C., Borchers D., (2016) 'Model-Based Distance Sampling.' JABES 21, 58–75 (2016). <https://doi.org/10.1007/s13253-015-0220-7>
- Cooch, E. and White, G. (2019) 'Program MARK," A gentle introduction"', <http://www.phidot.org/software/mark/docs/book/>.
- McClintock, B. T., White, G. C. and Pryde, M. A. (2019) 'Improved methods for estimating abundance and related demographic parameters from mark-resight data', Biometrics, 75(3), pp. 799–809. doi: 10.1111/biom.13058.
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- White, G. C. and Burnham, K. P. (1999) 'Program MARK: survival estimation from populations of marked animals', Bird study, 46(sup1), pp. S120–S139.

Attachment 1

31 May 2019

s49 - Sch4 - Personal information

Adani Mining Pty Ltd
Level 25, 10 Eagle Street
Brisbane QLD 4000

Dear s49 - Personal in

As a delegate of the administering authority under the *Environmental Protection Act 1994*, I have decided to approve the *Black-throated Finch Management Plan – Carmichael Coal Mine and Offsite Infrastructure version 8a* (May 2019) submitted to the administering authority on 28 May 2019 as required by condition I6 of Environmental Authority (EPML01470513) for the Carmichael Coal Mine. I have formed the view that the submitted Black-throated Finch Management Plan satisfies the requirements of environmental authority conditions I6, I8 and I9.

Should you require any further information, please contact me on telephone (07) 4987 9356 or by email at juliana.mccosker@des.qld.gov.au.

Yours sincerely

s49 - Sch4 - Signature

Juliana McCosker
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