FINAL ECOLOGICAL REVIEW OF CORRIDOR ROUTES
132kV POWERLINE – CANDOVER TO PONGOLA
(April 2013)

Compiled By : S C Bundy (BSc MSc Pr Sci Nat)
Checked By: A. M. Whitehead (BSc. Hons Pr Sci Nat)

Compiled for : Zitholele Consulting (Pty) Ltd

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The identification of a corridor route for the establishment of a 132kV power line between Candover and Pongola is the subject of a basic assessment exercise in terms of the National Environmental Management Act (107 of 1998).

Following the evaluation of three route options at a preliminary and secondary level, further quantitative ecological assessments have been undertaken on the proposed line routes. The data collated was subject to a number of statistical evaluations and considerations which served to consider the routing options on a sample basis, as well as a holistic basis across the lengths of the routes proposed.

The analysis of the line routes identified the northern route / corridor as the most appropriate corridor from a bio physical perspective, based on both quantitative and qualitative interpretation of the sites. A number of mitigatory and management options have been recommended for implementation should this routing option be considered by the assessment practitioner or sanctioned by the relevant authority.

1. Background

Zitholele Consulting (Pty) Ltd have been undertaking a basic environmental assessment process for the proposed establishment of a 132kV powerline between Candover and Pongola and also serving the Golela border post, on the Swaziland- South African border. The proponent is Eskom Eastern Region.

An initial review of possible corridor routes was undertaken by Zitholele Consulting (Pty) Ltd, with a preliminary ecological report on possible route options being compiled by Sustainable Development Projects cc for incorporation and consideration by the environmental assessment practitioners (EAP) and Eskom Eastern Region. This assessment identified the northern line route, with a southern and central line route option being suggested for comparative purposes, as being the most applicable and "optimal" route for establishment of the powerline.

While there was generally consensus amongst the various technical specialists and Eskom on the selection of the "optimal" route, there was a request for additional ecological information from Eskom relating to specific routes identified by the power utility. Such information was requested in order to substantiate and defend the final route selection and recommendation.

This report thus serves as the third and final report on the three line routing options and incorporates:

- Baseline ecological information that has been obtained through direct sampling methods employed within the line routes proposed.

- A quantitative and comparative review of the ecological significance of the proposed corridor routes.

- Identifies key physical and biological parameters within the proposed corridors that would be of significance in the evaluation and selection of possible line corridors.

- Identifies and selects a possible powerline route based upon bio – physical parameters for consideration within the basic assessment process.

The results of this assessment are provided below and serve to confirm the findings of the reports of March 2012 and March 2013, in respect of the most appropriate line route / corridor.

2. Methodology

Zitholele Consulting (Pty) Ltd provided a shape file indicating the outer perimeter of the study area, an area identified in consultation with Eskom Environmental Specialist personnel. The study area was viewed using aerial imagery provided through Google Earth, as well as overlaying such information with SANBI data relating to vegetation units for the area. In addition information was collated from on-site evaluations. Eskom Eastern Region confirmed and identified the three line routes for further evaluation.

The three broad route possibilities were noted as being ;

- a Northern route, which ostensibly follows the present power line running parallel to the N2
- A Central route, which ostensibly follows the R 66
- A Southern route, which lies along the southern edge of the study area

These routes are depicted in Fig. 1 below.

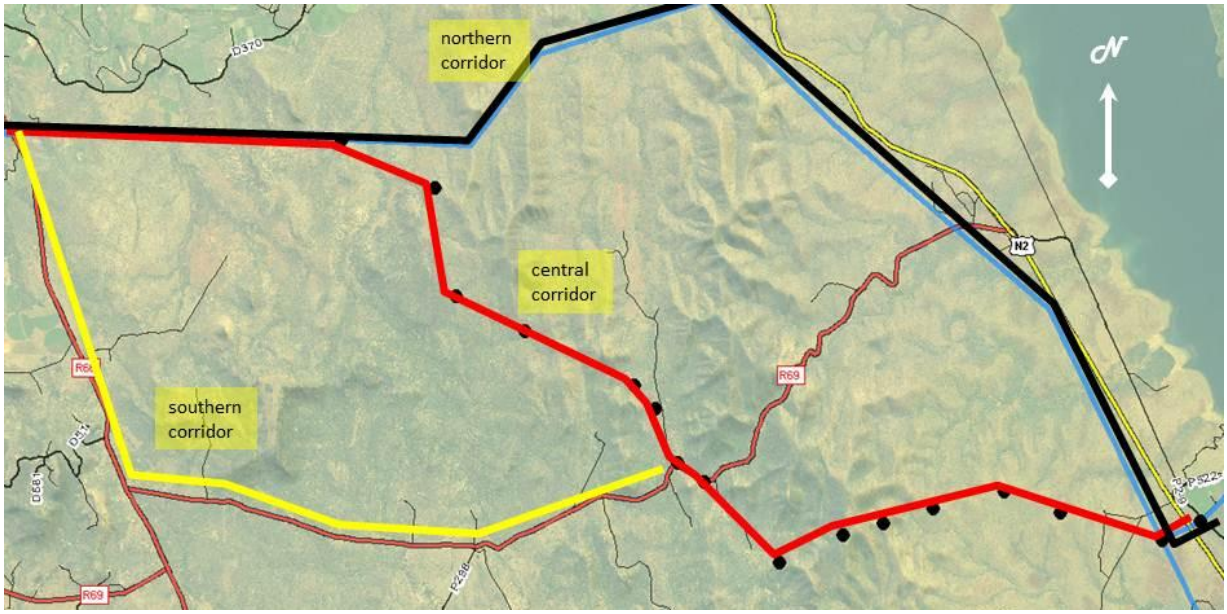


Fig. 1 Study area with Northern, Central and Southern Corridors identified (source Eskom Eastern Region).

The ecological investigations undertaken during the period November 2012 to March 2013 incorporated the following:

1. On site reconnaissance of terrain associated with such corridors.
2. Random sampling of vegetation and identification of associated physical factors at each sample site. Sampling included:
    a. The establishment of 50m transects through representative vegetative forms within the selected site. At some points more than one transect was analysed to ensure "representivity" within the selected site.
    b. Measurements of the following parameters were logged at each site
        i. Species present within transect. (Presence / absence)
        ii. Species dominance measured by occurrence within transect.
        iii. Bole width of woody vegetation within transect.
        iv. Elevation.

Sample sites and their approximate location are identified in Fig. 2 below

3. All data were logged and transferred to Excel spreadsheet for analysis

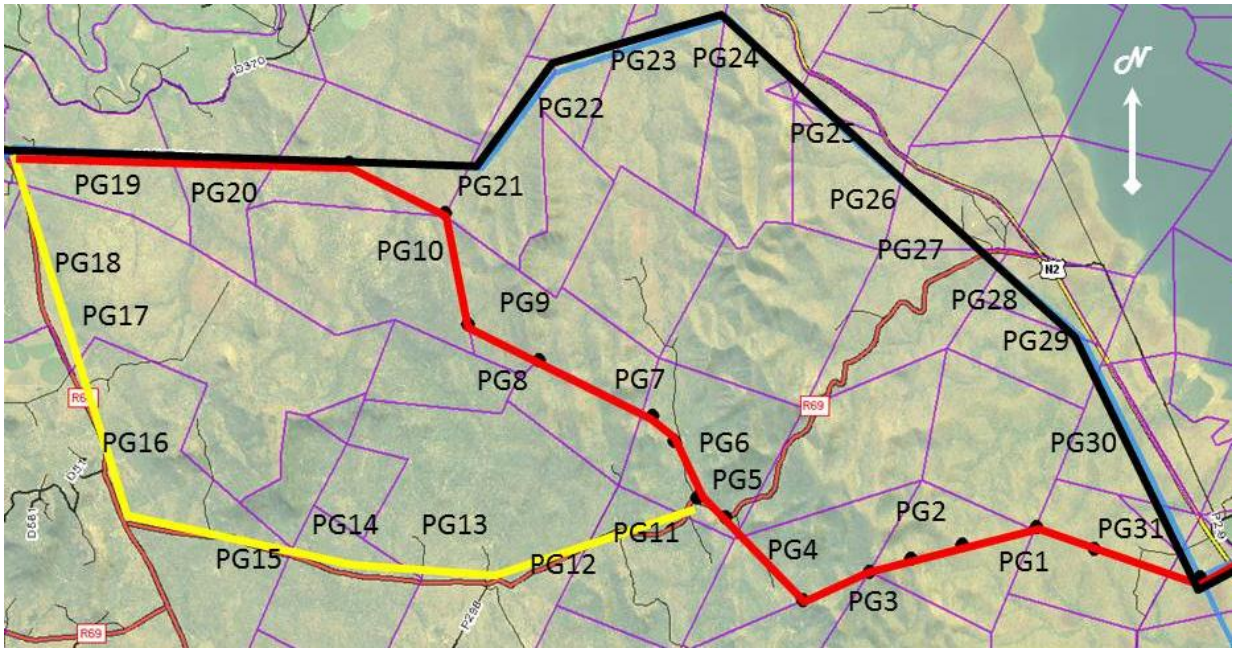


Fig. 2 Spatial layout of line route options with indicative and approximate sample points.

Data analysis was undertaken using a number of determinants, including:

- Evaluation of variations in habitat composition, species presence and absence and physical variance within data along the selected corridor routes.
- The use of multivariate analysis of all data including the use of :
    - Ordination
    - Correspondence analysis
    - Clustering techniques

The results of such data were analysed and interpreted in order to identify:

- Prevailing habitat structure within or along the selected line routes and comparatively between the line routes.

- The line route or corridor with the least geophysical and bio physical significance from an ecological perspective.

The findings of the above quantitative evaluation were considered against the qualitative review undertaken in March 2013 and the preliminary investigations of March 2012. As such

use was made of generally accepted environmental management norms where additional parameters were considered these parameters being:

- habitat transformation (i.e the degree to which naturally occurring habitat or vegetation cover, will be removed or altered). The quantitative data was considered to apply primarily to such parameters and provide an indication of the state (and recent ecological history) of the affected corridor route.

- terrestrial faunal impacts (i.e. the degree to which terrestrial fauna will be affected by either transformation of habitat or variation in the landscape through establishment of the powerline). Such impacts may be manifest in ousting of species, changes in population or changes in ethology of species. The impact of the powerlines on avifauna is also considered with such impacts relating to collisions of birds with powerlines, changes in behavior as well as ousting of species through changes in landscape.

These impacts are rated according to the following

Scale : the extent to which the impact will arise
Duration : a temporal estimate as to the timeframe of the impact
Magnitude : a qualitative evaluation of the severity of the impact.

Such impacts are measured according to the following parameters identified in Table 1.

Table 1. Quantitative parameters utilized in identifying degree of significance of impact.

Value	Scale	Value	Magnitude	Value	Duration
5	International	**10**	Very high / don't know	**5**	Permanent
4	National	**8**	High	**4**	Long term (ceases at closure)
3	Regional (>5km)	**6**	Moderate	**3**	Medium (5 -15)
2	Local (<5km)	**4**	Low	**2**	Short term (<5yrs)
1	Site	**2**	Minor	**1**	Immediate
0	None				

Impacts are adjudged using the above quantitative values in order to identify the cumulative level of impact and this outcome, together with the product of its probability is used to arrive at a "level" of impact. Probability is adjudged according to a further qualitative derived scale using the following values:

Probability values
5 - definite
4 – high probability
3 – medium probability
2. – low probability
1- improbable
0 - none

Thus the level of impact significance = [scale + magnitude + duration] x probability

In order to distinguish on a comparative basis, the products of the above function, an arbitrary scale of significance indicates that products >60 are considered "high", products between 30 – 60 are considered "moderate" and products below 30 are considered "low". The results of such analysis are provided below in section 4.

3. Results and Discussion

The collated raw data is attached in Annexure A and pertains to the three line routes under consideration.

A review of the data collated using SINOSIM a computation method for determining the significance of the data collated, indicates that such data is significant and that such significance was particularly relevant in respect of "bole width" and "elevation"

Table 2 Table indicates significance of results

Table 2. SINOSIM Results for significance of data

All Variables in model								
Total Variance	5.82466							
Variable	**Variance**	**% of variance**	**Eigenvalue**	**Probability**				
Total bole width	0.252439	4.33397	0.252439	0.00990099				
elev amsl	0.242776	4.16807	0.242776	0.00990099				
Average bole width	0.237612	4.07941	0.237612	0.019802				
No of specimens	0.226486	3.8884	0.226486	0.00990099				
The single best variable	Total bole width							
With best variable in model	Total bole width							
Variable	**Variance**	**% of variance**	**Eigenvalue 1**	**Eigenvalue 2**	**Probability axis 1**	**Probability axis 2**		
Average bole width	0.499984	8.58391	0.266043	0.233941	0.00990099	0.00990099		
elev amsl	0.497753	8.54561	0.258261	0.239492	0.00990099	0.00990099		
No of specimens	0.478457	8.21433	0.253159	0.225299	0.00990099	0.00990099		
Two best variable	Total bole width	Average bole width						
With 2 best variables in model	Total bole width	Average bole width						
Variable	Variance	% of variance	Eigenvalue 1	Eigenvalue 2	Eigenvalue 3	Probability axis 1	Probability axis 2	Probability axis 3
elev amsl	0.743344	12.762	0.271061	0.24739	0.224892	0.00990099	0.00990099	0.00990099
No of specimens	0.665425	11.4243	0.266083	0.245437	0.153904	0.00990099	0.00990099	0.00990099
The 3 best variables	Total bole width	Average bole width	elev amsl					

3.1 TWINSPAN

The data was then subject to analysis using Two Way Indicator Species Analysis (TWINSPAN), a statistical method which serves to consider the species identified within the sample sites and group such sites according to their species similarity. Such analysis serves to provide a classification of both species and samples and identifies species that determine sample similarity.

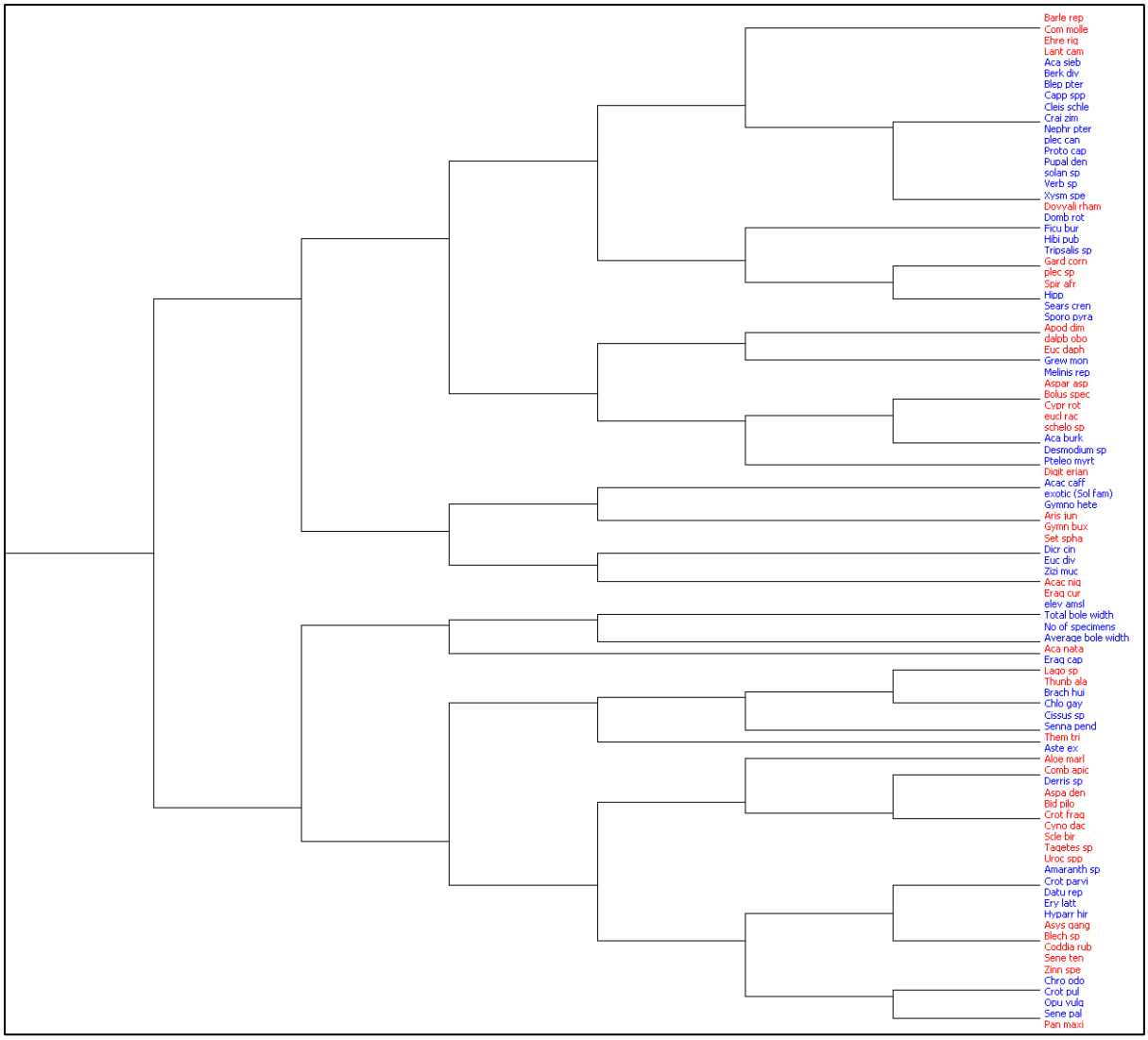


Fig. 3 TWINSPAN dendrogram of results for species across sample sites

Fig. 3 indicates that several community associes or "species clusters" were identified across all three line routes. Of interest, is the determining levels played by species such as *Aloe marlothi*, the Acacias and the exotic *Lantana camara*.

Further analysis of sites, using species clusters is presented in Fig 4.

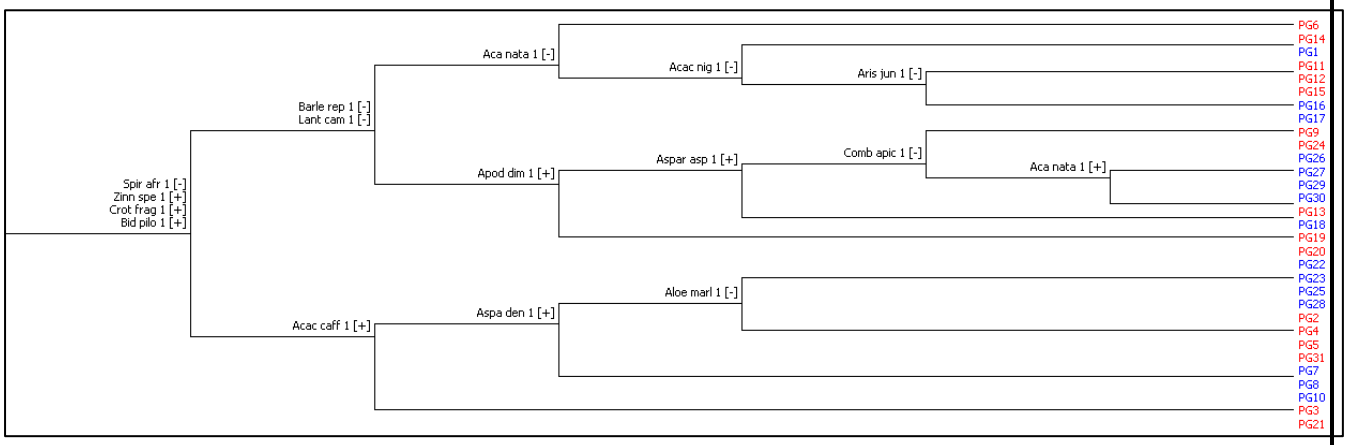


Fig 4 TWINSPAN Dendrogram indicating grouping of sample sites by species

Fig. 4 identifies that there is significant correlation of sample sites along routes. *Acacia natalitia* was found to be a common determinant along the eastern extent of the northern line route, where sample sites (PG26, 27, 29 and 30) were identified as having similar habitat composition. Similar trends can be noted in other sample groups.

Such findings serve to indicate that environmental factors were playing a significant role at select points along the line routes and that these factors were determining species composition and habitat structure. The TWINSPAN results however indicate that:

- much of the vegetation encountered along the **southern line route** (PG 1,2,3,4,11,12,13,14,15,16,17 and 18) show relative similarity and a general linear trend with low to moderate changes in species composition. Such result shows that
    - habitat along and within this route is primarily determined by natural environmental factors such as elevation
    - and by implication or extension, it can be suggested that much of the sample sites along this route are under sound veld management regimen.

- there is a weak correlation between sample sites along the **central line route** (PG 1,2,3,4,5,6,7,8,9,10,19,20), with little clustering and similarity between samples. This result suggests that habitat along this line route varies significantly, possibly on account of either the abandonment of farming activities at certain points along the route, transformation of the land on account of settlement or specific veld management regimen.

- The northern line route shows three distinct habitat structures. Such habitat forms are located to the east, the north east and west of the route and are related to human settlement activities, veld management regimen and the abandonment of farming activities amongst other factors.

3.2.Correspondence Analysis

The nature of these factors were further considered, using CANOCO (multi-dimensional correspondence analysis), an ordination method of determining the relationship between measured variables and samples. The results of this analysis are provided in the plot within Fig. 5 below.

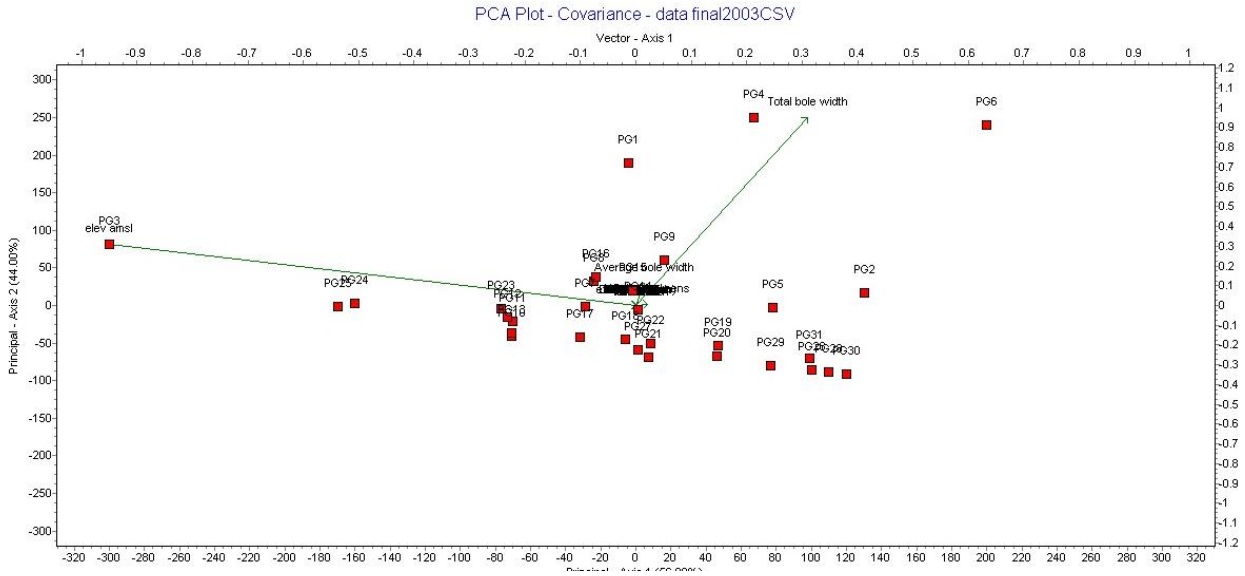


Fig. 5. PCA plot indicating significance of elevation on habitat form and structure

The CANOCO results indicate that bole width (a proxy for age of woody species) and elevation were significant factors in determining the habitat structure along the various line routes selected. Notably a trend can be identified in association with elevation, whereby elevation and average bole width showed some weak correlation for sites such as PG 3, PG23, PG24 and PG25. It can be interpreted from this result that higher elevations (Zululand Sourveld) showed some significantly mature specimens. It is however, to be noted that the clustering of the majority of samples shows that many of the sites lie at lower elevations

(Northern Zululand Lowveld) with most sample sites recording low average bole width and thus less mature woody habitat.

3.3 Linear Relationships

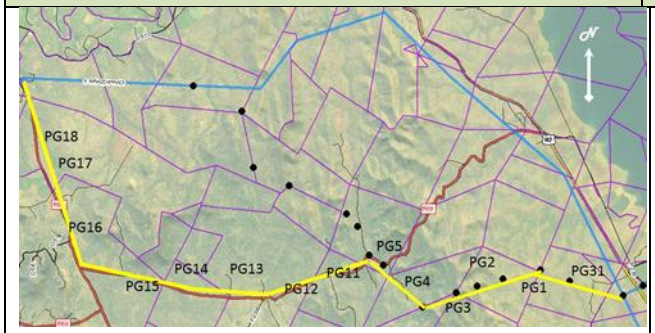
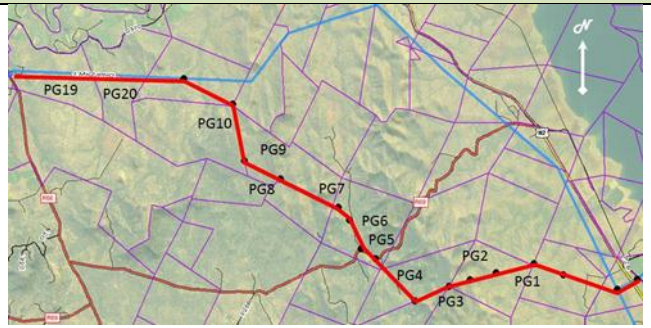
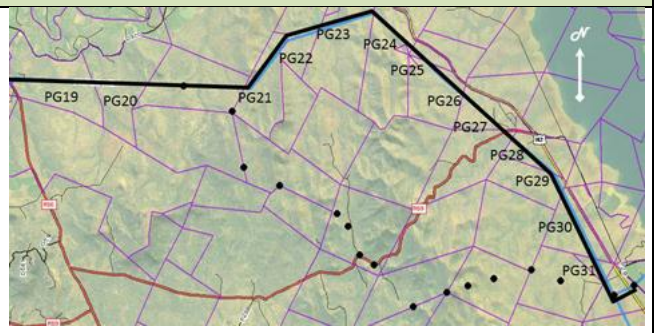
To support the above analyses and the interpretations of the samples, specific consideration was given to the collated data as they pertained to the specific corridor routes, namely the southern, central and northern line routes.

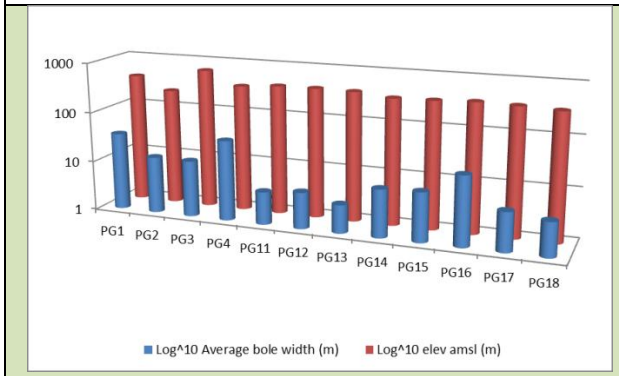
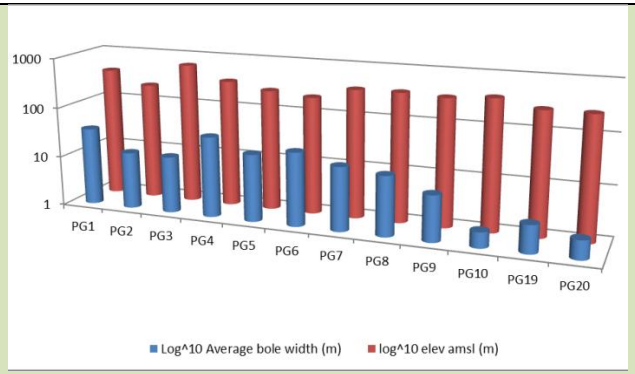
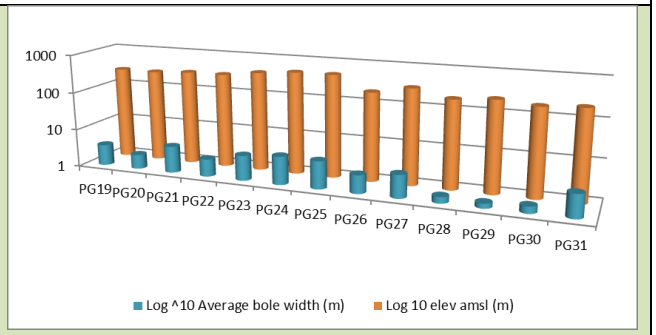
In this regard evaluations of the sample sites along the corridors were analysed which considered *inter alia*:

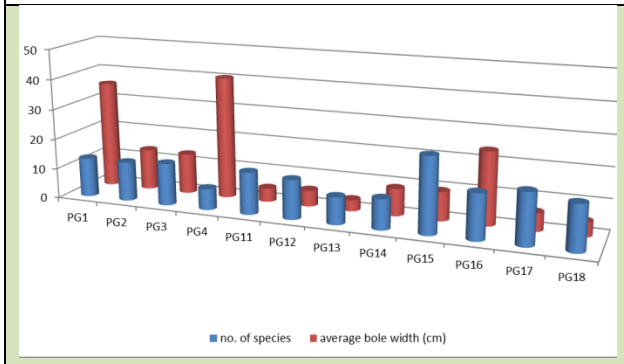
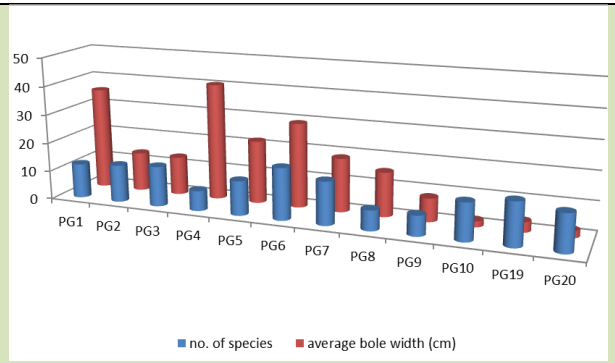
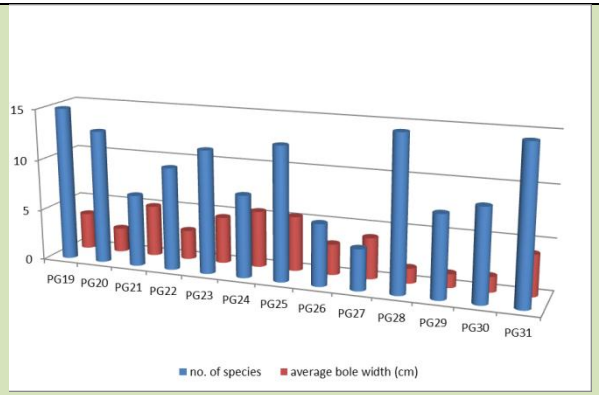
- The number of species recorded at sample sites within the corridors
- The average bole width
- Herbaceous, woody and total species counts

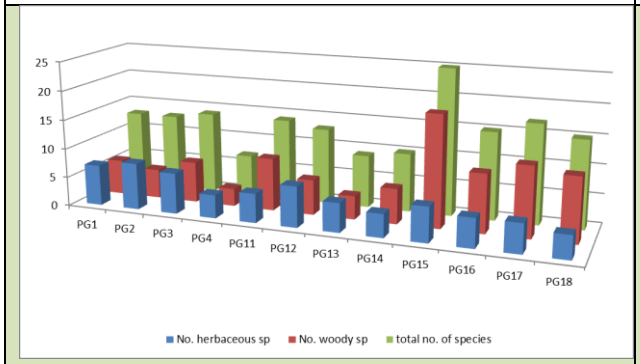
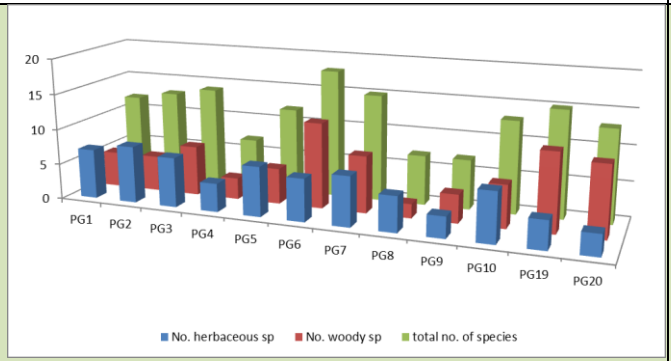
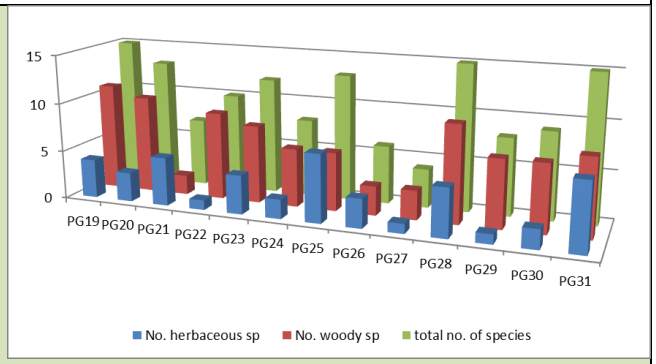
These results are presented in Table 3 below

Table 3. Comparative review of quantitative data associated with three line routes on proposed Pongola – Golela – Candover powerline

Southern Corridor	Central Corridor	Northern Corridor
		
General route description	**General route description**	**General route description**
The southern route traverses an east to west corridor before intersecting with the R 69, a rural road that bisects the study area. The route then intersects with the R66 before running parallel to this road and intersecting with the Pongola sub station. This route traverses primarily private game farms to the south and in its northern portions adjacent to the R 66. Some informal settlement has been identified centrally along this route (PG 11 and PG12),	The central route follows that same corridor as that proposed for the southern route within its southern portions, however at the R69 this corridor follows a more northerly route before intersecting with the existing northern line route and striking west to intersect with with Pongola sub station. This corridor traverses some existing game farms in the south and central portions of its route, as well as informally settled and moderately grazed areas and including formal agricultural lands, some of which have been abandoned or are reverting to game stocking.	The northern corridor runs parallel to an exisitng 132kV powerline, running due north, parallel to the N2 freeway before traversing in a westerly direction in and around the Pongola Reserve. The corridor traverses informally settled lands as well as formal agricultural lands and some private game farms.

Southern Corridor	Central Corridor	Northern Corridor
Comparative bole width vs elevation	**Comparative bole width vs elevation**	**Comparative bole width vs elevation**
		
The southern corridor shows a comparatively even elevation distribution across the route, with the exception of elevated points just west of the Mziki Farm. The data indicates that more mature woody specimens are present in the eastern portions of the line route, with the least mature woody specimens being present centally and as the route approaches the substation. This data is indicative of the clearance of forest and abandonment of agricultural lands that is occurring at points close to the R 69 as well as (possibly) bush encroachment in these areas. In addition, low bole width values at PG 15 – PG 18 are indicative of veld management practices employed by land owners.	The central line route depicts a more mature forested system to the east (as per the southern corridor) however, as the route traverses both agricultural lands and recently settled lands average bole width values decline. Notably elevation plays a weak role in the determination of the presence of more forested systems – PG 5 – PG 7. This data is indicative of a closed canopy system in and around the elevated portions of the eastern extent of this line route, while agricultural activities and settlement have affected the presence of larger and more mature woody specimens in the north of this corridor.	This result indicates that average bole width along most of the proposed line route is “low”. In and around PG 28, 29 and 30, the effect of recent settlement and grazing is noticeable, while agricultural activities in the west account for a similar, although slightly elevated value (PG 20, 21 22). Notably PG 23, 24 and 25 show the greatest bole width recorded along this line route, with such results being indicative of the nature of the Zululand Sourveld (with mature but more sparsely presented woody specimens), as well as improved management of the natural habitat within the Pongola Nature Reserve

Southern Corridor	Central Corridor	Northern Corridor
No. of species vs average bole width	**No. of species vs average bole width**	**No. of species vs average bole width**
		
The southern corridor route mimics and confirms the above results, indicating a profile where, along much of the route the dominance of generally more mature and woody specimens can be identified. There is a reduction centrally along this corridor of both species diveristy and woody species dominance (where settlement is occurring) however this is reversed to the north, with the exception of areas where veld management practices actively remove woody species.	The analystical results of species diversity and woody species maturity generally mimics that of the southern corridor and is the reciprocal of the northern corridor. More mature woody specimens are located within the southern extent of this corridor, while settlement and agricultural activities have resulted in the removal of woody specimens in the north, in closer proximity to the sub station.	The results of this data set indicate and confirm the above results such that the northern line route shows a low bole width value (generally immature or fewer wody species) along the entire route, when compared to the total number of species identified along this route. Comparison with the central and southern corridors indicates the reciprocal of the trends identified along those line routes. This profile is indicative of an ecologically transformed area, with only sample sites within the Pongola Nature Reserve showing woody species of reasonable size and maturity.

Southern Corridor	Central Corridor	Northern Corridor
Herbaceous vs Woody composition	**Herbaceous vs Woody composition**	**Herbaceous vs Woody composition**
		
The ratio of herbaceous to woody species is an indication of the nature as well as the ecological status of the prevailing habitat. The results of this analysis along the southern corridor indicates that woody species diversity in the south of the corridor is generally low, with *A nigrescens* dominating much of this vegetation type, albeit with a reasonably diverse sub canopy species composition. Woody species diversity is generally low across the central portions of this corridor, with diversity increasing as one progresses towards the substation. This profile corroborates the influence of veld management practices and human settlement on this route.	The profile of herbaceous to woody species in the central corridor route is similar to that identified for the southern route. Settlement and grazing, as well as veld management practices on certain farms serves to influence the presence of woody species.	Comparison of the route profile of the northern corridor with that of the southern and central corridors indicates one signficiant variation, this being the general dominance of woody species vs. herbaceous species across the line route. Such habitat structure is primarily the result of bush encroachment, as well as the dominance of agricultural weeds within abandoned and extant agricultural lands.

In summary, the findings of Table 3 indicate that from a holistic and "cross sectional" route perspective, the northern corridor route differs significantly in habitat composition and structure from the alternative southern and central line routes. Fig. 6 further confirms this opinion, where it is to be noted that the southern corridor route provided 38% of the species sampled in the evaluation exercise, while the central line route saw a somewhat smaller number of species, however, 4% greater than that of the northern line route.

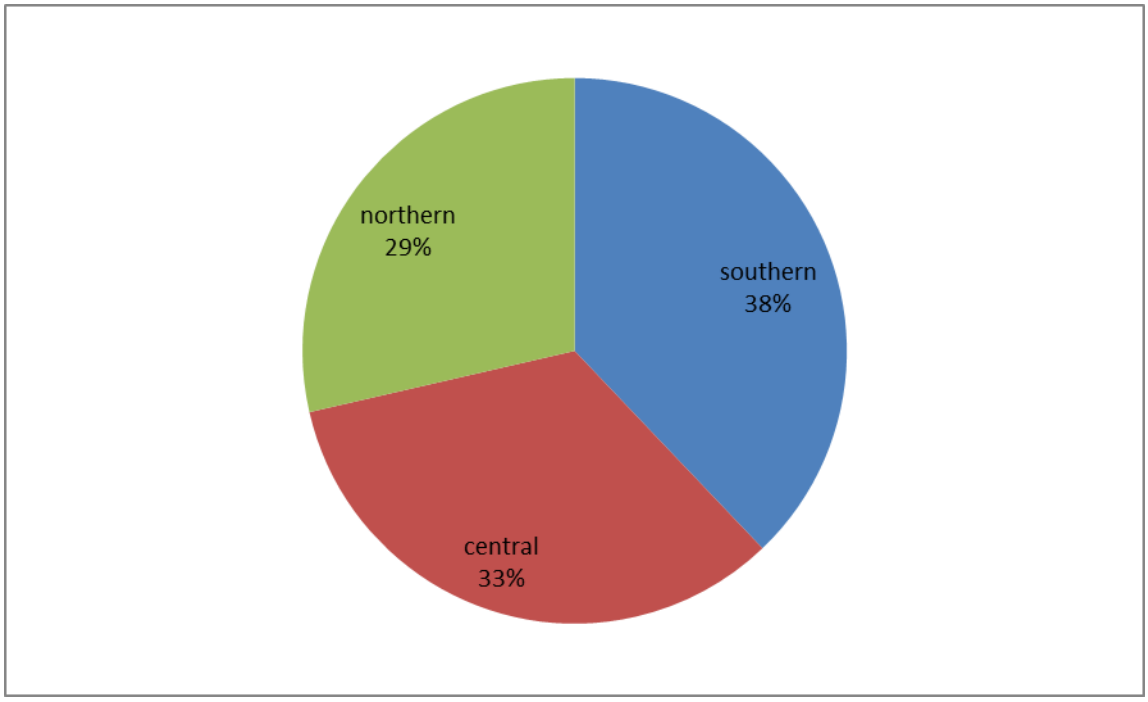


Fig. 6. Graph indicating presence of total species sampled per corridor route

4. Route Selection

The above data identifies that :

1. The northern corridor route offers, across its entire spectrum and route, a lower ecological risk when compared to the proposed southern and central corridors.

2. Some risk to habitat and hence faunal components, is evident in the vicinity of the Pongola Private Game Reserve, where Zululand Sourveld is to be traversed at elevated levels of the route.

3. Other portions of the northern line route comprise primarily of settled lands with clearance for stock grazing as well as intensive agricultural farming activities and in some areas, former agricultural lands undergoing seral reversion.

4. The central corridor route is also noted to traverse some elevated portions of the region, with possible impacts on Zululand Sourveld vegetation type. The route would also traverse some densely forested portions of the region, on moderate to steep slopes. This corridor route is subject to settlement and clearance on an informal basis, however portions of the route remain of "moderate" significance from a habitat and biodiversity perspective.

5. The southern corridor route offers the most significance from an ecological perspective, based primarily upon the fact that much of the land to be traversed by this route falls under management regimen associated with private game farm initiatives. As such, habitat along this route is of "moderate to high" ecological significance.

The above conclusion supports the qualitative findings proffered in the March 2013 report which are revised below in Table 4 to incorporate a qualitative conclusion based on the ecological findings presented above.

Table 4. Qualitative evaluation of negative impacts using prescribed methodology of comparative assessment.

Southern Route	**Magnitude**	**Duration**	**Scale**	**Sum of parameters**	**Probability**	**Product of Impacts**
Habitat transformation	8	4	2	14	4	56
Terrestrial faunal impacts	8	4	2	14	3	42
Avifaunal impacts	8	4	3	15	4	60
Significance rating						**52.66666667**
Central Route						
Habitat transformation	7	4	2	13	4	52
Terrestrial faunal impacts	8	4	2	14	3	42
Avifaunal impacts	8	4	3	15	4	60
Significance rating						**51.33333334**
Northern Route						
Habitat transformation	5	4	2	11	4	44
Terrestrial faunal impacts	6	4	2	12	3	36
Avifaunal impacts	6	4	3	13	4	52
Significance rating						**44.0**

The primary factors that contribute to the comparative lower significance rating along the northern route are;

- The presence of an existing powerline of similar structure and impact as that associated with the proposed powerline. As such, an additional powerline running adjacent to the existing structure would, (comparatively), amount to the concentrating of negative ecological impacts at a spatial level, rather than introducing new impacts on previously unencumbered points within the study area, namely the southern and central route options. Impacts that may arise from the new line being established along the northern corridor relate, not only to avian impacts through such effects as avian collisions with the line ("bird strikes"), but include more latent ecological impacts, such as the establishment of an additional physical strata which alters predator – prey relationships in respect of terrestrial faunal behaviour and populations. Such impacts, both identifiable and by extension, latent, are already present along the northern line route, but are absent from the other routes.

- That vehicular access is a significant qualitative aspect that supports the northern line route as the preferred route option. The establishment of the line along the southern and central route options would necessitate significant improvements to roadways, including river and dam crossings, pruning and removal of vegetation, as well as import of earth and stabilizing materials. The northern route offers generally well established and relatively well maintained road access points, a factor not found in the other routes.

- While the northern line route traverses the Pongola Private Game Reserve and related areas of land managed for "conservation and conservation related purposes", other portions of the line route show significant transformation to commercial agricultural lands. This factor is not noted along the southern and central route options, where commercial agricultural activities have ceased and seral processes have reverted to a secondary vegetative community, while only sporadic settlement and "shifting agricultural activities" are evident at points. In addition, the southern route shows significant veld management activities focussing on conservation objectives.

5. Mitigation Measures to be Employed On Northern Line Route

The selection of the northern line route as that route associated with the least (comparative) ecological impact, requires that a number of mitigation measures be undertaken to ensure that the identified impacts are avoided or mitigated. Such impact mitigation measures are proposed below.

1. Routing. The proposed line route should lie to the west of the existing 132kV line. By lying to the west of the existing line, the placement of towers on the scarp of the elevated points will be avoided, particularly in the northern sections of the route. This has ramifications for impacts upon avian behaviour.

2. Tower construction. The tower structures associated with the new line route should be established, where possible, in tandem or close proximity to the existing towers. In this manner, disturbance at edaphic, ground and aerial levels, will be consolidated from a spatial perspective.

3. Bird flight diverters (BFDs). BFDs should be established across the entire line route, with application to either the new or existing powerlines.

4. **Vegetation clearance** along the line route should be undertaken within and restricted to an 8m vegetation clearance path. Where appropriate and acceptable, the maintenance of identified specimens of significance (e.g large specimens of *Erythrina latissima*, found within the sourveld vegetation form) should be avoided and where required, subject to pruning, rather than felling, in order to establish towers and lines

5. Post construction management of cleared areas should ensue, whereby the invasion of the cleared servitude by exotic vegetation, as well as species such as *Dicrostachys cinerea* is addressed on an ongoing basis.

6. Identification of the upper flood terrace of the Pongola River should be established and the towers associated with the traversing of this river must be placed outside of these points.

6. Conclusion

This is the final ecological assessment of the Pongola – Candover –Golela 132kV powerline route. The assessment, undertaken from both a qualitative and quantitative perspective considered three possible line routes for the establishment of a proposed 132kV powerline.

The results of primary data collection with quantitative analysis of such data using recognised ecological analytical methods identified that the northern route, as identified in earlier reports, was the most appropriate and applicable route for such a powerline in terms of bio physical factors that are inherent within the region.

References

CAP IV Community Analysis Package Pisces International 2007

ECON II Pisces International 2007

EKZN Wildlife (2008) *Integrated Management Plan : Zululand Rhino Reserve*

Fey M. (2010) *Soils of Southern Africa* University Press

Ferguson Bruce K (1996) " The Maintenance of Landscape Health in the Midst of Land Use Change" Journal of Environmental Management. 48. 387-395

Google earth www.googleearth.com

M Shobrak (2001) "*Posturing behavior of the Lappet faced Vulture Torgos tracheliotus chicks on the nest plays a role in protecting them from high ambient temperatures*" Asian Raptor Bulletin V Bulletin 2

Mucina and Rutherford (2007) *The Vegetation Types of South Africa, Lesotho and Swaziland* Strelitzia

NEM Biodiversity Management Act 10 of 2004. (2011) "*National List of Ecosystems that are Threatened and in Need of Protection*" Govt. Gazette 344809

Pooley E (1998) *Trees of Eastern South Africa – A Complete Guide*.Flora and Fauna Publications Trust.

P S Roy and Behera MD (2002) Biodiversity Assessment at Landscape Level "Tropical Ecology Vol 3) Int. Society for Tropical Ecology