4.5.2 Residential Development

Since the start of mining in the area there has been the concomitant need for the erection of housing. With the decommissioning of certain mines and the establishment of tourism in the area further residential/holiday developments have followed and will continue to do so. In the areas surrounding Kleinzee and Port Nolloth this development could pose a risk to the coastal strip of dunes where *B. macrops* occurs as can be seen in Figure 4.3 where residential development is taking place directly within *B. macrops* habitat in Port Nolloth. As with mining, residential development involves the complete transformation of the immediate natural habitat where buildings are erected. After construction the inhabitants of the residences will add a continued impact through their access to the area. These developments are therefore likely to become the next major threat to *B. macrops* habitat when the mines finally close down. If residential development is to continue in these areas it must be properly managed so as not to destroy remaining habitat. Developments must be buffered from the habitat and controlled in terms of access to sensitive areas and their associated impacts.

Figure 4.3. Human impact at the Port Nolloth study site, where construction is taking place in pristine *B. macrops* habitat.

4.5.3 Distribution in Namibia

B. macrops is known to occur in both South Africa and Namibia, with very little known of its distribution in the latter. Currently the northern distribution of *B. macrops* is listed as reaching up to Lüderitz, in Namibia. However, to date there have been very few confirmed sightings. Of concern is the extensive habitat destruction due to mining activities, evidenced in available satellite imagery. It is essential that the status of *B. macrops* be investigated in this country if we are to achieve a realistic conservation target for the species.

4.5.4 Revised IUCN Red Data Classification

B. macrops is currently listed as Vulnerable (VU) (Minter, *et al*., 2004 (b)). This is based on a restricted distribution, with an area of occupancy of 501-2000 km^2, extensive habitat loss, and a predicted population decline of more than 50% in the next 30 years (from 2004). The area of occupancy currently accepted in the RDB 2004 (Mucina *et al.*, 2006) has been estimated at 1239.48 km^2 based on the original distribution of Koiingnaas in the South, and 10km inland. If we accept that the actual distribution is from Kleinzee in the south up to 6km inland, then the results now suggest that the area of occupancy should be revised to 841.85 km^2.

This represents 67.84% of the currently recognised area. However, it is highly unlikely that a viable population of frogs could survive within a mining site, unless part of the site encompasses some pristine ground. Analysis of the amount of habitat completely transformed by mining (no suitable habitat remaining) suggests that the actual area of occupancy remaining to *B. macrops* is in fact only 270.72 km^2. In addition very little is known of the actual distribution in Namibia and the similar threats it faces. Thus, if the percentage of pristine habitat remaining in Namibia is less than or similar to South Africa, the total area of habitat remaining to *B. macrops* may be as little as 541 km^2. It is therefore critical that the status of *B. macrops* be revised.

In light of this it is proposed that the conservation status of *B. macrops* should be elevated to that of Endangered (EN) based on; a restricted geographic range (area of occupancy < 5000 km^2), severely fragmented habitat, and a continuing decline in area, extent and quality of habitat.

4.6 Conclusion

The results of this study were fairly conclusive in their rejection of the occurrence of *B. macrops* as far south as Skulpfontein and up to 10 km inland. The actual distribution was a maximum of 6 km inland and 2 km south of the town of Kleinzee.

The reasons for this restricted distribution seem to lie primarily at the door of historical misidentification and a lack of accurate reporting as well as anthropogenic disturbance. Factors were assessed which may shed some light on the reasons for *B. macrops* distribution ceasing south of the town of Kleinzee, when the habitat south of this point appears to be suitable, however no significant correlations could be identified.

There appears to be a slight correlation between the presence of *B. macrops* and aeolian sand deposits although this is no doubt combined with other habitat requirements. No trends were isolated from the soil analysis, due to the small sample size obtained for locations at which *B. macrops* was sampled.

B. macrops was found in two vegetation types, Richtersveld Coastal Duneveld (SKs 1) and Namaqualand Coastal Duneveld (SKs 8) (Mucina *et al.,* 2006). However, there were no obvious trends in the distribution of *B. macrops* within either of these two vegetation types, other than a superficial indication that SKs 1 may be a preferable vegetation type.

Habitat suitability south of Kleinzee appears to be adequate for colonisation by *B. macrops* but this has not occurred, which may indicate that there is some barrier to migration which is not readily observable.

Fog deposition along the coast may be implicated in the cessation of the distribution of *B. macrops* south of Kleinzee however there is insufficient data to derive any conclusions presently. Further research in these areas aimed at investigating these relationships would be useful.

The genetics of three disparate populations of *B. macrops* were analysed for differences in a fragment of the 16S gene, in order to examine their relatedness. It was clear from this analysis that there are no genetic differences between these populations. This could be problematic for the survival of the species as the lack of genetic plasticity in the genome may limit its ability to survive if placed under stress by habitat loss and fragmentation.

It is abundantly clear that large-scale transformation of the landscape has taken place throughout much of what was once suitable *B. macrops* habitat. This is almost solely due to strip mining for alluvial diamonds. The area of occupancy of *B. macrops* within South Africa is now predicted to be as little as 270.72 km^2. This represents a 78.16% reduction in what was believed to be available to the species. In addition the overall distribution of *B. macrops* in southern Africa may be limited to approximately 541 km^2. Thus the conservation status of this species should be revised and in the opinion of the author elevated to Endangered (EN).

The extant populations must be provided with the protection necessary to reduce the threat of extinction, specifically in areas where there still remain viable populations, such as McDougall's Bay. Additional studies need to be conducted to determine the viability of the Kleinzee population, and whether establishing populations of *B. macrops* south of this point, through facilitating the colonisation of apparently suitable areas, is necessary.

REFERENCES

Allison, L.E., L. Bernstein, C.A. Bower, J.W. Brown, M. Fireman, J.T. Hatcher, H.E. Hayward, G.A. Pearson, R.C. Reeve, L.A. Richards, & L.V. Wilcox. 1969. Diagnosis and Improvement of Saline and Alkali Soils, Agricultural Handbook No. 60, United States Department of Agriculture. 160 pp.

Branch, W.R. 1988. The Revised South African Red Data Book – Reptiles and Amphibians. Journal of the Herpetological Association of Africa, 38: 32-41.

Branch, W.R. & Harrison, J.A. 2004. Conservation status and threats. Pp 13-29, in Minter, L.R., M. Burger, J.A. Harrison, H.H. Braack, P.J. Bishop, and D. Kloepfer, eds. Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland. SI/MAB Series #9. Smithsonian Institution, Washington, D.C. Pp. 17, 18, 21, 22, 168-170, 180-182.

Brekke, D.R., Hillyard, S.D. & Winokur, R.M. 1991. Behavior Associated with the Water Absorption Response by the Toad, *Bufo punctatus*. Copeia, 1991: 393-401.

Carrick, P.J. & Krüger, R. 2007. Restoring degraded landscapes in lowland Namaqualand: Lessons from the mining experience and from regional ecological dynamics. Journal of Arid Environments. 70: 767–781.

Carruthers, V.C. 2001. Frogs and frogging in southern Africa. Struik, Cape Town, 99 pp.

Carruthers, V.C. & Passmore, N.I. 1978. A note on *Breviceps macrops* Boulenger. Journal of the Herpetological Association of Africa. 17: 13-15.

Channing, A. 1976. Life histories of frogs in the Namib Desert. Zoologica Africana. 11: 299-312.

Channing, A. 1987. *Breviceps macrops* (Life History Notes). Journal of the Herpetological Association of Africa. 33: 33.

Channing, A. 1988. Opportunistic seasonal breeding by frogs in Namaqualand. Journal of the Herpetological Association of Africa. 35: 21-24.

Channing, A. Unpublished. Results of a monitoring study of *Breviceps macrops*: Population size, density, home ranges, movement, and population age structure.

Channing, A., Moyer, A., & Dawood, D.C. 2004. A new sand frog from central Tanzania (Anura: Ranidae: *Tomopterna*). Journal of the Herpetological Association of Africa. 53: 21-28.

Channing, A. & Minter, L. 2004. A new rain frog from Tanzania (Microhylidae: *Breviceps*). African Journal of Herpetology. 53: 147-154.

Collins, J.P. & Storfer, A. 2003. Global amphibian declines: Sorting the hypotheses. Diversity and Distributions, 9: 89-98.

Cooper, P.D. & Robinson, M.D. 1990. Water Balance and Bladder Function in the Namib Desert Sand Dune Lizard, *Aporosaura anchietae* (Lacertidae). Copeia 1990: 34-40.

Cowling, R.M., Esler, K.J., & Rundel, P.W. 1999. Namaqualand, South Africa – an overview of a unique winter-rainfall desert ecosystem. Plant Ecology 142: 3-21.

Crawford, E. & Kurta, A. 2000. Color of Pitfall Affects Trapping Success for Anurans and Shrews. Herpetological Review 31: 222-224.

Cree, A. 1989. Relationship Between Environmental Conditions and Nocturnal Activity of the Terrestrial Frog, *Leiopelma archeyi*. Journal of Herpetology, 23: 61-68.

De Villiers, A. 1988. *Breviceps macrops* Boulenger, 1907. Pp. 116-118 in Branch, W.R. (Ed.). South African Red Data Book – Reptiles and Amphibians. South African National Scientific Programmes, Report No. 151, August 1988.

Desmet, P.G. 1996. Vegetation and restoration potential of the arid coastal belt between Port Nolloth and Alexander Bay, Namaqualand, South Africa. MSc Thesis, University of Cape Town.

Duellman, W.E. 1999. Global Distribution of Amphibians: Patterns, Conservation and Future Challenges. Pp 1-30 in Duellman, W.E. (ed.). 1999. Patterns of Distribution of Amphibians. A Global Perspective. Johns Hopkins University Press, Baltimore, 633 pp.

Duellman, W.E. & Trueb, L. 1986. Introduction to the Amphibia. Pp 1-7; Food and Feeding, Pp 229-238 and Enemies and Defense, Pp 241-259 in Duellman, W.E. & Trueb, L. (1986) Biology of Amphibians. McGraw-Hill, New York, 670 pp.

Flannery, T. 2005. The Weather Makers. Penguin Books, England, 341 pp.

Frost, D. R. 2008. Amphibian Species of the World: an Online Reference. Version 5.2 (15 July, 2008). Electronic Database accessible at http://research.amnh.org/herpetology/amphibia/index.php American Museum of Natural History, New York, USA.

Goebel, A.M., Donnelly, J.M. & Atz, M.E. 1999. PCR primers and amplification methods for 12S ribosomal DNA, the Control Region, Cytochrome Oxidase 1, and Cytochrome *b* in bufonids and other frogs, and an overview of PCR primers which have amplified DNA in amphibians successfully. Molecular Phylogenetics and Evolution 11: 163-199.

Grant, K.P. & Licht, L.E. 1993. Acid Tolerance of Anuran Embryos and Larvae from Central Ontario. Journal of Herpetology 27: 1-6.

Hartwell, H.W. & Olivier, L.M. 1998. Stream amphibians as indicators of ecosystem stress: A case study from California's Redwoods. Ecological Applications 8: 1118-1132.

Hillyard, S.D., Von Seckendorff Hoff, K. and Propper, C.1998. The Water Absorption Response: A Behavioral Assay for Physiological Processes in Terrestrial Amphibians. Physiological and Biochemical Zoology 71(2): 127–138.

Hoffman, M.T. & Cowling, R.M. 1987. Plant physiognomy, phenology and demography. Pp. 1-34. In: Cowling, R.M. & Roux, P.W. (eds), The Karoo Biome: a preliminary synthesis. Part 2, vegetation and history. South African National Scientific Programme Report 142. FRD, Pretoria.

Hoffman, E.A. & Blouin, M.S. 2008. A review of colour and pattern polymorphisms in anurans. Biological Journal of the Linnean Society 70: 633–665.

Inger, R.F.; Stuebing, R.B. & Fui Lian, T. 1995. New species and new records of anurans from Borneo. The Raffles Bulletin of Zoology 43: 115-131.

IUCN. (2001). *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. ii + 30 pp.

Kiesecker, J.M., Blaustein, A.R. & Belden, K. 2001. Complex Causes of Amphibian Population Declines. Nature 410: 681-684.

Le Roux, A. 2005. Introduction: The Coastal Plain, Pp. 19-21 in Le Roux, A. 2005. Namaqualand, South African Wild Flowers Guide 1, Western Cape Nature Conservation Board. Ed. 3, Botanical Society of South Africa.

Lee, A.K. & Mercer, E.H. 1976. Cocoon Surrounding Desert-Dwelling Frogs. Science 157: 87-88.

Ling, R.W., VanAmberg, J.P. & Werner, J.K. 1986. Pond Acidity and its Relationship to Larval Development of *Ambystoma maculatum* and *Rana sylvatica* in Upper Michigan. Journal of Herpetology 20: 230-236.

Loveridge, J.P. & Craye, G. 1979 Cocoon formation in two species of southern African frogs. South African Journal of Science 75: 18-20.

McCarthy, T. & Rubidge, B. 2005. The story of the Earth and Life: A southern African perspective on a 4.6-billion-year journey. Struik, Cape Town. 333 pp.

Minter, L.R. 2003. Two new cryptic species of *Breviceps* (Anura: Microhylidae) from southern Africa. Journal of the Herpetological Association of Africa 52: 9-21.

Minter, L.R., Harrison, J.A., Burger, M. & Braack, H.H. 2004 (a). Genus *Breviceps*. Pp. 168-195 in Minter, L.R., M. Burger, J.A. Harrison, H.H. Braack, P.J. Bishop, and D. Kloepfer, eds. Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland. SI/MAB Series #9. Smithsonian Institution, Washington, D.C.

Minter, L.R., Channing, A. & Harrison, J. 2004 (b). *Breviceps macrops*. In: IUCN 2008. 2008 IUCN Red List of Threatened Species. www.iucnredlist.org . Downloaded on 20 January 2009.

Mucina, L., Jürgens, N., Le Roux, A., Rutherford, M.C., Schmiedel, U., Esler, K.J., Powrie, L.W., Desmet, P.G. & Milton, S.J. 2006. Succulent Karoo Biome. Pp 221-299 in Mucina, L. & Rutherford, M.C. (eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

NASA Landsat Program, 1999, Landsat ETM+, scene P177R801_7P19990711, USGS, Sioux Falls. www.glcfapp.umiacs.umd.edu:8080/esdi/index.jsp
NASA Landsat Program, 2001, Landsat ETM+, scene P177R080_7K20010411, USGS, Sioux Falls. www.glcfapp.umiacs.umd.edu:8080/esdi/index.jsp

Olivier, J, 2002. Fog water harvesting along the west coast of South Africa: A feasibility study. Water SA, 28 (4): 349-360.

Parsons, R.H., McDevitt, V., Aggerwal, V., Le Blang, T., Manley, K., Kim, N., Lopez, J. and Kenedy, A.A. 1993. Regulation of pelvic patch water flow in *Bufo marinus*: role of bladder volume and ANG II. AJP - Regulatory, Integrative and Comparative Physiology, 264 (6): 1260-1265.

Parsons, R.H. and Schwartz, R. 1991 Role of circulation in maintaining Na+ and K+ concentration in pelvic patch in *Rana catesbeiana*. American Journal of Physiology - Regulatory, Integrative and Comparative Physiology, 261 (3): 686-689.

Partridge, T.C. 1997. Evolution of landscapes. Pp. 5-20. In: Cowling, R.M., Richardson, D.M. & Pierce, S.M. (eds), The Vegetation of Southern Africa. Cambridge University Press, Cambridge.

Pounds, J.A, Bustamante, M. R., Coloma, L.A., Consuegra, J.A., Fogden, M.P.L., Foster, P.N., Le Marca, E., Masters, K.L., Merino-Viteri, A., Puschendorf, R., Ron, S.R., Sanchez-Azofeifa, G.A., Still, C.J. & Young, B.E. 2005. Widespread amphibian extinctions from epidemic disease driven by global warming. Nature

439: 161-167.

Poynton, J.C. 1964. Relationships between habitat and terrestrial breeding in amphibians. Evolution 18: 131.

Poynton, J.C. 1999. Distribution of Amphibians in Sub-Saharan Africa, Madagascar, and Seychelles. Pp 483-540 in Duellman, W.E. (ed.). 1999. Patterns of Distribution of Amphibians. A Global Perspective. Johns Hopkins University Press, Baltimore, 633 pp.

Rohr, J.R., Schotthoefer, A.M., Raffel, T.R., Carrick, H.J., Halstead, N., Hoverman, J.T., Johnson, C.M. Johnson, L.B., Lieske, C., Piwoni, M.D., Schoff, P.K. & Beasley, V.R. 2008. Agrochemicals increase trematode infections in a declining amphibian species. Nature 455: 1235-1239.

Ruibal, R., Tevis, L.Jr., & Roig, V. 1969. The terrestrial ecology of the Spadefoot Toad, *Scaphiopus hammondii*. Copeia 1969: 571-584.

Rutherford, M.C., Mucina, L., & Powrie, L.W. 2006. Biomes and Bioregions of Southern Africa. Pp 31-51 in Mucina, L. & Rutherford, M.C. (eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South Afican National Biodiversity Institute, Pretoria.

Santos, E.M.; Almeida, A.V. & Vasconcelos, S.D. 2004. Feeding habits of six anuran (Amphibia: Anura) species in a rainforest fragment in Northeastern Brazil. Iheringia, Série Zoologia 94: 433-438.

Seebacher, F & Alford, R.A. 1999. Movement and Microhabitat Use of a Terrestrial Amphibian (*Bufo marinus*) on a Tropical Island: Seasonal Variation and Environmental Correlates. Journal of Herpetology 33: 208-214.

Sullivan, P.A., Von Seckendorff Hoff, K. and Hillyard, S.D. 2000. Effects of Anion Substitution on Hydration Behavior and Water Uptake of the Red-spotted

Toad, *Bufo punctatus*: is there an Anion Paradox in Amphibian Skin? Chemical Senses 25: 167-172.

Summers, K. & Clough, M.E. 2001. The evolution of coloration and toxicity in the poison frog family (Dendrobatidae). Proceedings of the National Academy of Sciences of the United States of America 98: 6227-6232.

Thompson, G.G., Withers, P.C., McMaster, K.A. & Cartledge, V.A. 2005. Burrows of desert-adapted frogs, *Neobatrachus aquilonius* and *Notaden nichollsi*. Journal of the Royal Society of Western Australia 88: 17–23.

Toft, C.A. 1980. Feeding ecology of thirteen syntopic species of anurans in a seasonal tropical environment. Oecologia 45: 131-141.

Vences, M., Kosuch, J., Boistel, R., Haddad, C.F.B., La Marca, E., Lötters, S. & Veith, M. 2003. Convergent evolution of aposematic coloration in Neotropical poison frogs: a molecular phylogenetic perspective. Organisms Diversity & Evolution, 3: 215-226.

Word, J.M. and Hillman, S.S. 2005. Osmotically Absorbed Water Preferentially Enters the Cutaneous Capillaries of the Pelvic Patch in the Toad *Bufo marinus*. Physiological and Biochemical Zoology 78(1):40–47.

APPENDIX A: Proposed survey coordinates for the primary study site.

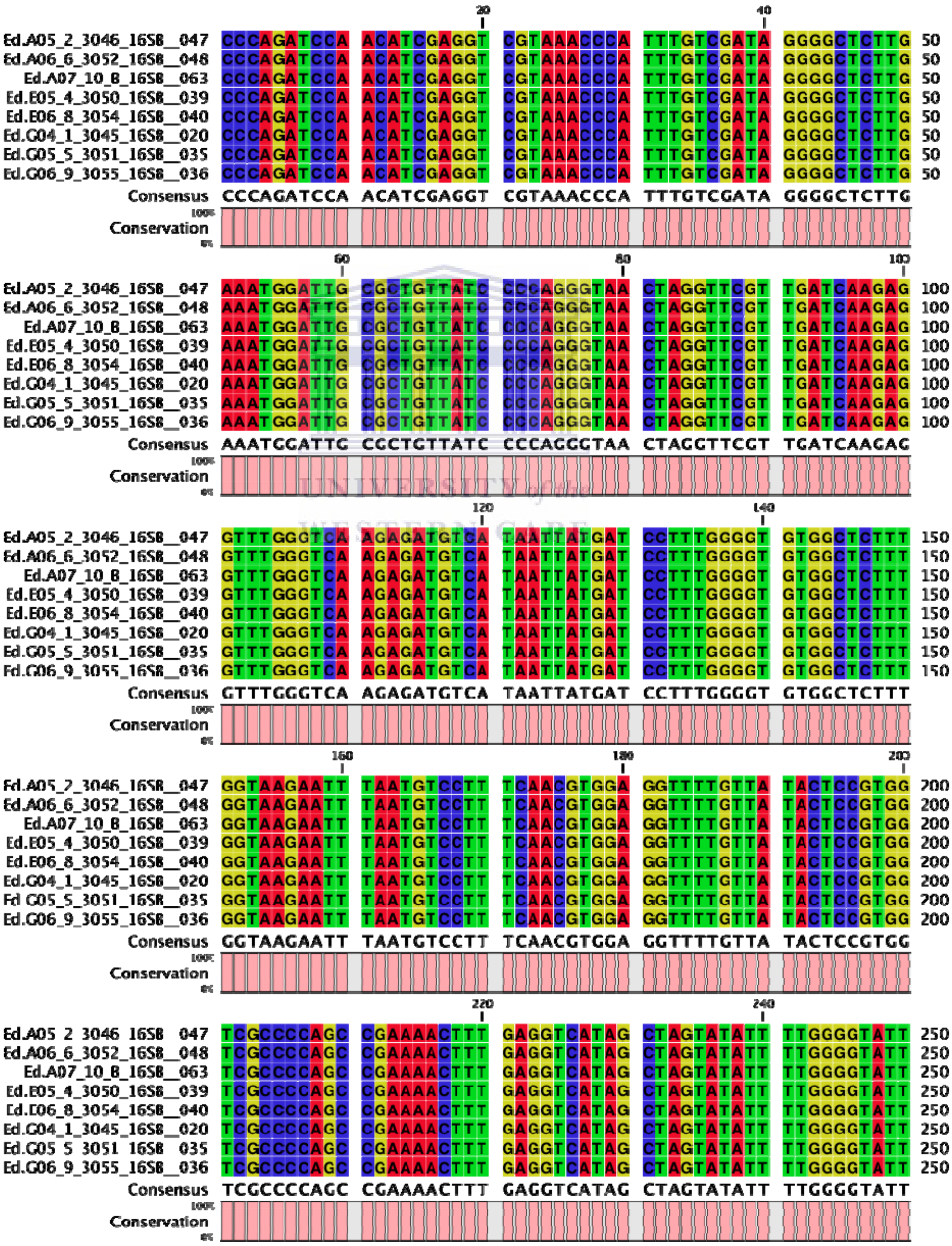
Proposed Point	North/South	East/West	Proposed Point	North/South	East/West
A1	S 29 41 00.0	E 17 03 15.0	B1	S 29 43 38.0	E 17 03 45.0
A2	S 29 41 00.0	E 17 04 30.0	B2	S 29 43 38.0	E 17 05 00.0
A3	S 29 41 00.0	E 17 05 45.0	B3	S 29 43 38.0	E 17 06 15.0
A4	S 29 41 00.0	E 17 07 00.0	B4	S 29 43 38.0	E 17 07 30.0
A5	S 29 41 00.0	E 17 08 15.0	B5	S 29 43 38.0	E 17 08 45.0
A6	S 29 41 00.0	E 17 09 30.0	B6	S 29 43 38.0	E 17 10 00.0
C1	S 29 46 16.0	E 17 04 15.0	D1	S 29 48 54.0	E 17 04 45.0
C2	S 29 46 16.0	E 17 05 30.0	D2	S 29 48 54.0	E 17 06 00.0
C3	S 29 46 16.0	E 17 06 45.0	D3	S 29 48 54.0	E 17 07 15.0
C4	S 29 46 16.0	E 17 08 00.0	D4	S 29 48 54.0	E 17 08 30.0
C5	S 29 46 16.0	E 17 09 15.0	D5	S 29 48 54.0	E 17 09 45.0
C6	S 29 46 16.0	E 17 10 30.0	D6	S 29 48 54.0	E 17 11 00.0
E1	S 29 51 32.0	E 17 06 00.0	F1	S 29 54 10.0	E 17 06 45.0
E2	S 29 51 32.0	E 17 07 15.0	F2	S 29 54 10.0	E 17 08 00.0
E3	S 29 51 32.0	E 17 08 30.0	F3	S 29 54 10.0	E 17 09 15.0
E4	S 29 51 32.0	E 17 09 45.0	F4	S 29 54 10.0	E 17 10 30.0
E5	S 29 51 32.0	E 17 11 00.0	F5	S 29 54 10.0	E 17 11 45.0
E6	S 29 51 32.0	E 17 12 15.0	F6	S 29 54 10.0	E 17 13 00.0
G1	S 29 56 48.0	E 17 08 15.0	H1	S 29 59 26.0	E 17 09 30.0
G2	S 29 56 48.0	E17 09 30.0	H2	S 29 59 26.0	E 17 10 45.0
G3	S 29 56 48.0	E 17 10 45.0	H3	S 29 59 26.0	E 17 12 00.0
G4	S 29 56 48.0	E 17 12 00.0	H4	S 29 59 26.0	E 17 13 15.0
G5	S 29 56 48.0	E 17 13 15.0	H5	S 29 59 26.0	E 17 14 30.0
G6	S 29 56 48.0	E 17 14 30.0	H6	S 29 59 26.0	E 17 15 45.0
I1	S 30 02 04.0	E 17 10 00.0	J1	S30 04 42.0	E17 11 00.0
I2	S 30 02 04.0	E 17 11 15.0	J2	S30 04 42.0	E17 12 15.0
I3	S 30 02 04.0	E 17 12 30.0	J3	S30 04 42.0	E17 13 30.0
I4	S 30 02 04.0	E 17 13 45.0	J4	S30 04 42.0	E17 14 45.0
I5	S 30 02 04.0	E 17 15 00.0	J5	S30 04 42.0	E17 16 00.0
I6	S 30 02 04.0	E 17 16 15.0	J6	S30 04 42.0	E17 17 15.0
K1	S30 07 20.0	E17 11 30.0	L1	S30 09 58.0	E17 13 15.0
K2	S30 07 20.0	E17 12 45.0	L2	S30 09 58.0	E17 14 30.0
K3	S30 07 20.0	E17 14 00.0	L3	S30 09 58.0	E17 15 45.0
K4	S30 07 20.0	E17 15 15.0	L4	S30 09 58.0	E17 17 00.0
K5	S30 07 20.0	E17 16 30.0	L5	S30 09 58.0	E17 18 15.0
K6	S30 07 20.0	E17 17 45.0	L6	S30 09 58.0	E17 19 30.0

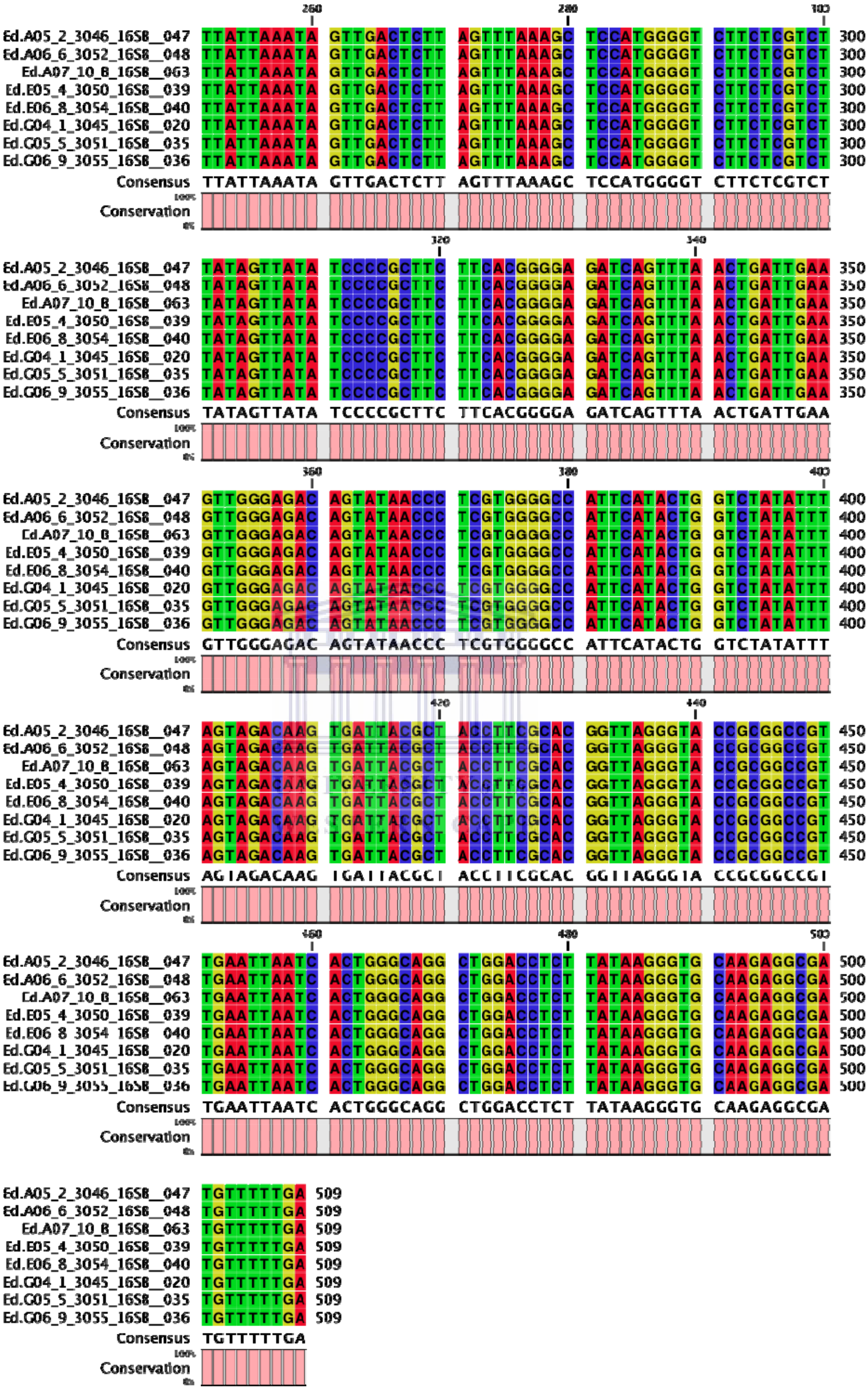
APPENDIX B: Coordinates sampled within the primary study site once assumptions were adhered to. The initial letter relates to a transect ('A' directly south of Kleinzee, and 'B' 5 km south of 'A' etc), two letter before a number indicates a location between two transects. The number relates to the point along the transect ('1' being at the coast, '2' approximately 2 km from the coast etc). The second letter indicated multiple sample sites within close proximity to another.

Point	North/South	East/West	Elevation (m)	Distance from Coast (m)	Trap Hours	Person Minutes
A1	29 41 01.6	17 03 16.1	9	131	48	80
AB1	29 42 24.3	17 03 14.3	15	107	0	180
AB2	29 42 32.1	17 03 31.8	12	259	0	390
B1/A	29 43 21.7	17 03 38.2	8	133	24	260
B1/B	29 43 22.1	17 03 38.4	26	140	24	270
B2	29 44 02.4	17 04 45.2	64	2000	24	60
B3	29 43 32.5	17 06 22.4	96	4500	24	40
B4	29 43 36.8	17 07 49.3	97	6900	24	60
B5	29 43 38.2	17 08 54.3	116	8600	24	60
C1/A	29 46 26.3	17 04 15.3	9	236	24	150
C1/B	29 46 15.2	17 04 10.0	12	116	24	105
C2/A	29 45 55.2	17 05 29.9	150	2800	24	0
C2/B	29 45 56.6	17 05 30.0	150	2800	24	0
C3/A	29 46 20.7	17 06 47.1	132	4250	24	0
C3/B	29 46 21.6	17 06 47.3	98	4250	24	0
D1/A	29 49 11.2	17 04 41.8	2	93	24	30
D1/B	29 49 10.9	17 04 47.5	6	152	24	0
D1/C	29 49 18.4	17 04 54.8	16	270	24	0
D2	29 49 17.7	17 06 11.7	49	2300	24	60
D5/A	29 49 05.0	17 09 36.5	148	8000	24	0
D5/B	29 49 05.9	17 09 37.6	151	8000	24	0
E1/A	29 51 25.0	17 05 48.2	7	118	24	60
E1/B	29 51 26.6	17 05 54.4	11	123	24	60
E1/C	29 51 43.2	17 06 14.5	18	403	24	0
E2/A	29 51 45.1	17 06 37.4	27	1000	24	0
K1	30 07 59.4	17 11 54.2	20	30	0	240
L1	30 09 27.5	17 13 09.9	20	50	0	720

Appendix C: The genetic sequence for a fragment of the 16S gene of *B. macrops*, followed by the alignment of all eight specimens.

```
  1 CCCAGATCCA ACATCGAGGT CGTAAACCCA TTTGTCGATA GGGGCTCTTG AAATGGATTG
 61 CGCTGTTATC CCCAGGGTAA CTAGGTTCGT TGATCAAGAG GTTTGGGTCA AGAGATGTCA
121 TAATTATGAT CCTTTGGGGT GTGGCTCTTT GGTAAGAATT TAATGTCCTT TCAACGTGGA
181 GGTTTTGTTA TACTCCGTGG TCGCCCCAGC CGAAAACTTT GAGGTCATAG CTAGTATATT
241 TTGGGGTATT TTATTAAATA GTTGACTCTT AGTTTAAAGC TCCATGGGGT CTTCTCGTCT
301 TATAGTTATA TCCCCGCTTC TTCACGGGGA GATCAGTTTA ACTGATTGAA GTTGGGAGAC
361 AGTATAACCC TCGTGGGGCC ATTCATACTG GTCTATATTT AGTAGACAAG TGATTACGCT
421 ACCTTCGCAC GGTTAGGGTA CCGCGGCCGT TGAATTAATC ACTGGGCAGG CTGGACCTCT
481 TATAAGGGTG CAAGAGGCGA TGTTTTTGA
```




260 280 300
Ed.A05_2_3046_16SB_047 TTATTAAATA GTTGACTCTT AGTTTAAAGC TCCATGGGGT CTTCTCGTCT 300
Ed.A06_6_3052_16SB_048 TTATTAAATA GTTGACTCTT AGTTTAAAGC TCCATGGGGT CTTCTCGTCT 300
Ed.A07_10_B_16SB_063 TTATTAAATA GTTGACTCTT AGTTTAAAGC TCCATGGGGT CTTCTCGTCT 300
Ed.E05_4_3050_16SB_039 TTATTAAATA GTTGACTCTT AGTTTAAAGC TCCATGGGGT CTTCTCGTCT 300
Ed.E06_8_3054_16SB_040 TTATTAAATA GTTGACTCTT AGTTTAAAGC TCCATGGGGT CTTCTCGTCT 300
Ed.G04_1_3045_16SB_020 TTATTAAATA GTTGACTCTT AGTTTAAAGC TCCATGGGGT CTTCTCGTCT 300
Ed.G05_5_3051_16SB_035 TTATTAAATA GTTGACTCTT AGTTTAAAGC TCCATGGGGT CTTCTCGTCT 300
Ed.G06_9_3055_16SB_036 TTATTAAATA GTTGACTCTT AGTTTAAAGC TCCATGGGGT CTTCTCGTCT 300
Consensus TTATTAAATA GTTGACTCTT AGTTTAAAGC TCCATGGGGT CTTCTCGTCT
Conservation
320 340
Ed.A05_2_3046_16SB_047 TATAGTTATA TCCCCGCTTC TTCACGGGGA GATCAGTTTA ACTGATTGAA 350
Ed.A06_6_3052_16SB_048 TATAGTTATA TCCCCGCTTC TTCACGGGGA GATCAGTTTA ACTGATTGAA 350
Ed.A07_10_B_16SB_063 TATAGTTATA TCCCCGCTTC TTCACGGGGA GATCAGTTTA ACTGATTGAA 350
Ed.E05_4_3050_16SB_039 TATAGTTATA TCCCCGCTTC TTCACGGGGA GATCAGTTTA ACTGATTGAA 350
Ed.E06_8_3054_16SB_040 TATAGTTATA TCCCCGCTTC TTCACGGGGA GATCAGTTTA ACTGATTGAA 350
Ed.G04_1_3045_16SB_020 TATAGTTATA TCCCCGCTTC TTCACGGGGA GATCAGTTTA ACTGATTGAA 350
Ed.G05_5_3051_16SB_035 TATAGTTATA TCCCCGCTTC TTCACGGGGA GATCAGTTTA ACTGATTGAA 350
Ed.G06_9_3055_16SB_036 TATAGTTATA TCCCCGCTTC TTCACGGGGA GATCAGTTTA ACTGATTGAA 350
Consensus TATAGTTATA TCCCCGCTTC TTCACGGGGA GATCAGTTTA ACTGATTGAA
Conservation
360 380 400
Ed.A05_2_3046_16SB_047 GTTGGGAGAC AGTATAACCC TCGTGGGGCC ATTCATACTG GTCTATATTT 400
Ed.A06_6_3052_16SB_048 GTTGGGAGAC AGTATAACCC TCGTGGGGCC ATTCATACTG GTCTATATTT 400
Ed.A07_10_B_16SB_063 GTTGGGAGAC AGTATAACCC TCGTGGGGCC ATTCATACTG GTCTATATTT 400
Ed.E05_4_3050_16SB_039 GTTGGGAGAC AGTATAACCC TCGTGGGGCC ATTCATACTG GTCTATATTT 400
Ed.E06_8_3054_16SB_040 GTTGGGAGAC AGTATAACCC TCGTGGGGCC ATTCATACTG GTCTATATTT 400
Ed.G04_1_3045_16SB_020 GTTGGGAGAC AGTATAACCC TCGTGGGGCC ATTCATACTG GTCTATATTT 400
Ed.G05_5_3051_16SB_035 GTTGGGAGAC AGTATAACCC TCGTGGGGCC ATTCATACTG GTCTATATTT 400
Ed.G06_9_3055_16SB_036 GTTGGGAGAC AGTATAACCC TCGTGGGGCC ATTCATACTG GTCTATATTT 400
Consensus GTTGGGAGAC AGTATAACCC TCGTGGGGCC ATTCATACTG GTCTATATTT
Conservation
420 440
Ed.A05_2_3046_16SB_047 AGTAGACAAG TGATTACGCT ACCTTCGCAC GGTTAGGGTA CCGCGGCCGT 450
Ed.A06_6_3052_16SB_048 AGTAGACAAG TGATTACGCT ACCTTCGCAC GGTTAGGGTA CCGCGGCCGT 450
Ed.A07_10_B_16SB_063 AGTAGACAAG TGATTACGCT ACCTTCGCAC GGTTAGGGTA CCGCGGCCGT 450
Ed.E05_4_3050_16SB_039 AGTAGACAAG TGATTACGCT ACCTTCGCAC GGTTAGGGTA CCGCGGCCGT 450
Ed.E06_8_3054_16SB_040 AGTAGACAAG TGATTACGCT ACCTTCGCAC GGTTAGGGTA CCGCGGCCGT 450
Ed.G04_1_3045_16SB_020 AGTAGACAAG TGATTACGCT ACCTTCGCAC GGTTAGGGTA CCGCGGCCGT 450
Ed.G05_5_3051_16SB_035 AGTAGACAAG TGATTACGCT ACCTTCGCAC GGTTAGGGTA CCGCGGCCGT 450
Ed.G06_9_3055_16SB_036 AGTAGACAAG TGATTACGCT ACCTTCGCAC GGTTAGGGTA CCGCGGCCGT 450
Consensus AGTAGACAAG TGATTACGCT ACCTTCGCAC GGTTAGGGTA CCGCGGCCGT
Conservation
460 480 500
Ed.A05_2_3046_16SB_047 TGAATTAATC ACTGGGCAGG CTGGACCTCT TATAAGGGTG CAAGAGGCGA 500
Ed.A06_6_3052_16SB_048 TGAATTAATC ACTGGGCAGG CTGGACCTCT TATAAGGGTG CAAGAGGCGA 500
Ed.A07_10_B_16SB_063 TGAATTAATC ACTGGGCAGG CTGGACCTCT TATAAGGGTG CAAGAGGCGA 500
Ed.E05_4_3050_16SB_039 TGAATTAATC ACTGGGCAGG CTGGACCTCT TATAAGGGTG CAAGAGGCGA 500
Ed.E06_8_3054_16SB_040 TGAATTAATC ACTGGGCAGG CTGGACCTCT TATAAGGGTG CAAGAGGCGA 500
Ed.G04_1_3045_16SB_020 TGAATTAATC ACTGGGCAGG CTGGACCTCT TATAAGGGTG CAAGAGGCGA 500
Ed.G05_5_3051_16SB_035 TGAATTAATC ACTGGGCAGG CTGGACCTCT TATAAGGGTG CAAGAGGCGA 500
Ed.G06_9_3055_16SB_036 TGAATTAATC ACTGGGCAGG CTGGACCTCT TATAAGGGTG CAAGAGGCGA 500
Consensus TGAATTAATC ACTGGGCAGG CTGGACCTCT TATAAGGGTG CAAGAGGCGA
Conservation
Ed.A05_2_3046_16SB_047 TGTTTTTGA 509
Ed.A06_6_3052_16SB_048 TGTTTTTGA 509
Ed.A07_10_B_16SB_063 TGTTTTTGA 509
Ed.E05_4_3050_16SB_039 TGTTTTTGA 509
Ed.E06_8_3054_16SB_040 TGTTTTTGA 509
Ed.G04_1_3045_16SB_020 TGTTTTTGA 509
Ed.G05_5_3051_16SB_035 TGTTTTTGA 509
Ed.G06_9_3055_16SB_036 TGTTTTTGA 509
Consensus TGTTTTTGA
Conservation