Kunene Regional Ecological Assessment

Results and Discussion: Volume 2 of 3

Prepared for the

Kunene People's Park Technical Committee

by Round River Conservation Studies

Principal Investigators: Jeff Muntifering, Dr. Christopher Lockhart and Richard Tingey
Assisting Investigators: Julian Griggs, Dr. Kimberley Heinemeyer, Dr. Jennifer Lalley, and Dennis Sizemore

2008

Contents

Results

Base data
The first objective in the KREA was to assess the available data necessary to produce the ecological analysis within the Project Area. Key data gaps were then identified and attempted to be filled by focused KREA field initiatives.

Project Area was defined as the Proposed Park Area (Palmwag, Etendeka and Hobatere Concessions) and the adjacent conservancies (Torra, ≠Khoadi //Hoas, Sesfontein, Anabeb, Omatendeka, Ehirovipuka) and an additional 4 communal conservancies (Purros, Okangundumba, Ozondundu, Orupupa, Otjambangu) that wide-ranging wildlife, particularly elephants and lions from the immediate Project Area, were also known to utilize. It should be noted that although political boundaries were used in the assessment, since these area defined the scope of the planning area, actual watershed boundaries of the Hoanib, Uniab, Koigab, and Huab River Systems were quite similar in size (not including the commercial farmlands of the upper Huab catchment).

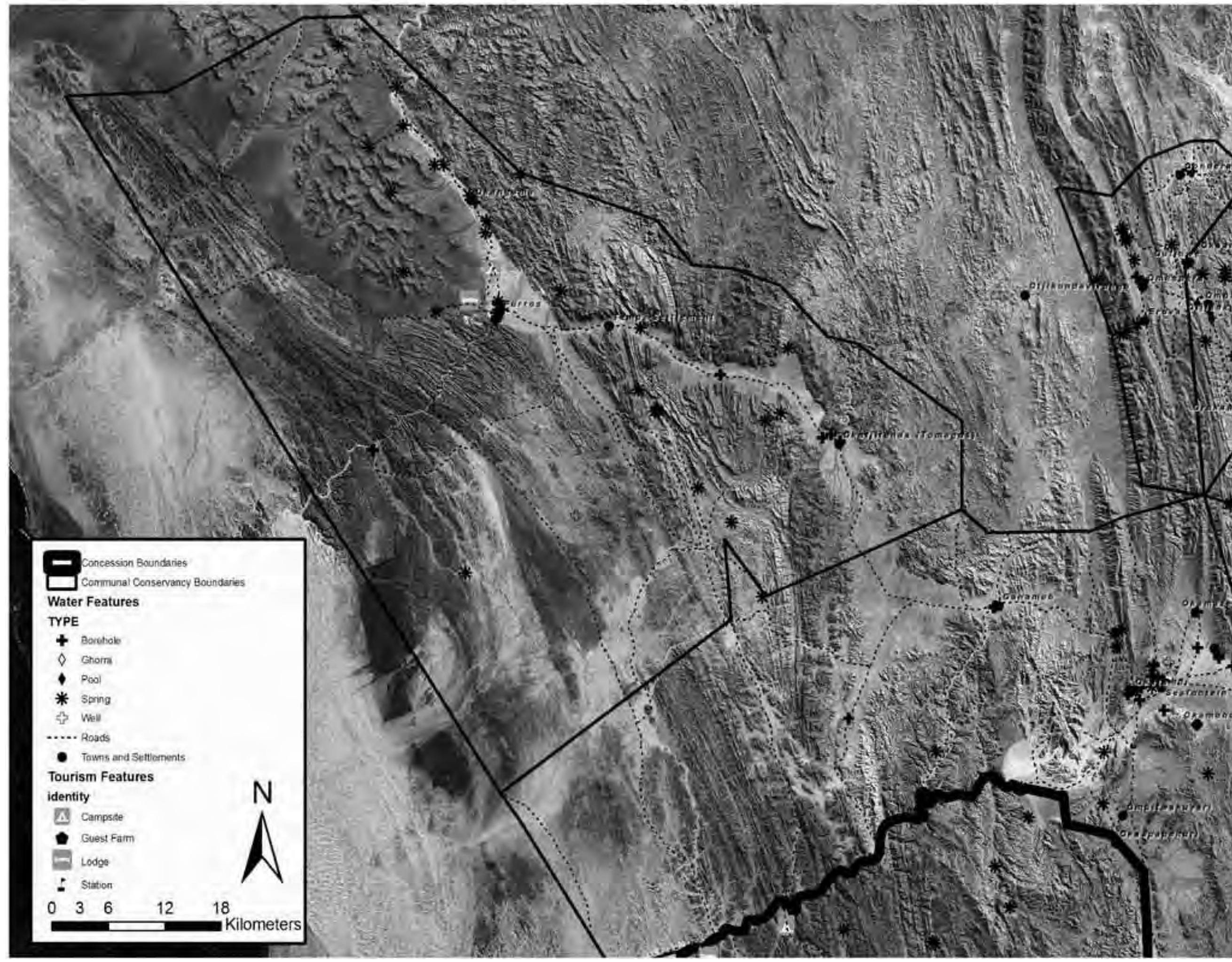
KEY	
MET	Ministry of Environment and Tourism
DSS	Directorate of Scientific Services
MLR	Ministry of Lands and Resettlement
DSM	Directorate of Survey and Mapping
MA	Ministry of Agriculture
DWA	Directorate of Water Affairs
SRT	Save the Rhino Trust
SRTM	Shuttle Radar Topographical Mission
KREA	Kunene Regional Ecological Assessment
	Local Informant Interviews
	Local Community Surveys

	Data	Data Sourced
Infrastructure	*Cities and Towns*	ConInfo, MLR-DSM, KREA
	Settlements and households	ConInfo, MLR-DSM, KREA
	Main Roads	ConInfo, MLR-DSM
	District Roads	ConInfo, MLR-DSM
	Tracks	ConInfo, MLR-DSM, SRT, KREA
	Lodges	ConInfo, SRT, KREA
	Campsites	ConInfo, SRT, KREA
	Airstrips	ConInfo, SRT, KREA
Landscape Resources	*Natural Waters*	MLR-DSM, ConInfo, SRT, KREA
	Man-made Waters	MA-DWA, ConInfo, SRT, KREA
	Elevation	Digital Elevation Model (DEM), SRTM
	Slope	Digital Elevation Model (DEM), SRTM
	Drainages	Digital Elevation Model (DEM), SRTM
	Landscape Ruggedness	Digital Elevation Model (DEM), SRTM
	Topographical Position Index	Digital Elevation Model (DEM), SRTM
Ecological Land Unit	*Landscapes*	Namibia Atlas
	Rainfall	Namibia Atlas
	Geology	Namibia Atlas
	Landforms	Digital Elevation Model (DEM), SRTM
	Moisture Flow Accumulation	Digital Elevation Model (DEM), SRTM
Key Species	*Black Rhino*	SRT, MET-DSS, KREA
	Elephant	MET-DSS, Namibia Elephant and Giraffe Trust, KREA
	Lion	Predator Conservation Trust, KREA
	Rare and Endemic Species	MET-DSS, Scientific Literature (see References)
	Other Game	MET-DSS, SRT, KREA

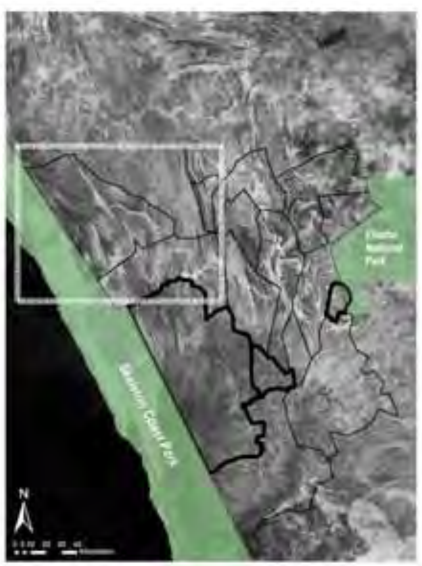
Infrastructure Features & Water Resources

From the collected and collated base data we created Proximity Maps for a variety of features such as:

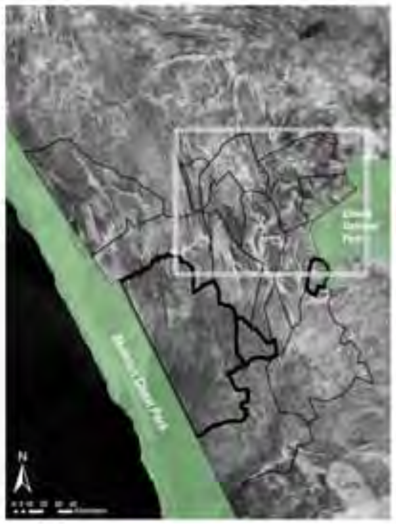
- Distance to nearest city/town
- Distance to nearest settlement/household
- Distance to nearest Tourism feature
- Distance to nearest Main Road
- Distance to nearest District Road
- Distance to nearest Track
- Distance to nearest Permanent Spring
- Distance to nearest Temporary Spring
- Distance to nearest Borehole
- Distance to nearest Well

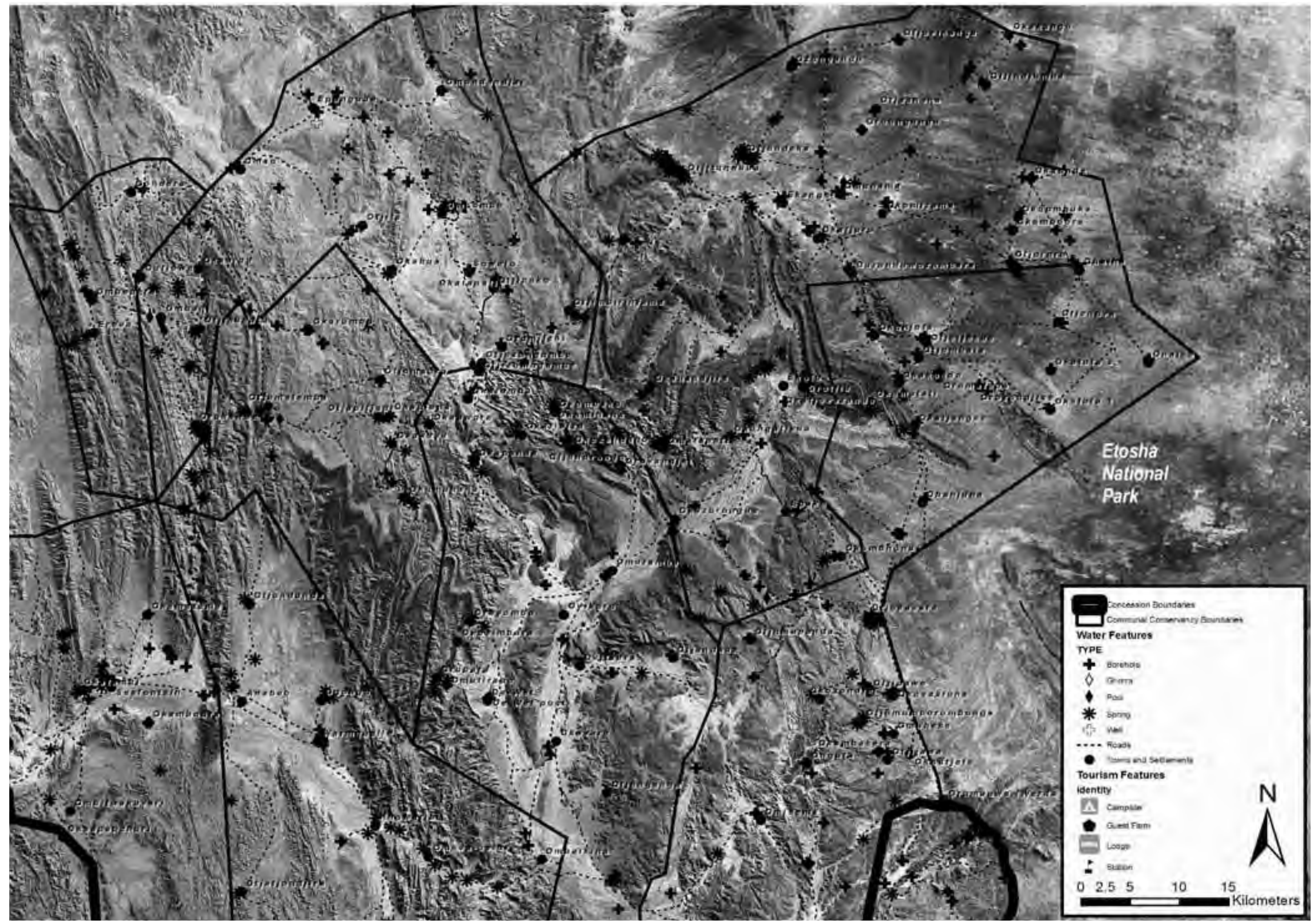


Northwest Project Area Map Extent

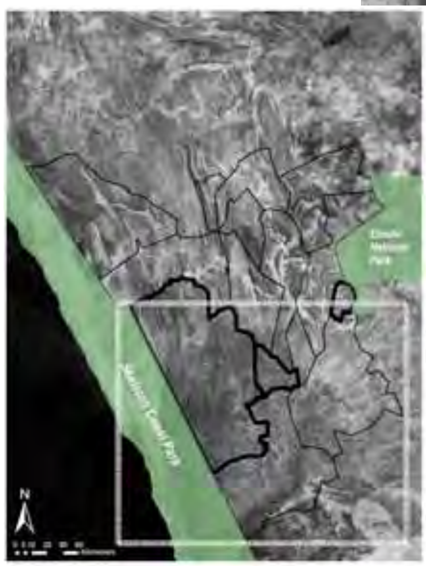


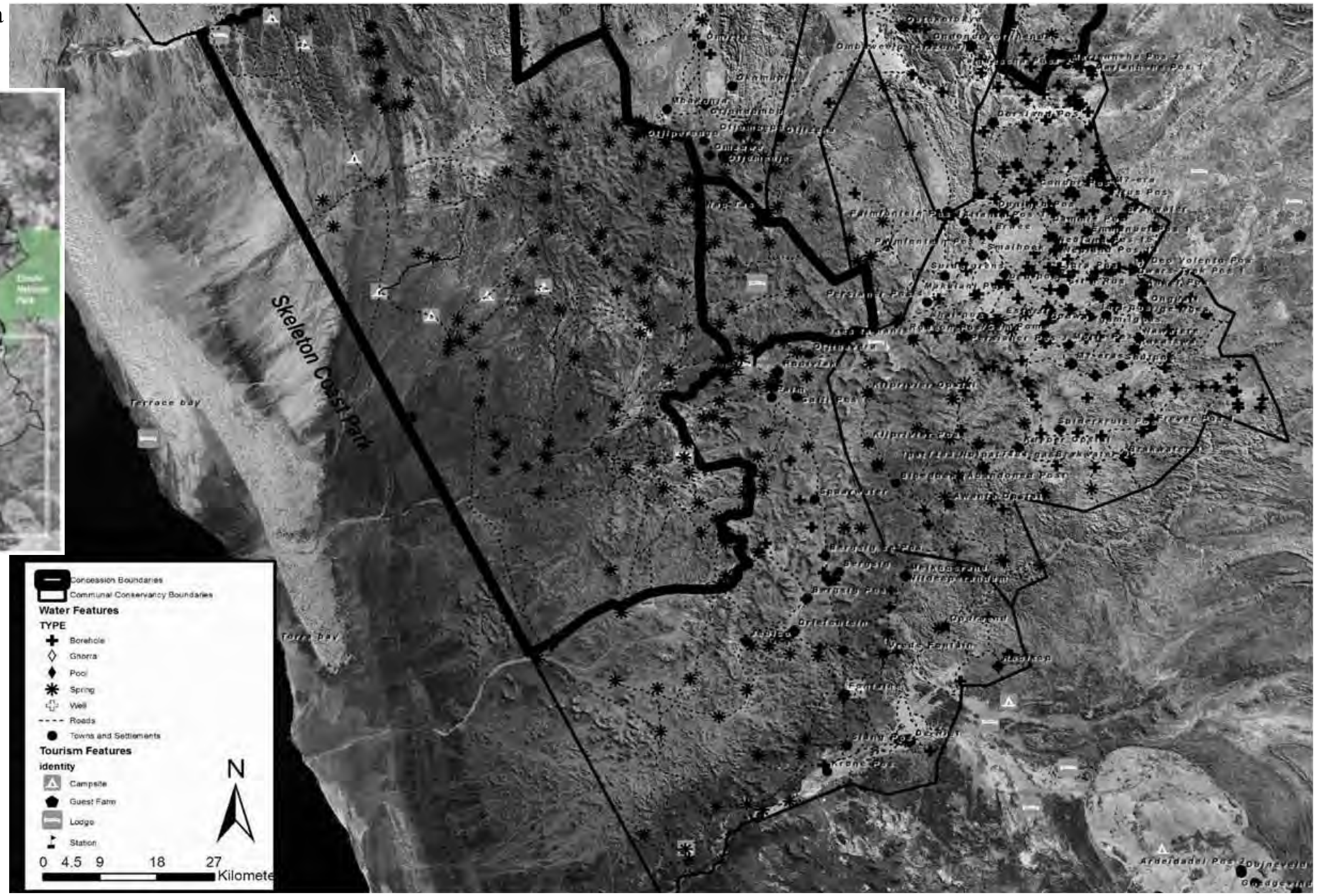
Northeast Project Area Map Extent





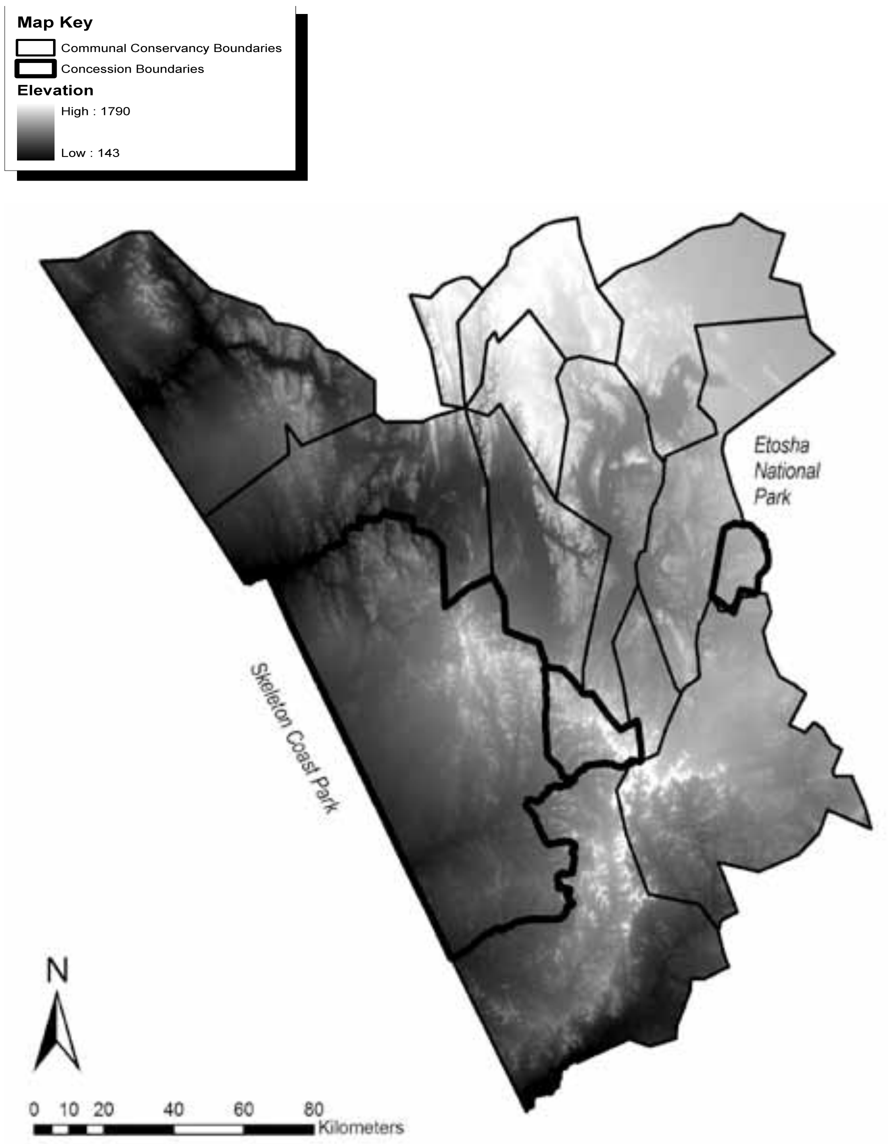
Southern Project Area Map Extent

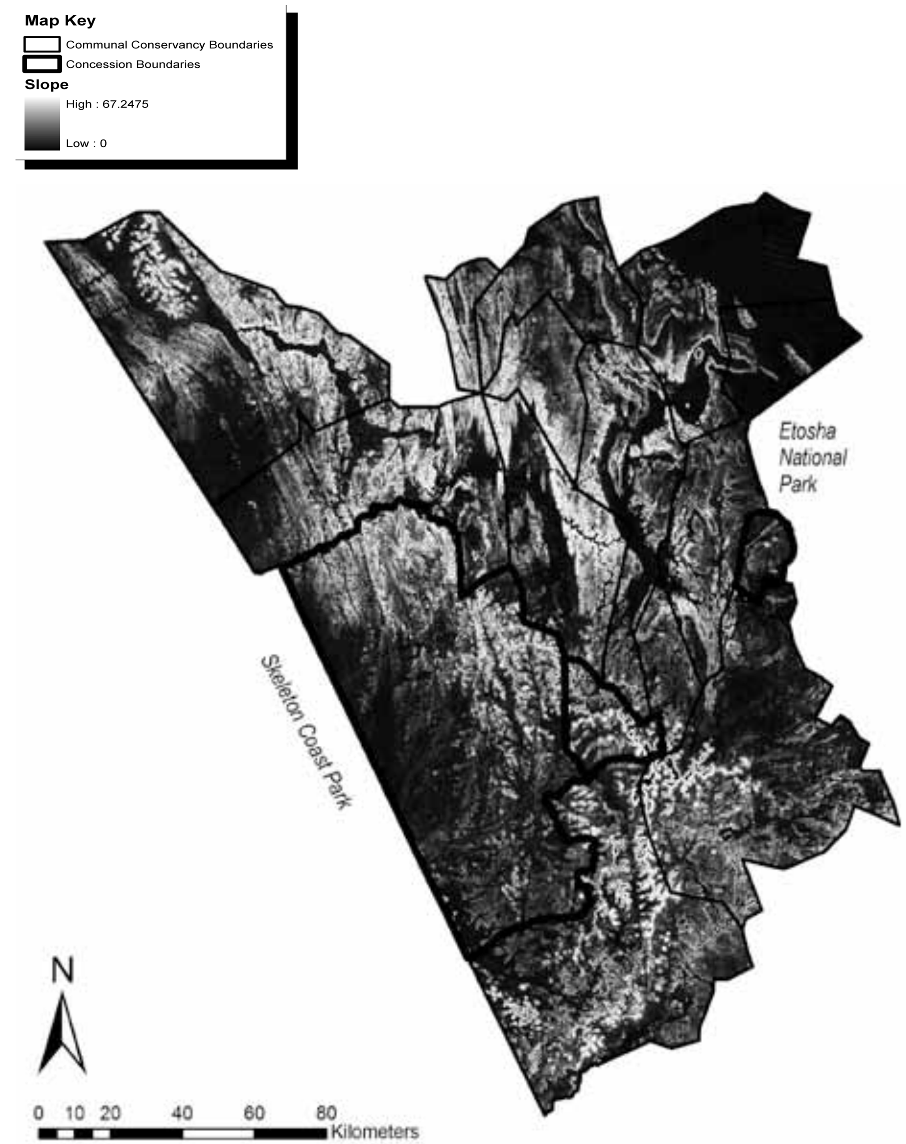




Landscape features

We also created a suite of landscape feature maps that characterized the project area such as:



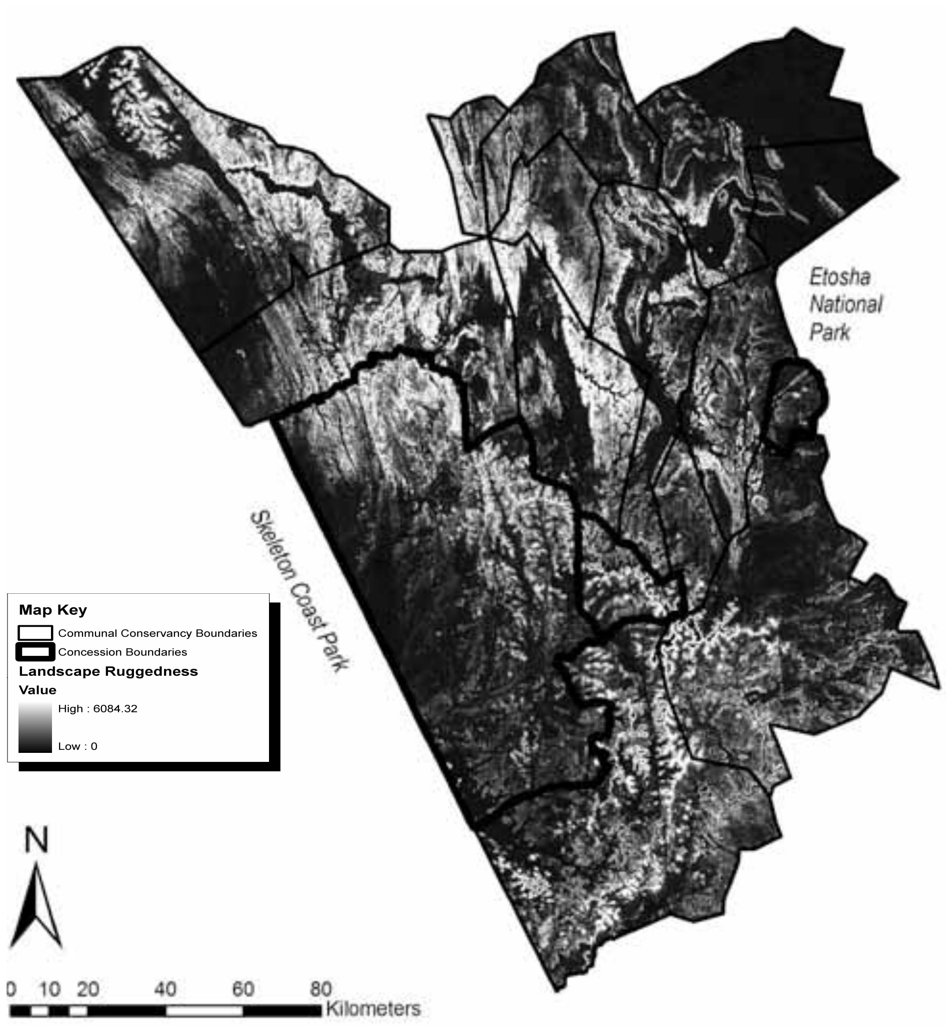


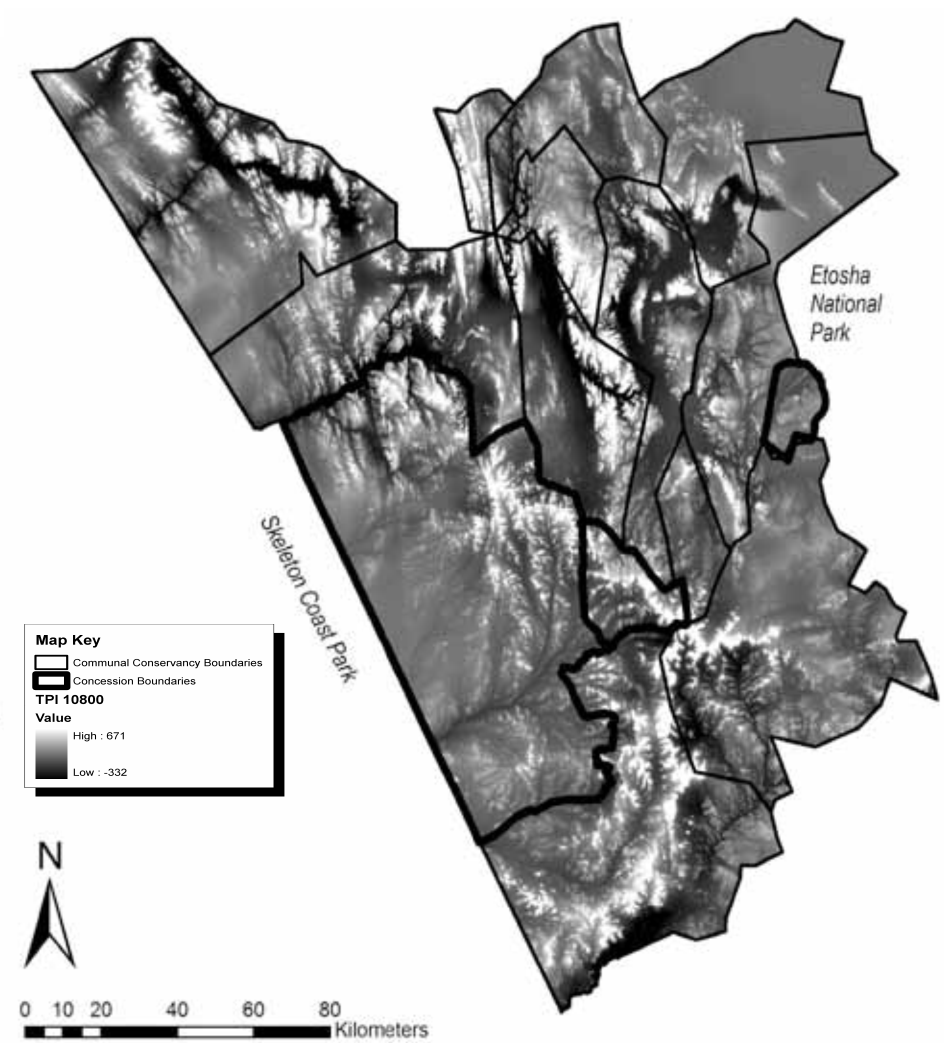
Landscape Ruggedness

Relative measure of the change in elevation in a given area. Areas with large elevation change / area are more ‘rugged’.

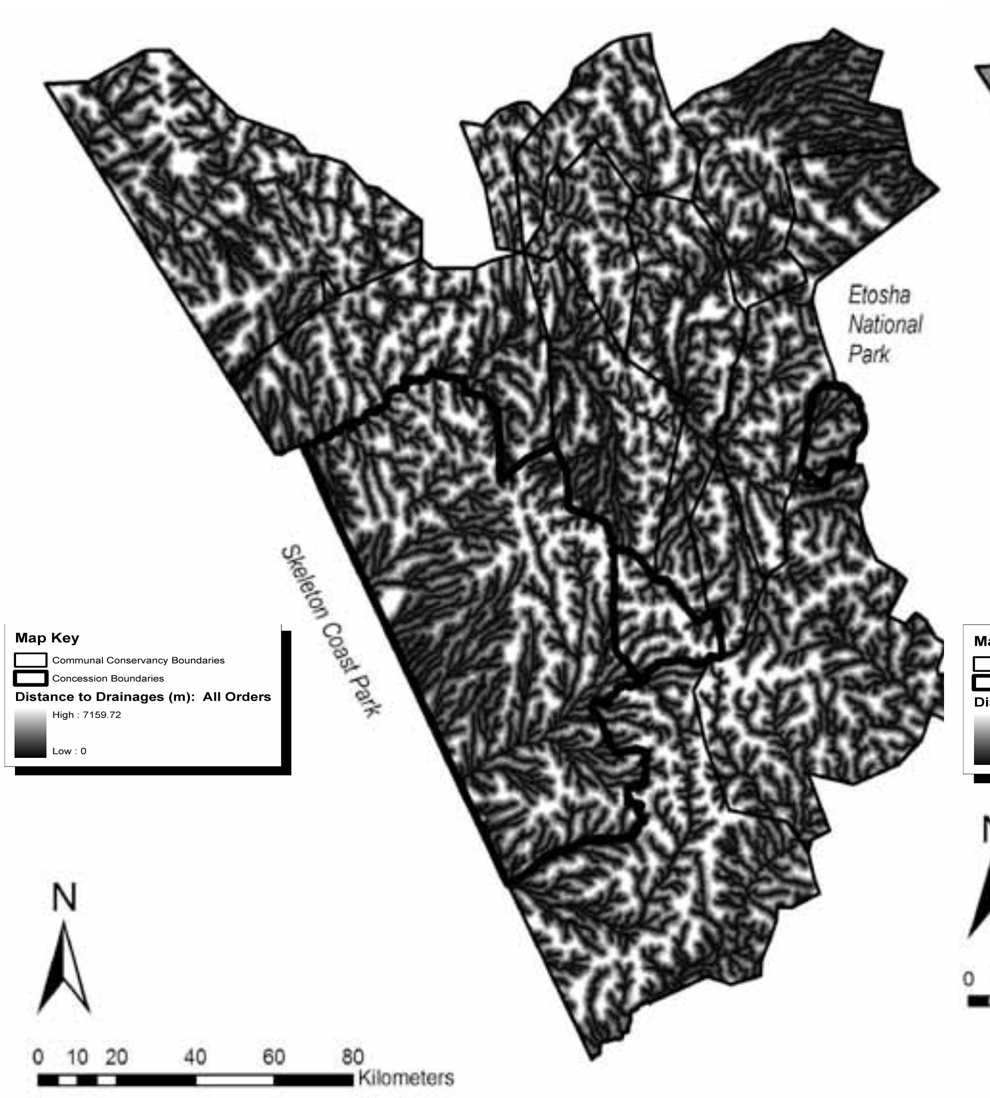
Topographical Position Index (TPI)

Measure of elevation relative to surrounding average elevation. Drainages and valleys are relatively lower (low TPI) than the surrounding area.

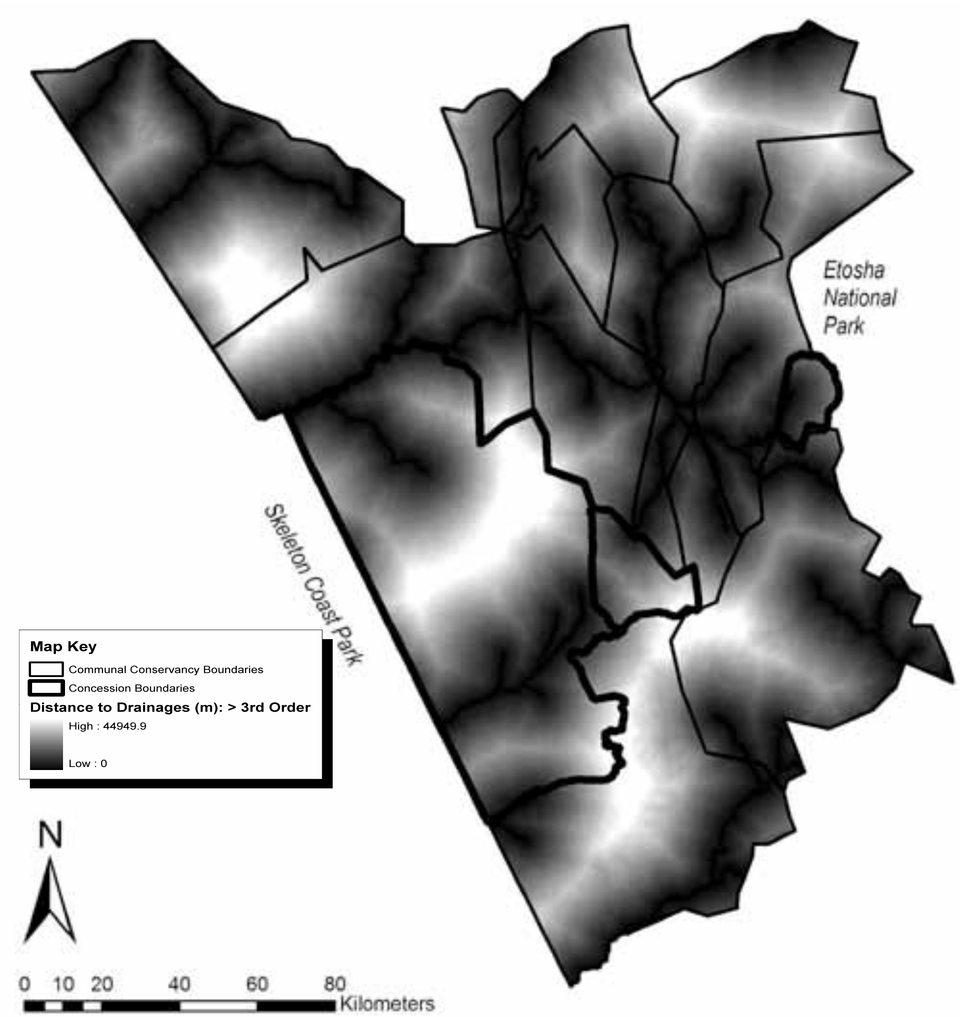




Distance from Drainages (all orders)

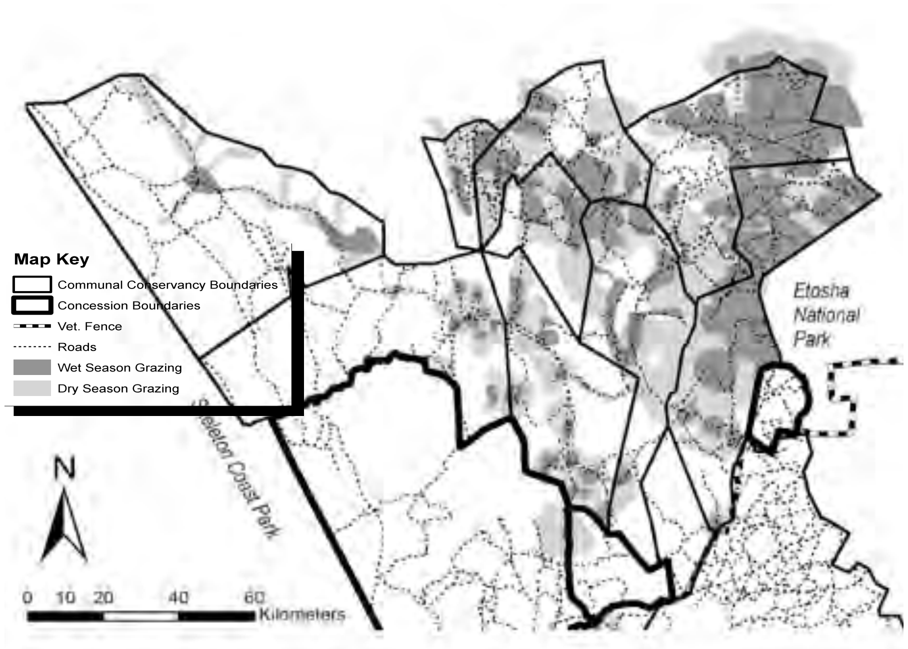


Distance from Major Drainages (3rd Order or higher)



Mapping Traditional Land Use Values

Northern Livestock Grazing Distribution



Defining currency of use North of the Red Line

• Local livestock herders in Anabeb, Sesfontein, Purros, Omatendeka, Ehirovipuka, Okangundumba, Ozondundu, Orupupa, and Otjambangu Conservancies were interviewed from February 2007 - June 2008 to map areas utilized by their livestock during the an average wet and dry season. These areas were classified as High Probability Livestock Grazing Areas (HPLGA) within each conservancy boundary.

• The remaining area, outside of the HPLGAs where livestock and/or people were said to not utilize, were classified as low probability livestock grazing areas (LPLGA).

Habitat Modeling Framework

• A suite of independent resource and human impact variable surfaces were generated using a GIS from available data sources.

• Resource and human impact values were attributed to 500 random sites drawn from the 'high probability livestock grazing areas' and 500 random sites drawn from the 'low probability livestock grazing area' for both wet and dry season range.

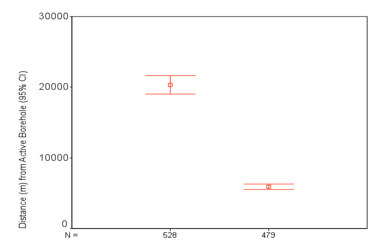
• A livestock distribution probability statistical model was generated using multiple logistic regression to maximize likelihood estimates and then extrapolated to produce a spatially-explicit livestock grazing probability surface across the study region.

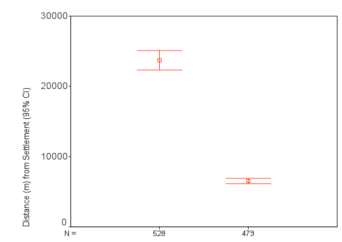
• The model's predictive accuracy was tested using independent cattle, goat and sheep observations recorded during aerial surveys by MET in 2005 and 2007.

Livestock Grazing Distribution Characteristics

During the dry season, livestock north of the Red Line were relatively more likely to be distributed across:

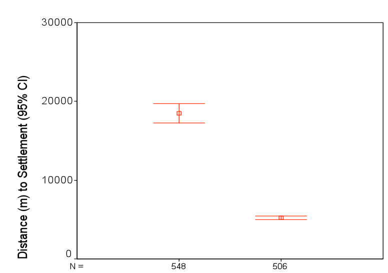
- Areas that are closer to permanent Settlements,
- Areas that are closer to active Boreholes,
- Areas that are closer to Natural Water features,
- Areas with a lesser degree of Slope,
- Areas that are slightly further from District Roads

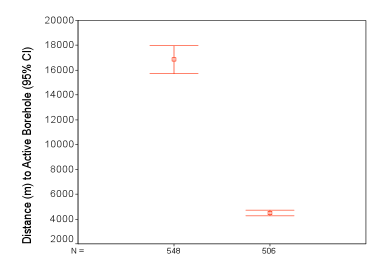




During the wet season, livestock north of the Red Line were relatively more likely to be distributed across:

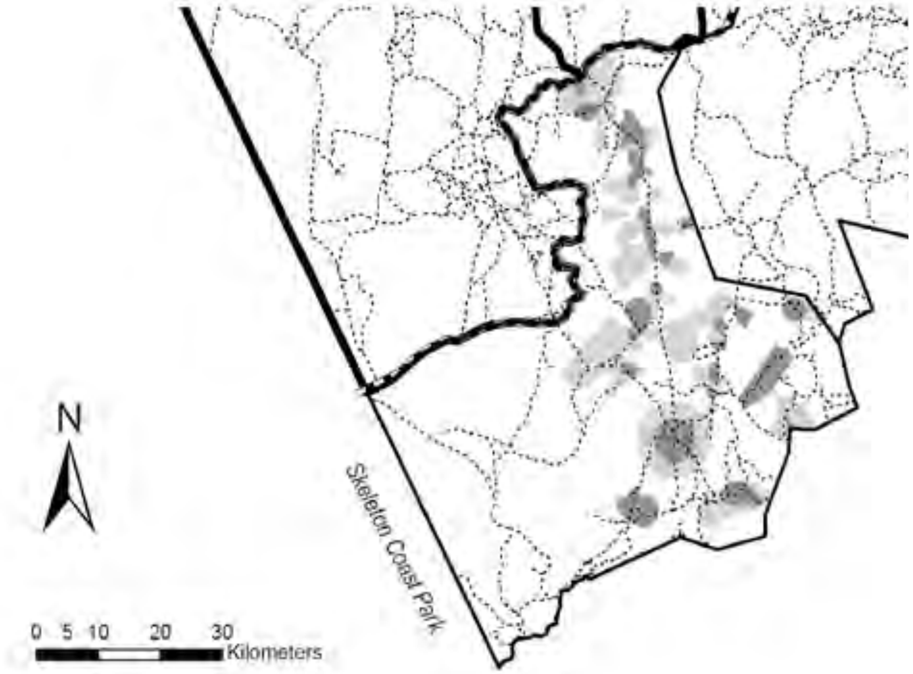
- Areas that are closer to permanent Settlements,
- Areas that are closer to active Boreholes,
- Areas with a lesser degree of Slope,
- Areas that are closer to Cities or Towns





* Bars indicate individual variables' 95% range of values between HPBAs and LPBAs.

Southern Livestock Grazing Distribution



Defining currency of use South of the Red Line

• Local livestock herders in Torra and #Khoadi //Hoas Conservancy were interviewed from February 2007 - June 2008 to map areas utilized by their livestock during the an average wet and dry season. These areas were classified as High Probability Livestock Grazing Areas (HPLGA) within each conservancy boundary.

• The remaining area, outside of the HPLGAs where livestock and/or people were said to not utilize, were classified as low probability livestock grazing areas (LPLGA).

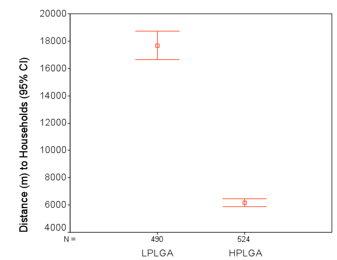
Habitat Modeling Framework

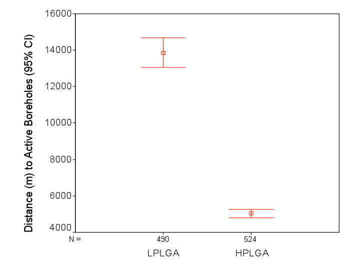
• A suite of independent resource and human impact variable surfaces were generated using a GIS from available data sources.
• Resource and human impact values were attributed to 500 random sites drawn from the 'high probability livestock grazing areas' and 500 random sites drawn from the 'low probability livestock grazing area' for both wet and dry season range.
• A livestock distribution probability model was generated using multiple logistic regression to maximize likelihood estimates.
• The resulting livestock distribution model was then extrapolated to produce a spatially-explicit livestock grazing probability surface across the study region.
• The model's predictive accuracy was tested using independent cattle, goat and sheep observations recorded during aerial surveys by MET in 2005 and 2007.

Livestock Grazing Distribution Characteristics

During the dry season, livestock south of the Red Line were relatively more likely to be distributed across:

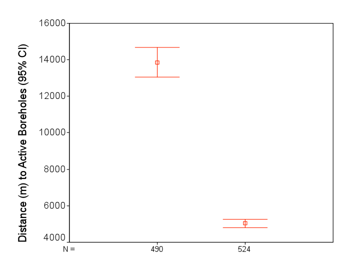
- Areas that are closer to permanent Households,
- Areas that are closer to active Boreholes,
- Areas that are slightly further from District Roads
- Areas that are closer to Cities and Towns

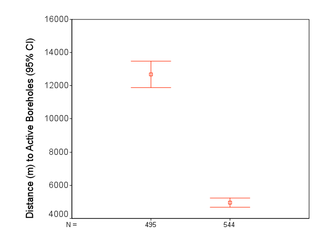




During the wet season, livestock south of the Red Line were relatively more likely to be distributed across:

- Areas that are closer to permanent Households,
- Areas that are closer to active Boreholes,
- Areas that are closer to Vehicle Tracks





* Bars indicate individual variables' 95% range of values between HPBAs and LPBAs.

Wet Season Livestock Grazing Distribution

Southern Grazing Area Model Summary Statistics

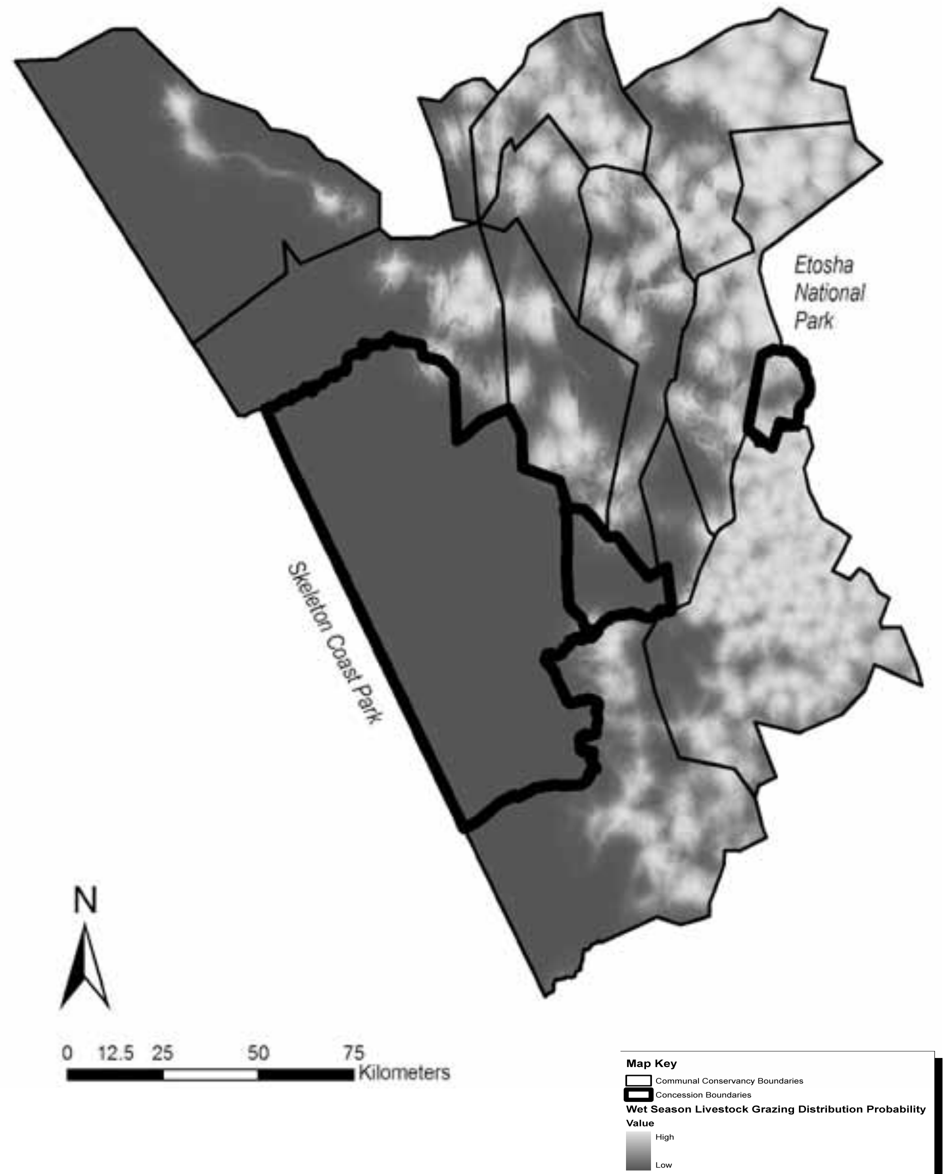
Variables in Model	β coefficient	Standard Error	R
Households (path distance)	-0.0002	1.65E-05	-0.2408
Boreholes (path distance)	-2.00E-04	2.19E-05	-0.1866
Vehicle Tracks (path distance)	-2.00E-04	2.98E-05	-0.1465

Northern Grazing Area Model Summary Statistics

Variables in Model	β coefficient	Standard Error	R
Settlements (path distance)	-0.0002	2.69E-05	-0.1845
Boreholes (path distance)	-3.00E-04	2.97E-05	-0.2287
Slope	-0.05	0.0142	-0.0848
City and Town (path distance)	-2.60E-05	7.58E-06	-0.0816

Summary Table for Wet Season Livestock Values within Conservancies

NAME	AREA (ha)	MEAN	STD	SUM	Value / ha
#Khoadi //Hoas	334860.00	0.65	0.28	261787.00	0.78
Omatendeka	161851.00	0.41	0.29	80349.40	0.50
Ehirovipuka	197753.00	0.62	0.27	148491.00	0.75
Puros	356134.00	0.04	0.13	19281.50	0.05
Anabeb	156937.00	0.32	0.30	60200.80	0.38
Ozondundu	74498.80	0.34	0.30	30412.10	0.41
Otjambangu	34721.60	0.30	0.28	12453.20	0.36
Sesfontein	246456.00	0.16	0.27	48633.00	0.20
Okangundumba	113020.00	0.55	0.27	75430.40	0.67
Orupupa	187848.00	0.65	0.27	148348.00	0.79
Torra	348860.00	0.25	0.28	105537.00	0.30



Dry Season Livestock Grazing Distribution

Southern Grazing Area Model Summary Statistics

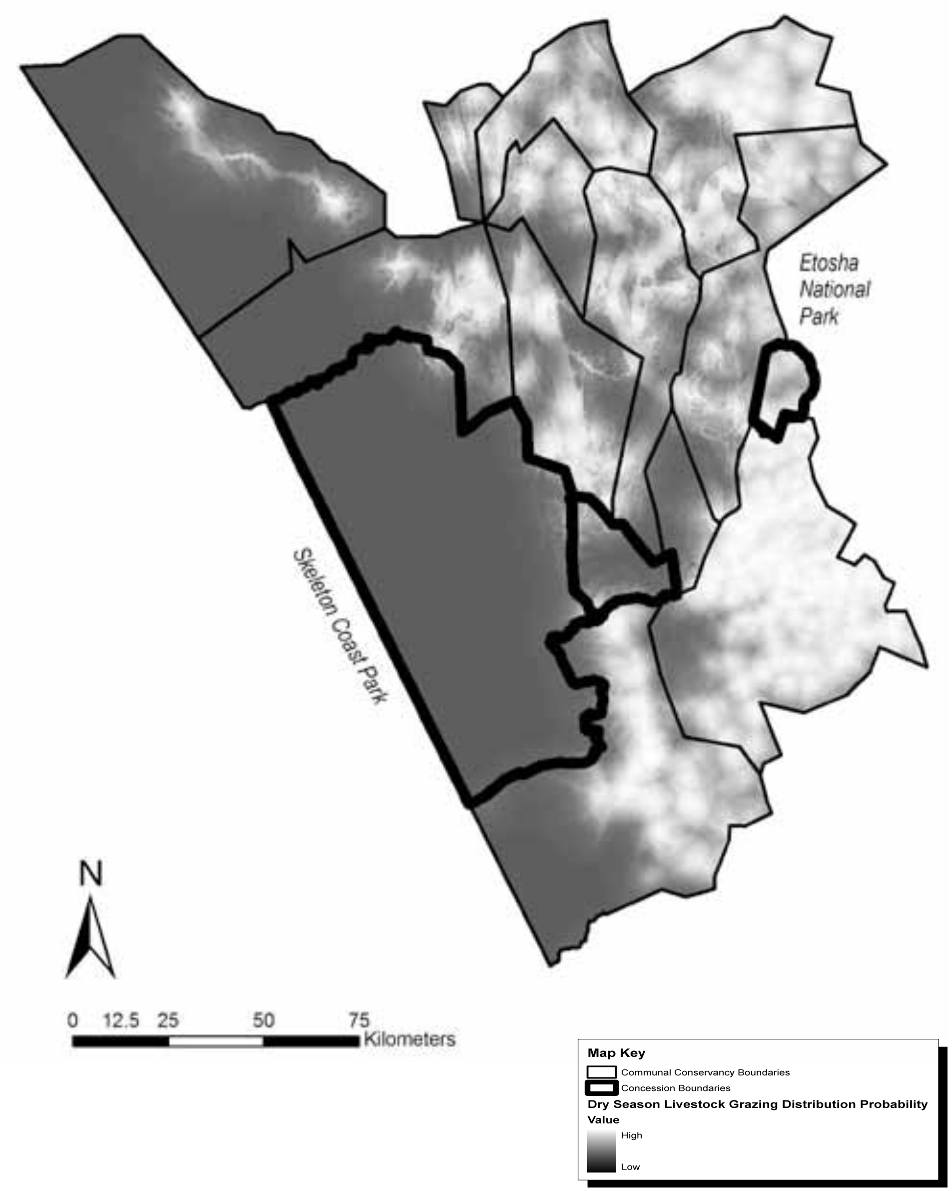
Variables in Model	β coefficient	Standard Error	R
Households (path distance)	-0.0001	2.19E-05	-0.172
Boreholes (path distance)	-2.00E-04	2.65E-05	-0.1992
District Roads (path distance)	-5.60E-05	1.62E-05	-0.0837
City and Town (path distance)	-2.10E-05	7.70E-06	-0.061

Northern Grazing Area Model Summary Statistics

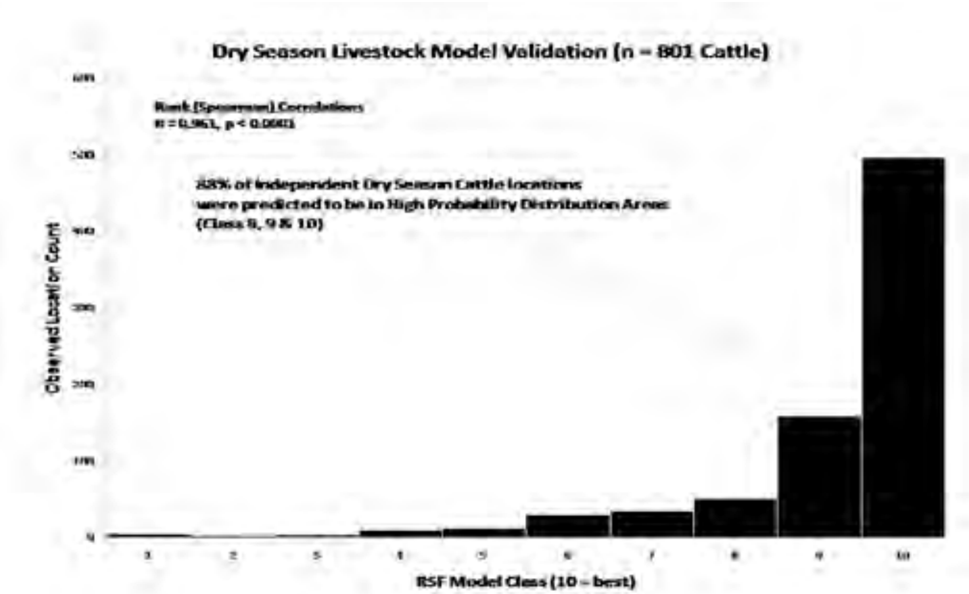
Variables in Model	β coefficient	Standard Error	R
Settlements (path distance)	-0.0002	2.43E-05	-0.2043
Natural Water (path distance)	-3.80E-05	1.79E-05	-0.0428
Boreholes (path distance)	-1.00E-04	2.39E-05	-0.1356
Slope	-0.0506	0.0119	-0.1073
District Roads (path distance)	3.11E-05	1.13E-05	0.0633

Summary Table for Dry Season Livestock Values within Conservancies

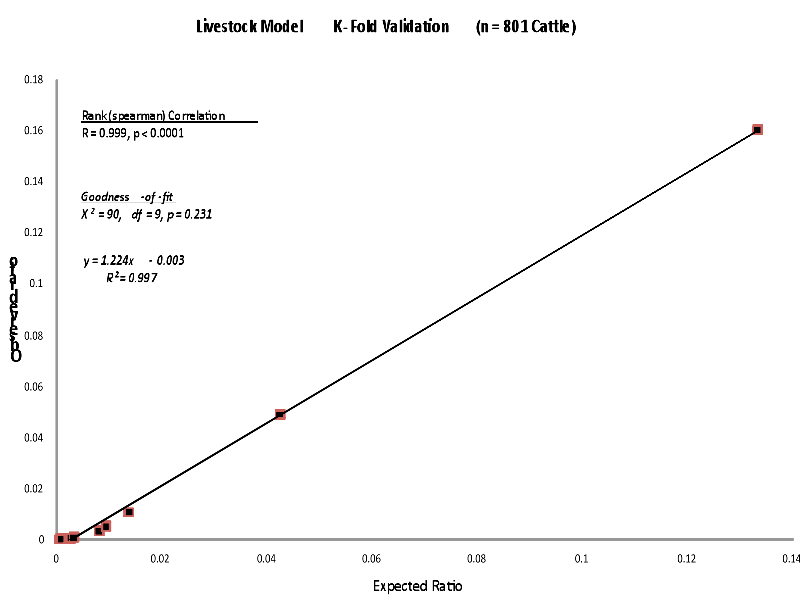
NAME	AREA (ha)	MEAN	STD	SUM	Value / ha
#Khoadi //Hoas	334860.00	0.78	0.23	316301.00	0.94
Omatendeka	161851.00	0.55	0.26	106695.00	0.66
Ehirovipuka	197753.00	0.60	0.20	142947.00	0.72
Puros	356134.00	0.09	0.18	39759.00	0.11
Anabeb	156937.00	0.50	0.28	95401.80	0.61
Ozondundu	74498.80	0.49	0.27	43849.40	0.59
Otjambangu	34721.60	0.49	0.26	20634.50	0.59
Sesfontein	246456.00	0.21	0.29	61150.60	0.25
Okangundumba	113020.00	0.63	0.20	85701.70	0.76
Orupupa	187848.00	0.71	0.20	161975.00	0.86
Torra	348860.00	0.41	0.35	173793.00	0.50

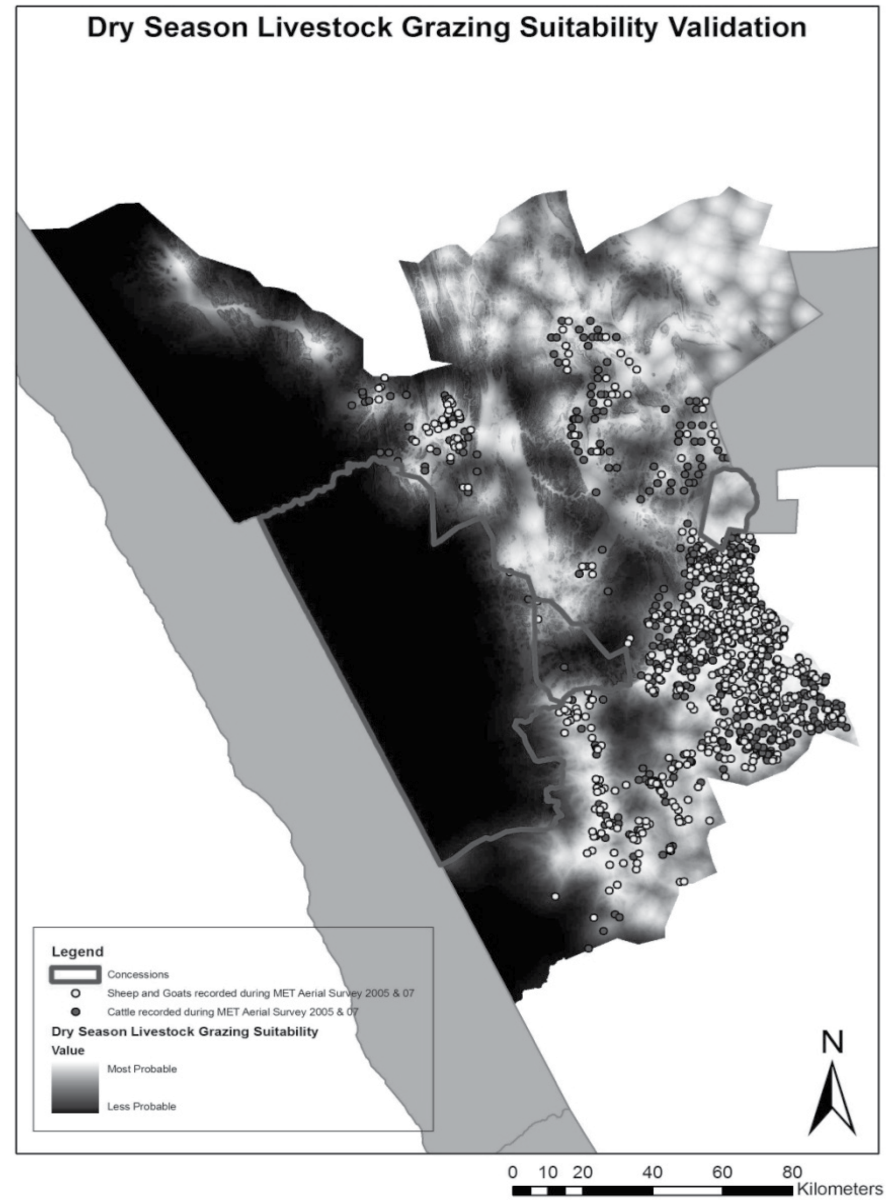


Livestock Model Validation (Dry Season)



In order to assess whether or not the RSF model is approximately proportional to the probability of use, K-Fold Cross Validation is required. A model that meets this assumption has a slope different from 0 but not different from one, an intercept near 0, a high R2 value (spearman), and a non-significant X2 Goodness-of-fit value.





Core Wildlife Habitat: Focal Species

Kunene People's Park Conservation Objective

Protect Core Wildlife Habitat

Desert Elephant Habitat

Why are elephants a good focal species?

- Key tourism attraction
- Provide many landscape ecosystem services such as seed dispersal for important plants
- Need large areas to maintain viable populations, so their conservation requirements also act as an 'umbrella' for many other native species
- Good data and knowledge on regional elephant space use

Defining patch-level currency of use & availability

- Sampled GPS locations for 3 breeding cows and 4 dominant bulls (2002 – 2006)
- Only one location per day per individual was randomly sampled to reduce spatial autocorrelation (n = 1,383)
- To estimate a 'patch' extent to sample for availability, we calculated 95% fixed-width probability kernels for each marked individual

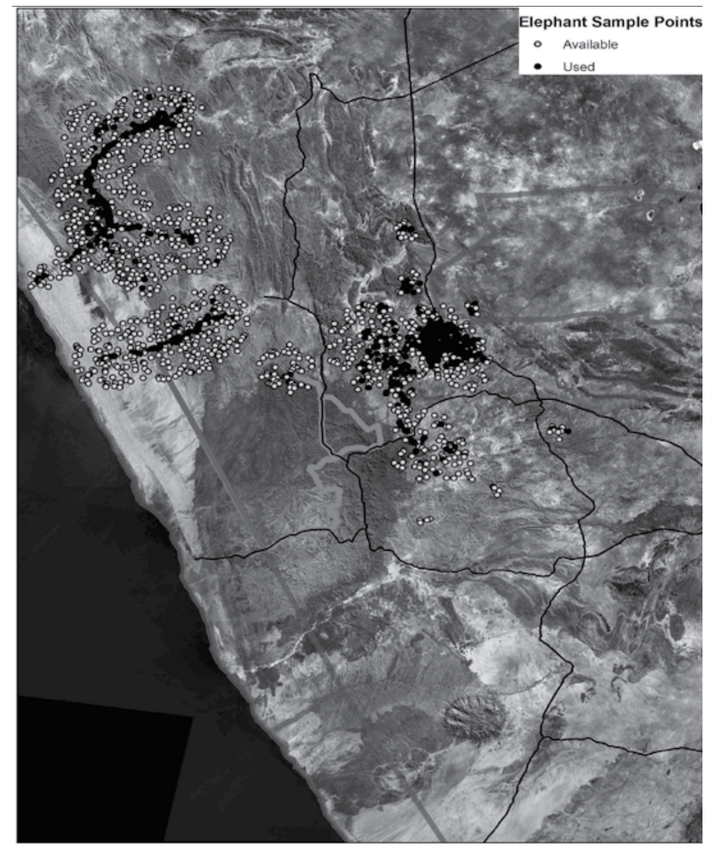
Habitat Modeling Framework

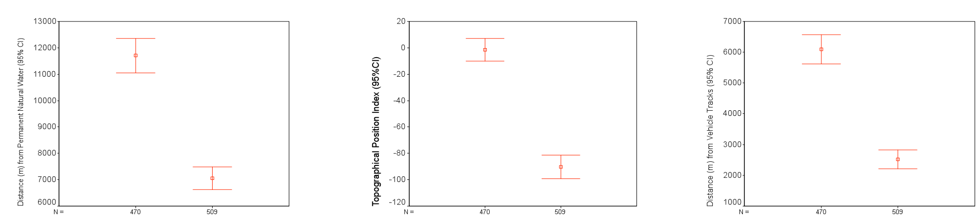
- Resource and human impact values were linked to a selected 'used' sample and equal number of randomly selected 'available' sites.
- An RSF model was generated using multiple logistic regression to identify key predictor variables and their 'weighted' contribution to habitat suitability
- The resulting elephant RSF was then scaled to produce a spatially-explicit relative probability use (habitat suitability) surface across the study region

Key Elephant Habitat Characteristics

Within their home ranges, desert elephants sampled exhibit significant preference towards:

- Areas that are relatively lower than the surrounds (low Topographical Position Index value),
- Areas that are closer to Natural Water features, especially permanent springs,
- Areas that are closer to active and accessible Man-made Water features, especially boreholes,
- Areas that are closer to Vehicle Tracks
- Areas with a lesser degree of Slope





*** Bars indicate individual variables' 95% range of values between Available and Used Sites.**

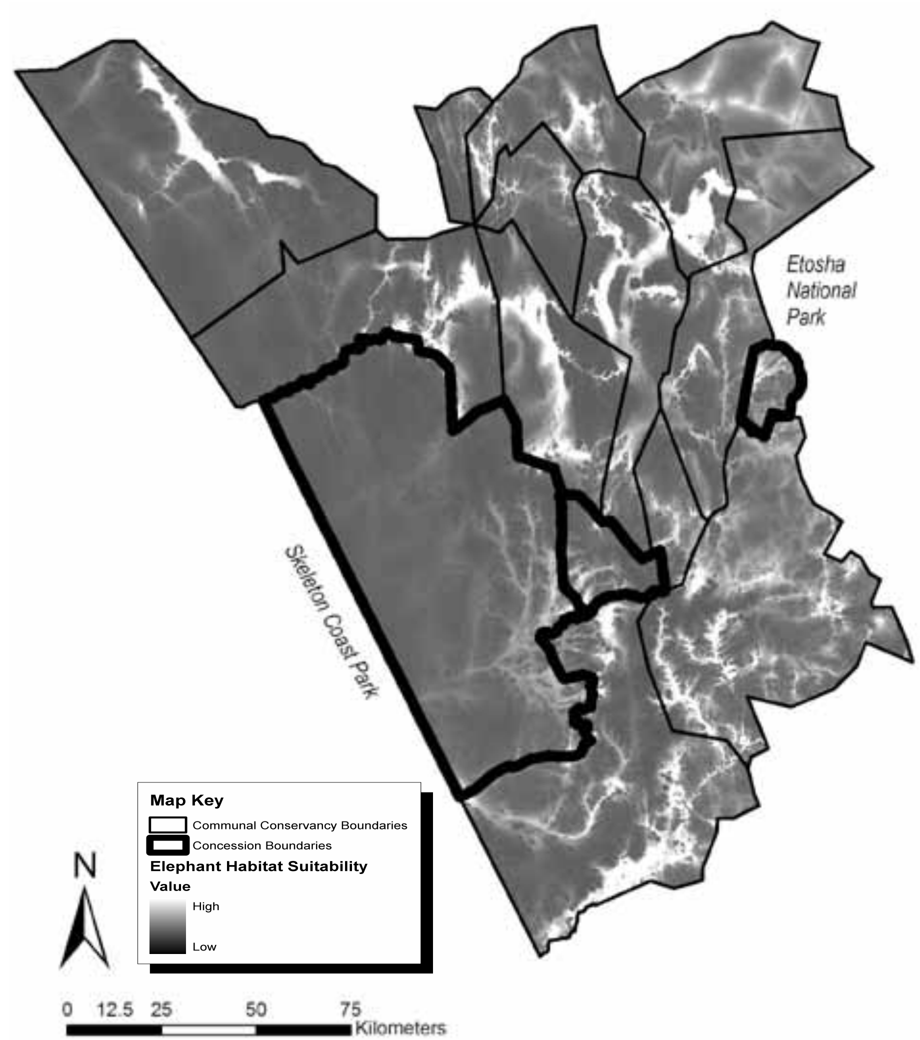
Elephant Habitat Suitability

Habitat Modeling Summary Statistics

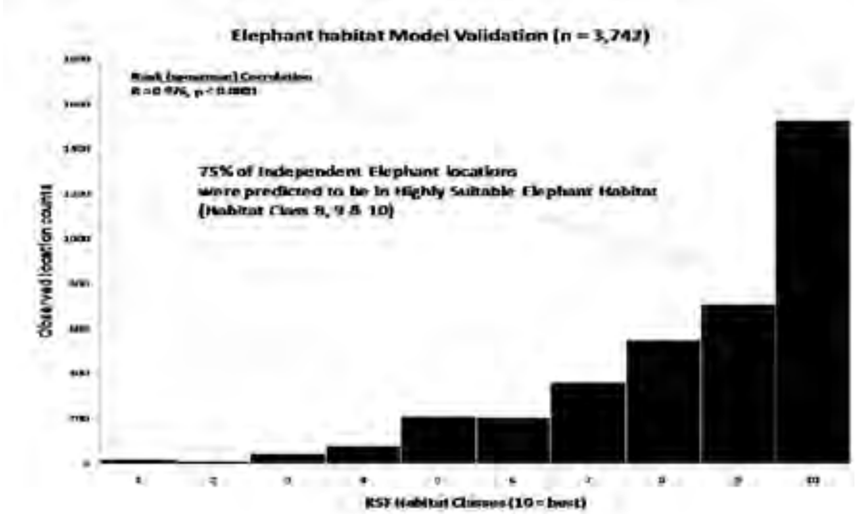
Variables in Model	β coefficient	Standard Error	R
Topograpphical Postion Index	-0.0082	0.0011	-0.2057
Natural Water (path distance)	-3.70E-05	5.89E-06	-0.1658
Borehole (path distance)	-6.20E-05	1.60E-05	-0.0971
Tracks (path distance)	-0.0002	2.19E-05	-0.2075
Slope	-0.0828	0.016	-0.1348

Summary Table for Elephant Habitat Values

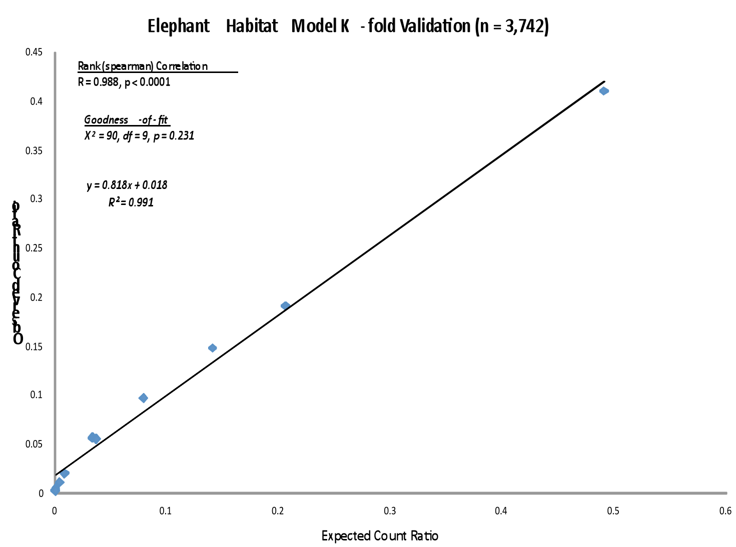
	NAME	AREA (ha)	MEAN	STD	SUM	Value/ha
Concession	*Hobatere*	25805.50	0.06	0.04	1763.77	0.07
	Etendeka	50780.60	0.03	0.04	1802.23	0.04
	Palmwag	577555.00	0.02	0.02	11067.70	0.02
Conservancy	*#Khoadi //Hoas*	334860.00	0.05	0.04	19398.60	0.06
	Omatendeka	161851.00	0.05	0.06	9949.98	0.06
	Ehirovipuka	197753.00	0.04	0.03	9347.42	0.05
	Puros	356134.00	0.02	0.07	9286.46	0.03
	Anabeb	156937.00	0.05	0.07	9197.83	0.06
	Ozondundu	74498.80	0.02	0.03	1940.03	0.03
	Otjambangu	34721.60	0.02	0.02	804.72	0.02
	Sesfontein	246456.00	0.03	0.05	7749.73	0.03
	Okangundumba	113020.00	0.04	0.05	5508.74	0.05
	Orupupa	187848.00	0.06	0.06	13698.30	0.07
	Torra	348860.00	0.05	0.06	19624.30	0.06

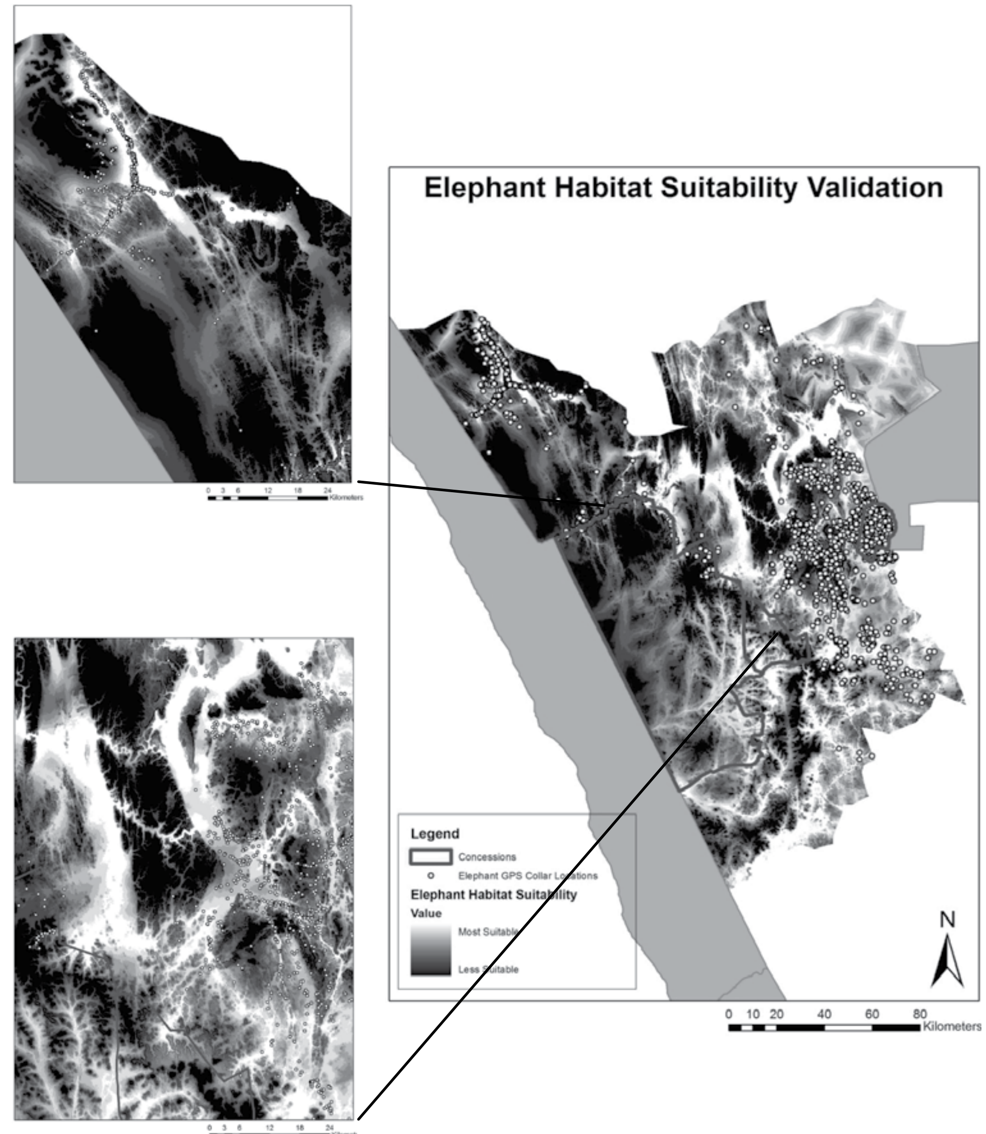


Elephant Model Validation



In order to assess whether or not the RSF model is approximately proportional to the probability of use, K-Fold Cross Validation is required. A model that meets this assumption has a slope different from 0 but not different from one, an intercept near 0, a high R2 value (spearman), and a non-significant X2 Goodness-of-fit value.





Desert Lion Habitat

Why are lions a good focal species?

- Key tourism attraction
- Provide many landscape ecosystem services such as predatory population control of native game species
- Understanding lion habitat selection could help reduce human/lion conflict
- Need large areas to maintain viable populations, so their conservation requirements also act as an 'umbrella' for many other native species
- Good data and knowledge on regional lion space use

Defining patch-level currency of use & availability

- Sampled VHF collar locations for 6 females/cubs and 3 pride male groups (2000 – 2006)
- Only one location per day per individual was randomly sampled to reduce spatial autocorrelation (n = 221)
- To estimate a 'patch' extent to sample for availability, we calculated 95% fixed-width probability kernels for each marked individual

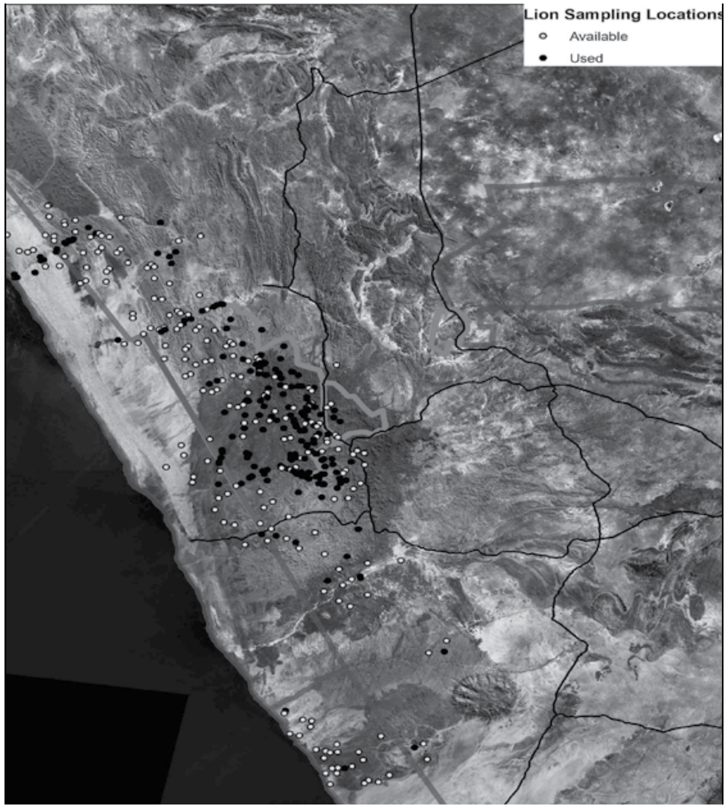
Habitat Modeling Framework

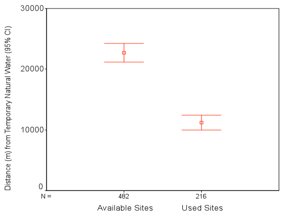
- Resource and human impact values were linked to a selected 'used' sample and equal number of randomly selected 'available' sites.
- An RSF model was generated using multiple logistic regression to identify key predictor variables and their 'weighted' contribution to habitat suitability
- The resulting elephant RSF was then scaled to produce a spatially-explicit relative probability use (habitat suitability) surface across the study region

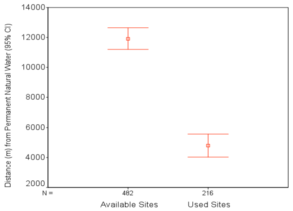
Key Lion Habitat Characteristics

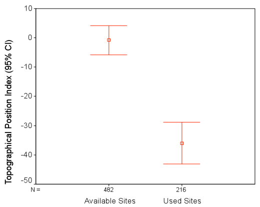
Within their home ranges, desert lions sampled exhibit significant preference towards:

- Areas that are relatively lower than the surrounding landscape (low Topographical Position Index value),
- Areas that are closer to Natural Water features, including both permanent and temporary springs,
- Areas that can be characterized by higher levels of Landscape Ruggedness









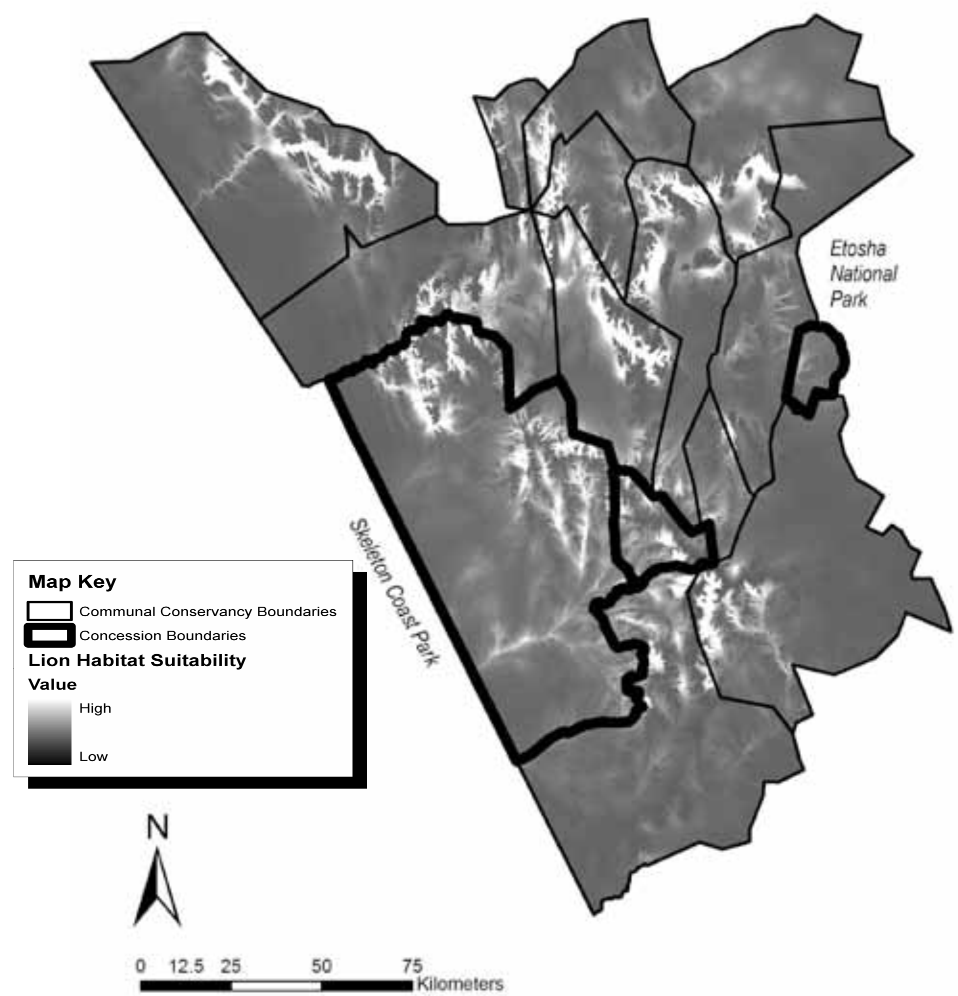
Lion Habitat Suitability

Habitat Modeling Summary Statistics

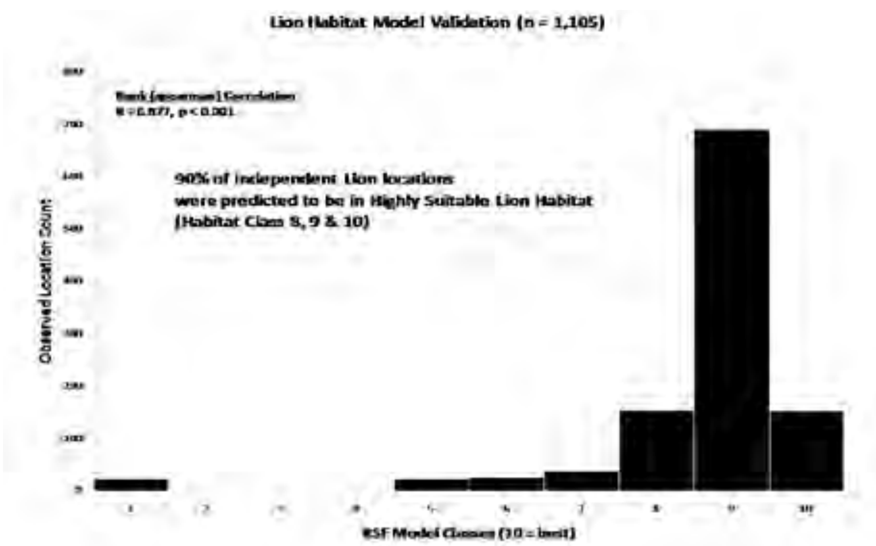
Variables in Model	β coefficient	Standard Error	R
Topograpphical Postion Index	-0.0142	0.0022	-0.2096
Natural Water (path distance)	-1.00E-04	2.01E-05	-0.2409
Natural Temp Water (path distance)	-4.30E-05	9.23E-06	-0.1495
Landscape Ruggedness	0.0012	4.00E-04	0.0879

Summary Table for Lion Habitat Values

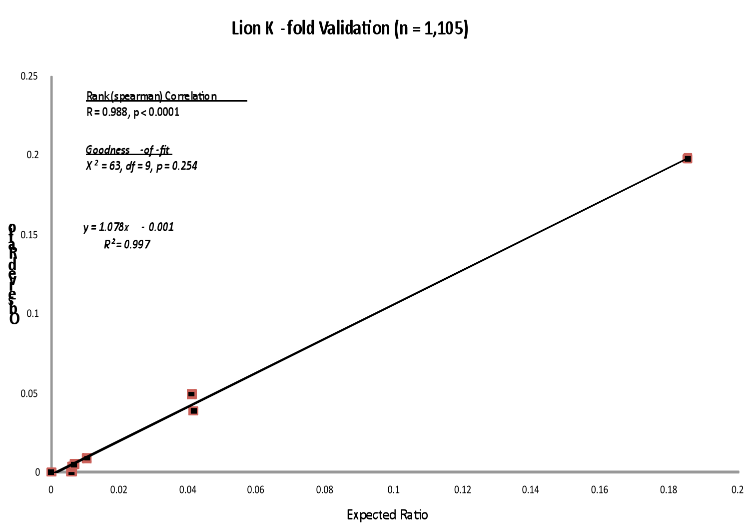
	NAME	AREA (ha)	MEAN	STD	SUM	Value/ha
Concession	*Hobatere*	25806	0.09	0.05	2860	0.11
	Etendeka	50781	0.17	0.14	10323	0.20
	Palmwag	577555	0.13	0.14	88346	0.15
Conservancy	*#Khoadi //Hoas*	334860	0.06	0.12	24135	0.07
	Omatendeka	161851	0.16	0.20	31146	0.19
	Ehirovipuka	197753	0.07	0.07	15656	0.08
	Puros	356134	0.11	0.21	45287	0.13
	Anabeb	156937	0.20	0.24	37714	0.24
	Ozondundu	74499	0.14	0.20	12518	0.17
	Otjambangu	34722	0.13	0.13	5286	0.15
	Sesfontein	246456	0.10	0.15	29852	0.12
	Okangundumba	113020	0.09	0.14	12957	0.11
	Orupupa	187848	0.12	0.14	27915	0.15
	Torra	348860	0.07	0.09	30331	0.09

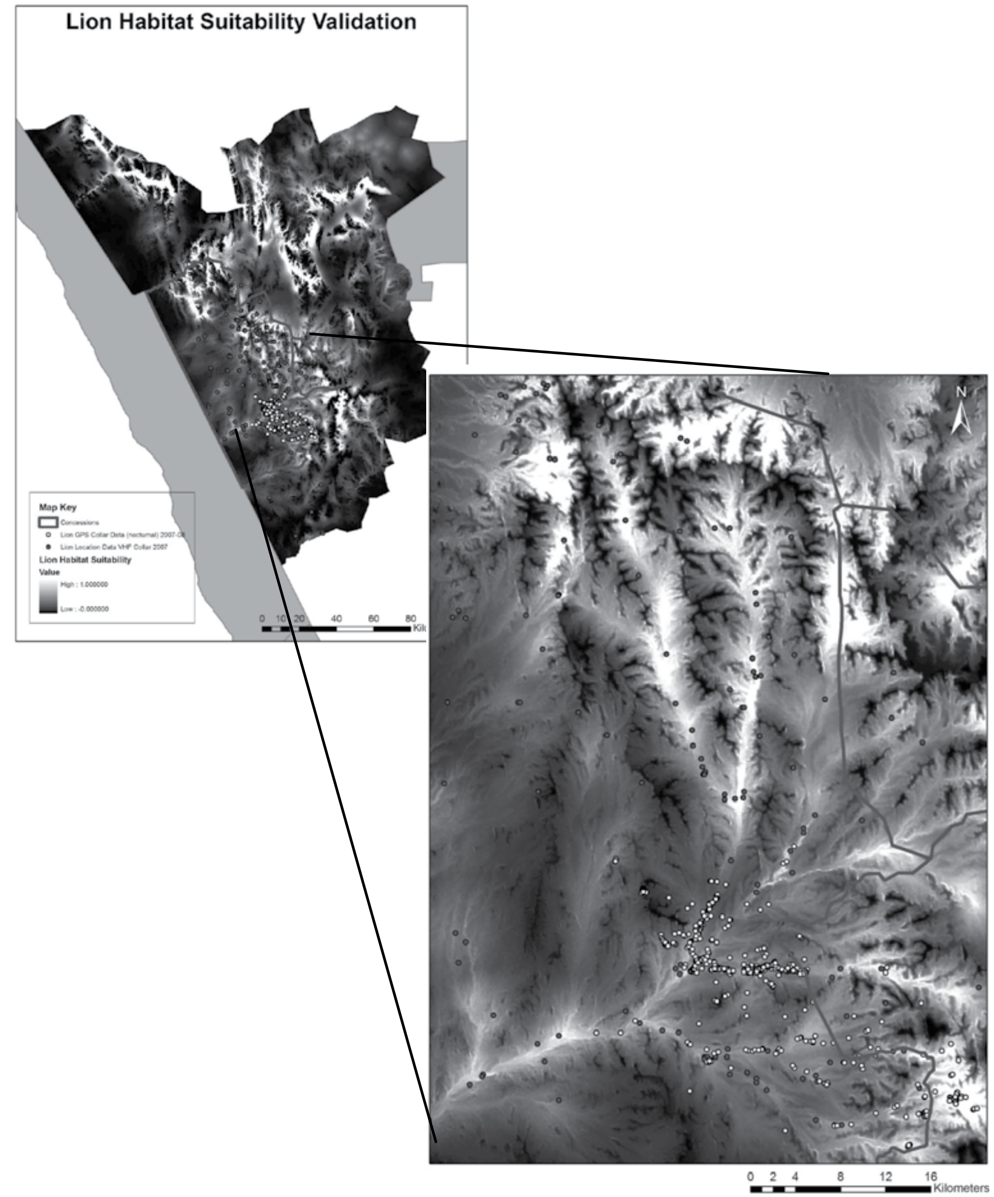


Lion Model Validation



In order to assess whether or not the RSF model is approximately proportional to the probability of use, K-Fold Cross Validation is required. A model that meets this assumption has a slope different from 0 but not different from one, an intercept near 0, a high R2 value (spearman), and a non-significant X2 Goodness-of-fit value.





Desert Black Rhino Habitat

Why are Black Rhion's a good focal species?

- Key tourism attraction with successful 'Rhino Tourism Camps' already in place
- Highly endangered (Global Pop. Estimates = ~3,500), Kunene population is the largest free-ranging population in the world
- Good indicator of disturbance due to their high sensitivity
- Need large areas to maintain viable populations, so their conservation requirements also act as an 'umbrella' for many other native species
- Good data and knowledge on regional rhino space use

Defining patch-level currency of use & availability

- Independent breeding female (n = 7) locations were used to calculate 95% utility distribution across the Etendeka landscape to define High Probable Breeding Areas (HPBAs).
- Areas outside the HPBAs were considered Low Probability Breeding Areas (LHBAs)
- 500 random samples were taken in each to compare habitat characteristics between.

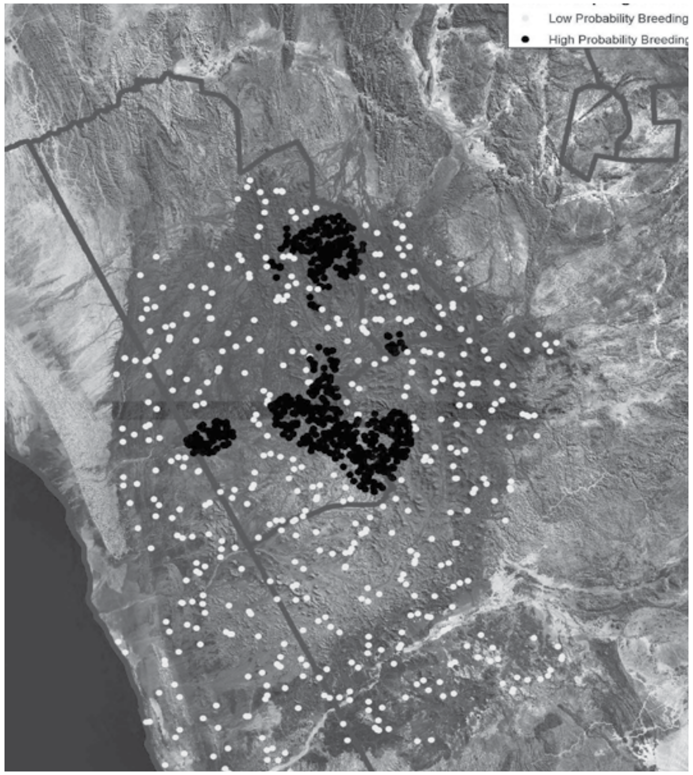
Habitat Modeling Framework

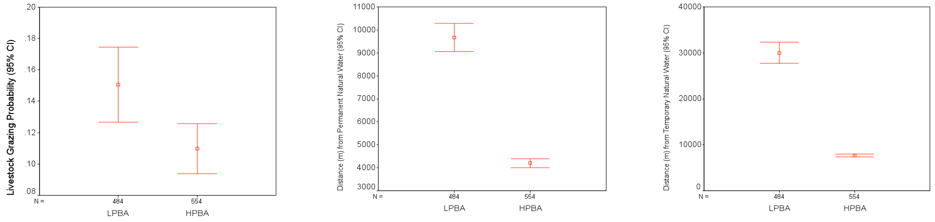
- Resource and human impact values were linked to a selected 'used' sample and equal number of randomly selected 'available' sites
- An RSF model was generated using multiple logistic regression to identify key predictor variables and their 'weighted' contribution to relative habitat suitability
- The resulting rhino RSF was then scaled to produce a spatially-explicit relative probability use (habitat capability) surface across the study region

Key Black Rhino Breeding Habitat Characteristics

Within the Etendeka Landscape, desert black rhino breeding areas sampled can be characterized by:

- Areas that have a relatively lower probability of experiencing Livestock Grazing
- Areas that are closer to Natural Water features, including both permanent and temporary springs.





*** Bars indicate individual variables' 95% range of values between Available and Used Sites.**

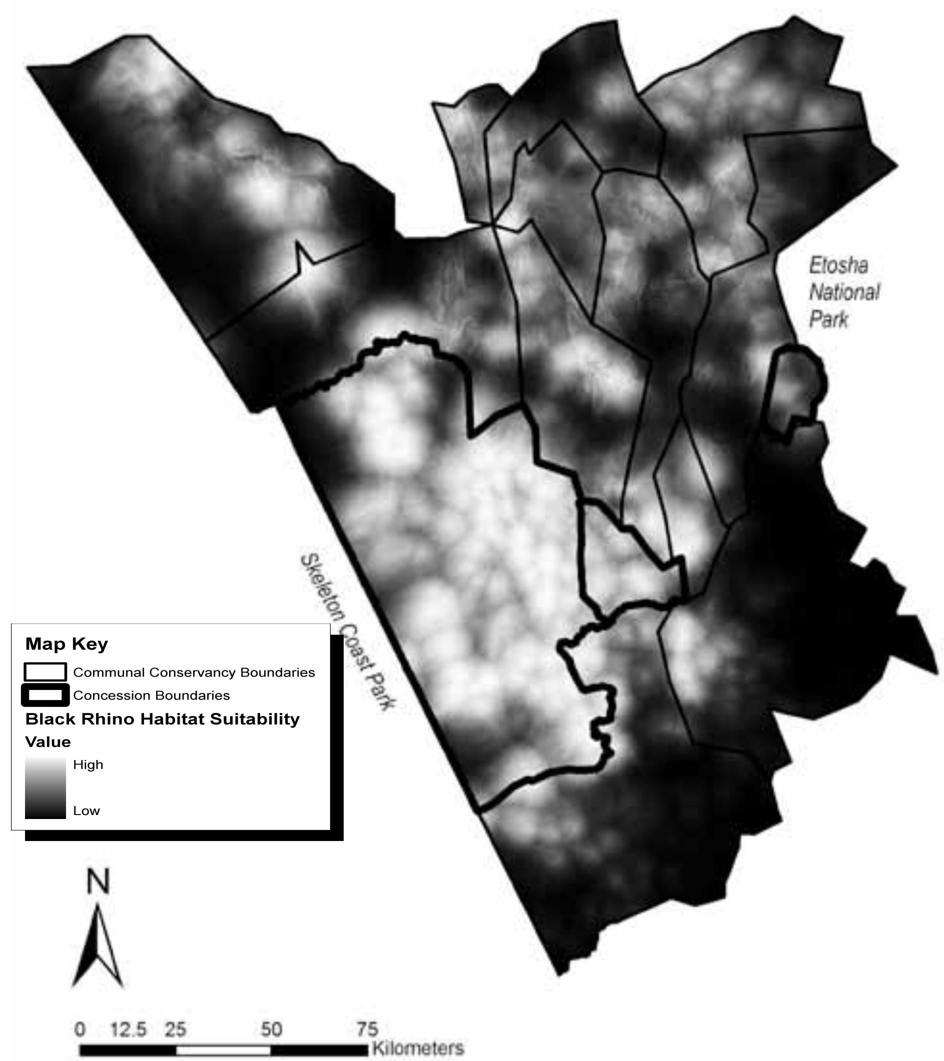
Black Rhino Habitat Suitability

Habitat Modeling Summary Statistics

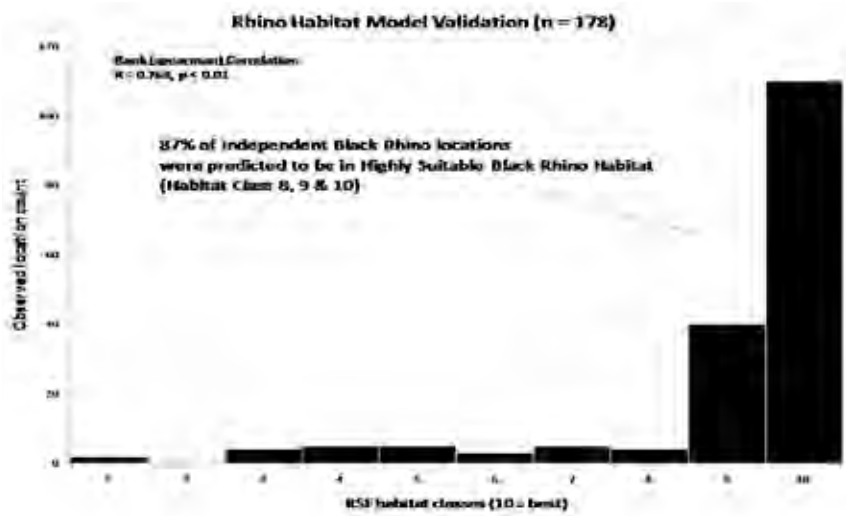
Variables in Model	β coefficient	Standard Error	R
Livestock Grazing Distribution Model	-2.7082	0.3875	-0.1807
Natural Water (path distance)	-2.00E-04	3.05E-05	-0.213
Natural Temp Water (path distance)	-1.00E-04	1.63E-05	-0.2274

Summary Table for Black Rhino Habitat Values

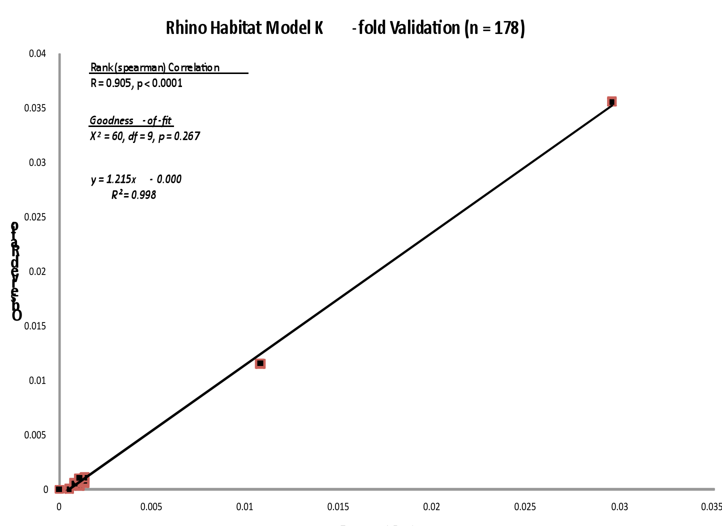
	NAME	AREA (ha)	MEAN	STD	SUM	Value/ha
Concession	*Hobatere*	25805.50	0.33	0.16	10400.90	0.40
	Etendeka	50780.60	0.72	0.14	43882.50	0.86
	Palmwag	577555.00	0.70	0.24	484832.00	0.84
Conservancy	*#Khoadi //Hoas*	334860.00	0.11	0.20	44185.80	0.13
	Omatendeka	161851.00	0.36	0.24	70940.50	0.44
	Ehirovipuka	197753.00	0.22	0.19	53208.40	0.27
	Puros	356134.00	0.31	0.27	132114.00	0.37
	Anabeb	156937.00	0.46	0.22	87099.90	0.55
	Ozondundu	74498.80	0.40	0.16	36408.60	0.49
	Otjambangu	34721.60	0.48	0.22	20194.70	0.58
	Sesfontein	246456.00	0.30	0.26	90666.20	0.37
	Okangundumba	113020.00	0.25	0.20	34035.40	0.30
	Orupupa	187848.00	0.41	0.19	93998.40	0.50
	Torra	348860.00	0.23	0.27	97682.40	0.28

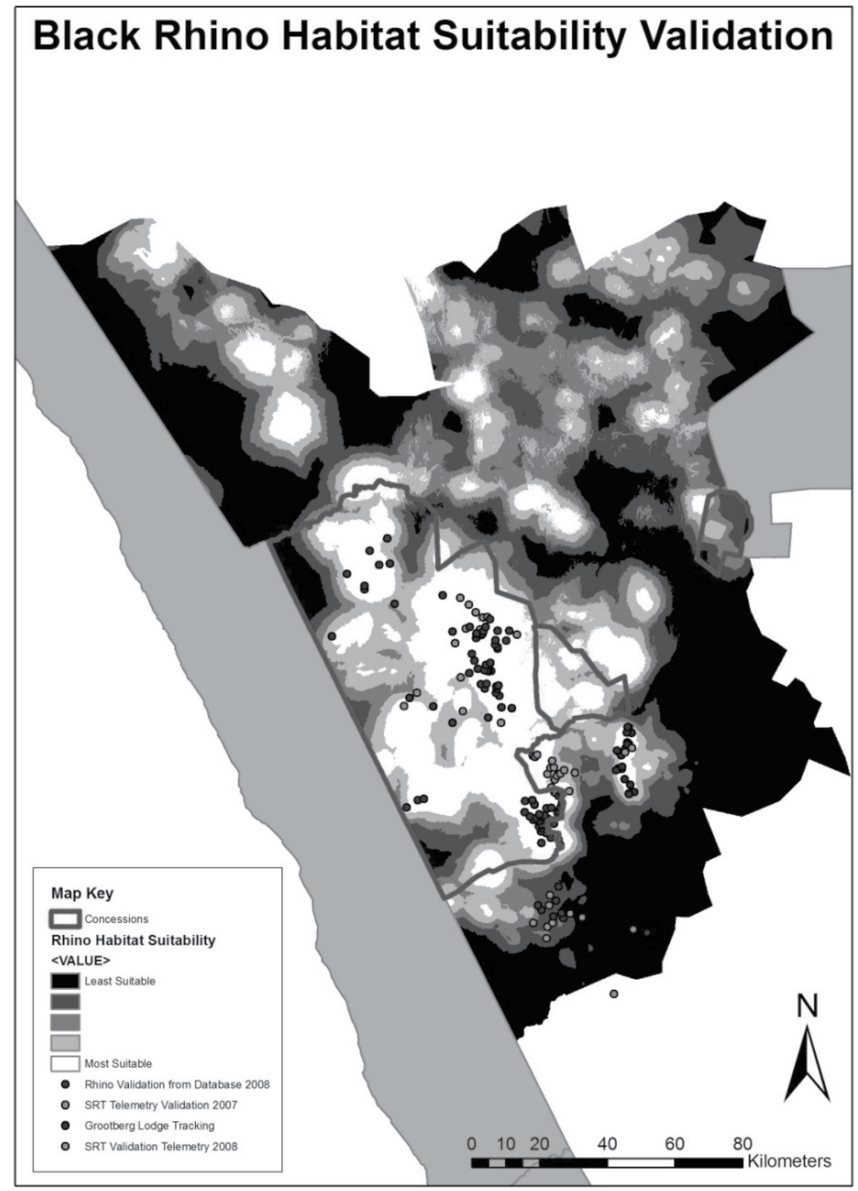


Black Rhino Model Validation



In order to assess whether or not the RSF model is approximately proportional to the probability of use, K-Fold Cross Validation is required. A model that meets this assumption has a slope different from 0 but not different from one, an intercept near 0, a high R2 value (spearman), and a non-significant X2 Goodness-of-fit value.





Focal Species Coverage

Free-ranging Kunene Wildlife and Livestock represented by mapped Elephant Habitat Classes

We assessed the additional coverage provided by modeling elephant habitat for other native, data-deficient species. We used location data collected by MET aerial surveys over the project site in 2005 and 2007. Nearly 6,000 independent locations for a suite of wildlife and livestock were recorded. As expected, a high number of elephant locations (64%) were found in areas predicted to be good elephant habitat (the upper 3 quantiles of elephant RSF model). Additionally, livestock (cattle, sheep and goats) each were found to be in the best elephant habitat more than 50% of the time. **Elephant habitat does not appear to be a very good surrogate for other large mammal representation in the region with low coverage probabilities.**

HIGH REPRESENTATION (%)	
Sheep & Goats	***69.9***
Cattle	***65.0***
Elephant	***51.9***
Ostrich	*40.7*
Giraffe	*35.3*
Springbok	*35.1*
Oryx	*29.0*
Black Rhino	*26.5*
Mountain Zebra	*25.3*

Legend
Highly Represented
Somewhat Represented
Poorly Represented

	Habitat Class	Springbok		Cattle		Black Rhino		Mountain Zebra		Giraffe		Sheep & Goats		Elephant		Oryx		Ostrich	
		Count	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
LOW	1	77	8.5	7	0.9	4	11.8	201	14.4	10	4.9	4	0.7	1	1.9	196	12.7	20	5.3
	2	33	3.7	4	0.5	4	11.8	60	4.3	5	2.5	3	0.5	4	7.4	77	5.0	18	4.8
	3	95	10.5	16	2.0	4	11.8	174	12.5	16	7.8	5	0.9	1	1.9	177	11.5	32	8.5
	4	78	8.7	23	2.9	6	17.6	156	11.2	19	9.3	15	2.7	5	9.3	172	11.2	31	8.2
MED	5	112	12.4	36	4.5	4	11.8	158	11.3	26	12.7	24	4.2	3	5.6	178	11.6	47	12.5
	6	116	12.9	80	10.0	2	5.9	159	11.4	31	15.2	39	6.9	7	13.0	158	10.3	36	9.6
	7	74	8.2	115	14.4	1	2.9	136	9.7	25	12.3	80	14.2	5	9.3	135	8.8	39	10.4
HIGH	8	97	10.8	149	18.6	3	8.8	143	10.2	19	9.3	99	17.5	5	9.3	122	7.9	39	10.4
	9	103	11.4	204	25.5	4	11.8	117	8.4	30	14.7	130	23.0	9	16.7	156	10.1	42	11.2
	10	116	12.9	167	20.9	2	5.9	93	6.7	23	11.3	166	29.4	14	25.9	168	10.9	72	19.1
	Total	**901**	**100**	**801**	**100**	**34**	**100**	**1397**	**100**	**204**	**100**	**565**	**100**	**54**	**100**	**1539**	**100**	**376**	**100**

Focal Species Coverage

Free-ranging Kunene Wildlife and Livestock represented by mapped Lion Habitat Classes

We assessed the additional coverage provided by modeling lion habitat for other native, data-deficient species. We used location data collected by MET aerial surveys over the project site in 2005 and 2007. Nearly 6,000 independent locations for a suite of wildlife and livestock were recorded. Like the elephant model, a high proportion (> 50%) of elephant, black rhino, mountain zebra and giraffe locations were found in areas predicted to be good elephant habitat (the upper 3 quantiles of elephant RSF model). Livestock (cattle, sheep and goats) were only found in good elephant habitat < 20% of the time. **Lion habitat seems to be a decent surrogate for other large mammal representation with 4 other native species above or near 50% coverage.**

Elephant	***64.8***
Black Rhino	***58.8***
Mountain Zebra	***52.0***
Giraffe	***51.0***
Springbok	*46.4*
Oryx	*36.7*
Ostrich	*33.2*
Sheep & Goats	*19.6*
Cattle	*17.4*

Highly Represented
Somewhat Represented
Poorly Represented

	Habitat Class	Springbok		Cattle		Black Rhino		Mountain Zebra		Giraffe		Sheep & Goats		Elephant		Oryx		Ostrich	
		Count	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
LOW	1	38	4.2	193	24.1	0	0.0	45	3.2	14	6.9	130	23.0	3	5.6	129	8.4	12	3.2
LOW	2	45	5.0	136	17.0	1	2.9	37	2.6	16	7.8	110	19.5	2	3.7	122	7.9	18	4.8
LOW	3	57	6.3	105	13.1	0	0.0	66	4.7	12	5.9	81	14.3	4	7.4	118	7.7	40	10.6
LOW	4	67	7.4	71	8.9	2	5.9	90	6.4	16	7.8	45	8.0	3	5.6	153	9.9	33	8.8
MED	5	65	7.2	57	7.1	3	8.8	102	7.3	9	4.4	29	5.1	2	3.7	105	6.8	52	13.8
MED	6	106	11.8	54	6.8	3	8.8	158	11.3	21	10.3	41	7.3	2	3.7	183	11.9	61	16.2
MED	7	105	11.7	45	5.6	5	14.7	172	12.3	12	5.9	18	3.2	3	5.6	164	10.7	35	9.3
HIGH	8	127	14.1	58	7.3	4	11.8	228	16.3	30	14.7	39	6.9	8	14.8	190	12.3	62	16.5
HIGH	9	162	18.0	46	5.8	10	29.4	278	19.9	37	18.1	41	7.3	7	13.0	214	13.9	33	8.8
HIGH	10	129	14.3	35	4.4	6	17.6	221	15.8	37	18.1	31	5.5	20	37.0	161	10.5	30	8.0
	Total	**901**	**100**	**800**	**100**	**34**	**100**	**1397**	**100**	**204**	**100**	**565**	**100**	**54**	**100**	**1539**	**100**	**376**	**100**

Focal Species Coverage

Free-ranging Kunene Wildlife and Livestock represented by mapped Black Rhino Habitat Classes

We assessed the additional coverage provided by modeling black rhino habitat for other native, data-deficient species. We used location data collected by MET aerial surveys over the project site in 2005 and 2007. Nearly 6,000 independent locations for a suite of wildlife and livestock were recorded. As expected, a high number of black rhino locations (85.3%) were found in areas predicted to be the best rhino habitat (the upper 3 quantiles of black rhino RSF model). Additionally, mountain zebra, springbok, giraffe, and oryx each were found to be in the best elephant best more than 50% of the time. It is interesting to note the excellent coverage that black rhino habitat appears to provide for key ungulate species such as mountain zebra and springbok. Livestock (cattle, sheep and goats) were only found in good elephant habitat < 5% of the time. **Black Rhino habitat appears to be a very good 'umbrella' for other native large mammal representation with 5 species above or near 50% coverage (particularly the endemic Mountain Zebra at 71%)**

HIGH REPRESENTATION (%)	
Black Rhino	***85.3***
Mountain Zebra	***70.9***
Springbok	***63.8***
Giraffe	***52.9***
Oryx	***50.6***
Ostrich	*44.7*
Elephant	*37.0*
Sheep & Goats	*3.9*
Cattle	*3.1*

	Habitat Class	Springbok		Cattle		Black Rhino		Mountain Zebra		Giraffe		Sheep & Goats		Elephant		Oryx		Ostrich	
		Count	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*	*Count*	*%*
LOW	1	60	6.7	412	51.5	0	0.0	14	1.0	22	10.8	324	57.3	4	7.4	94	6.1	35	9.3
	2	52	5.8	116	14.5	0	0.0	21	1.5	10	4.9	67	11.9	7	13.0	136	8.8	41	10.9
	3	34	3.8	64	8.0	0	0.0	40	2.9	6	2.9	43	7.6	3	5.6	123	8.0	21	5.6
	4	29	3.2	65	8.1	2	5.9	68	4.9	3	1.5	40	7.1	7	13.0	109	7.1	26	6.9
MED	5	38	4.2	48	6.0	0	0.0	78	5.6	16	7.8	34	6.0	2	3.7	63	4.1	35	9.3
	6	50	5.5	36	4.5	0	0.0	76	5.4	19	9.3	19	3.4	4	7.4	102	6.6	26	6.9
	7	63	7.0	35	4.4	3	8.8	109	7.8	20	9.8	16	2.8	7	13.0	133	8.6	24	6.4
HIGH	8	129	14.3	19	2.4	7	20.6	209	15.0	25	12.3	17	3.0	2	3.7	175	11.4	38	10.1
	9	190	21.1	5	0.6	6	17.6	298	21.3	40	19.6	3	0.5	7	13.0	269	17.5	64	17.0
	10	256	28.4	1	0.1	16	47.1	484	34.6	43	21.1	2	0.4	11	20.4	335	21.8	66	17.6
	Total	**901**	**100**	**801**	**100**	**34**	**100**	**1397**	**100**	**204**	**100**	**565**	**100**	**54**	**100**	**1539**	**100**	**376**	**100**

Ecological Land Units and Special Elements

Kunene People's Park Conservation Objectives

Maintain biodiversity and natural beauty, Conserve rare and endangered species

Limiting regional representation goals on individual or a suite of species' (focal species) protection requirements has been highly criticized due to the poor assumption that these species alone provide adequate coverage for full biodiversity representation. An additional technique that compliments focal species' potentially incomplete umbrella effect is to classify and map unique ecosystems. This approach makes the assumption that generally, unique species compositions will be linked closely to specific ecological communities or land units (ELUs). Another benefit of incorporating an ecosystem approach is the relative ease and accuracy (compared with acquiring useful information on data deficient species) of describing and mapping these ELU features due to the recent advances in remote sensing and availability of high resolution satellite imagery. Establishing representation goals that account for each unique ELU thus acts as a 'course filter' in the assessment process, capturing additional critical features that may have been missed by focal species representation alone. Additionally, characterizing and mapping ELUs allow easy adjustments in goals for specific classes that may be vital for rare and/or endemic species (special elements). For example, the flat top Etendeka mesas are known to be critical refugia for a diverse array of rare and endemic plants. Thus we can identify these areas by combining specific landscapes (Etendeka Lavas) and landforms (areas that are relatively high and flat) while also adjusting the representation goals for this extra important ELU class.

Based upon local informant recommendations and literature review, we created an ELU classification that included unique combinations of:

- Namibia's Landscapes (Atlas): Central Western Plains, Etendeka Plateau, Kalahari Sandveld, Kamanjab Plateau, Karstveld, Kunene Hills
- Geology (Atlas): Granite, Lavas and sandstone, Limestones and dolomites, rhyolites and sandstones, sands and calcrete, sandstones and shales, schists and dolomites
- Landforms (RRCS): Relatively low and flat, Relatively low and gentle slope, Relatively low and moderate slope, Relatively low and steep slope, Relatively high and flat, Relatively high and gentle slope, Relatively high and moderate slope, Relatively high and steep slope
- Rainfall (Atlas) (mm): 50 – 350 in six 50 mm interval classes
- Flow Accumulation (RRCS): 1 – 5 classes with 5 being the highest (main river channels – Hoanib)

This created 814 unique ELU classes or ecological communities across the project area illustrating the landscape diversity of the region.

Additionally, we utilized the Namibia's National Biodiversity Atlas and expert opinion (M. Griffin, personal communication) to extract rare and endemic birds, mammals, amphibians and reptiles that are believed to occur in the project area (see Appendix 1 & 2). The database also contained information regarding broad critical habitat classes that could be identified within the ELU classes. We also included 'mesa specialist' plants surveyed by Burke (2003) in the project area. These special elements were accounted for in various ELU classes.

Landscape Connectivity

Kunene People's Park Conservation Objective

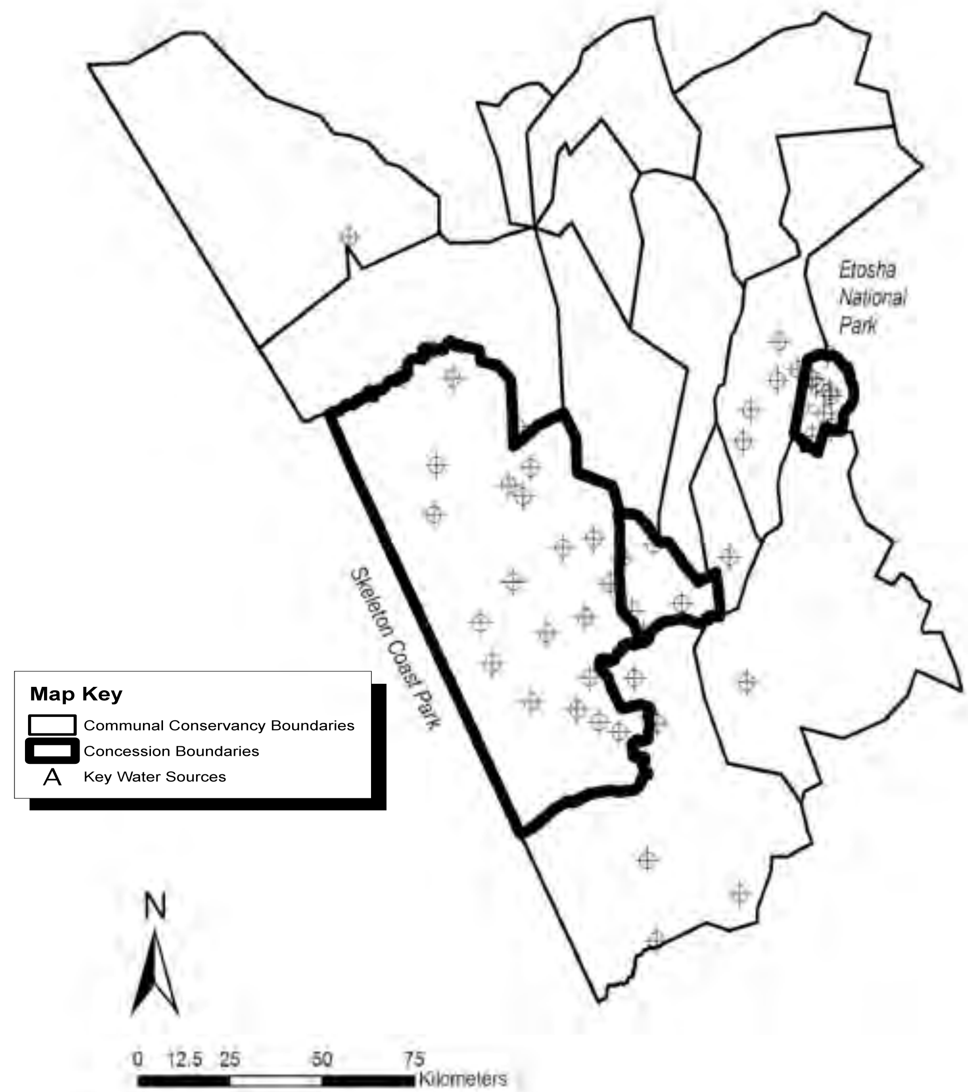
Provide a link between the Etosha National Park and Skeleton Coast Park and with neighboring conservancies

Analysis and Synthesis Objectives

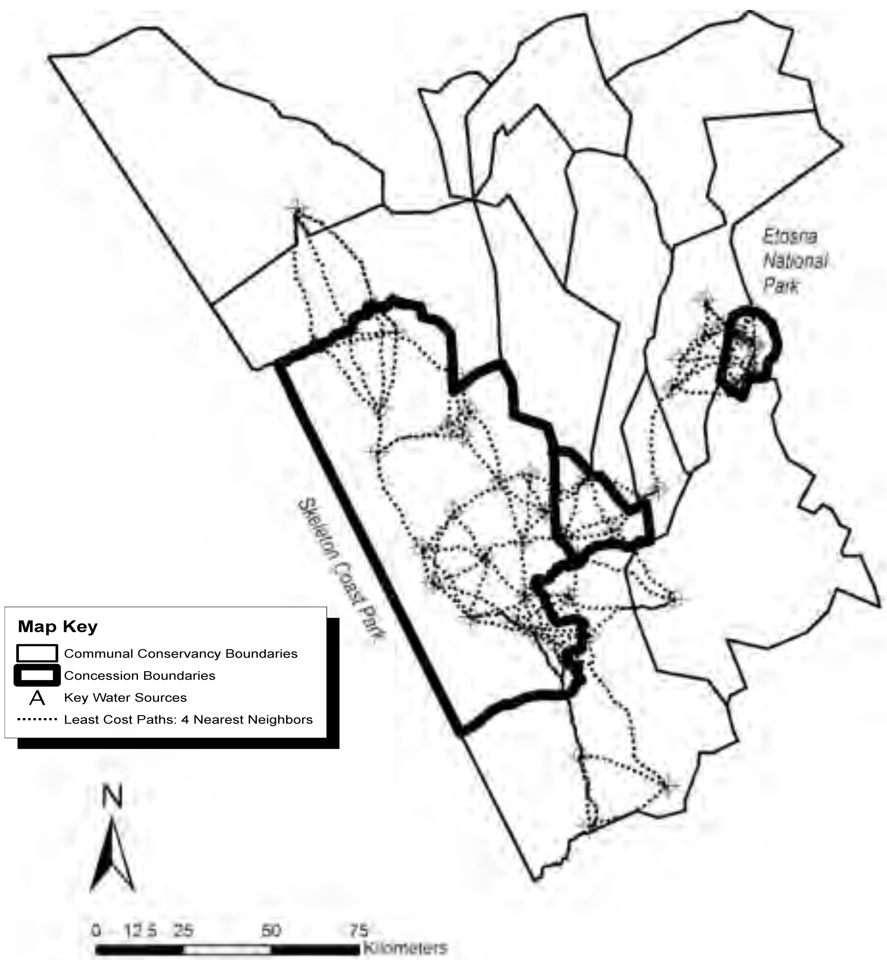
- Identify areas on the landscape that may be critical for maintaining local and regional-scale migration routes between key wildlife living areas or water sources in the region
- Integrate the connectivity values model into a regional ecological assessment as a key component to set representation goals for the project area

Modeling Approach: Defining regional-scale wildlife corridors

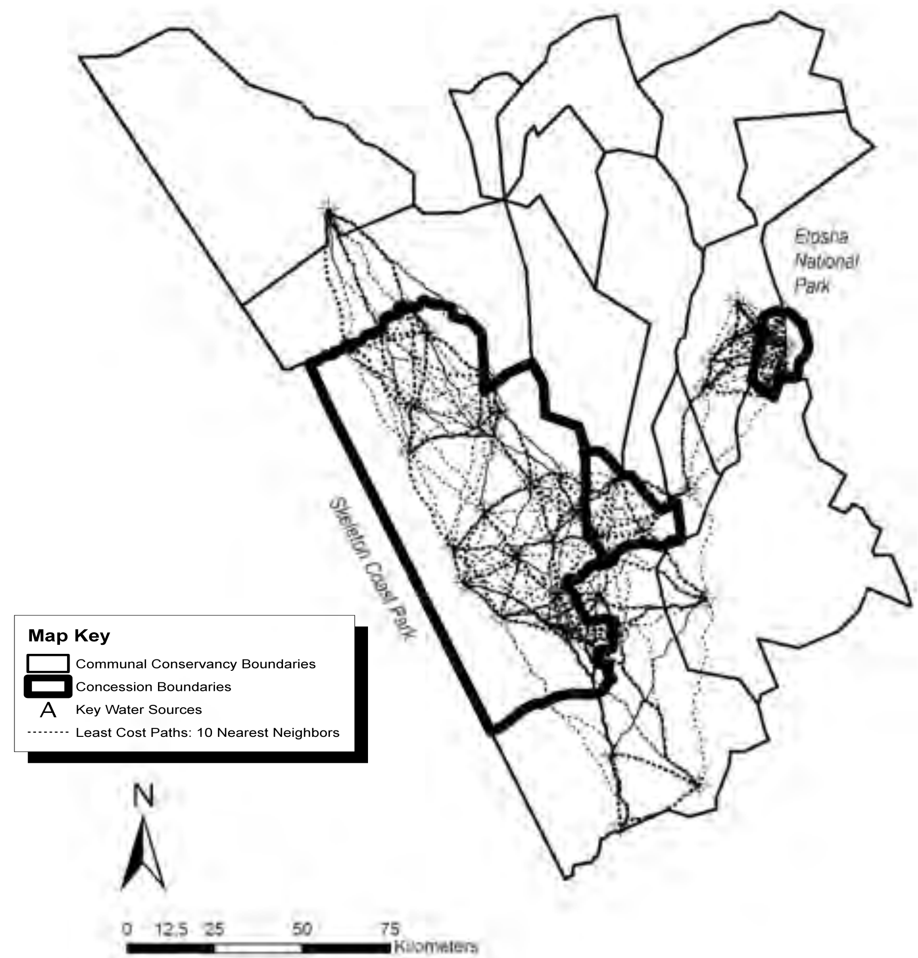
- Key water points identified by local informants were classified as 'source' locations from which connecting paths and corridors were generated using a customized ArcGIS global cost-path function.
- Least-cost paths in the model are defined as the paths that simultaneously minimize the actual distance travelled between source locations and amount of 'effort' expended to navigate the topography encountered along the path. The effort required to cross a specific parcel of land is expressed in the model as the relative steepness of slope given at any location. The model is parameterized such that relatively steeper slope incurs more travel cost than gentler slope.



Local Landscape Connectivity
Key Water to 4 Nearest Neighbours

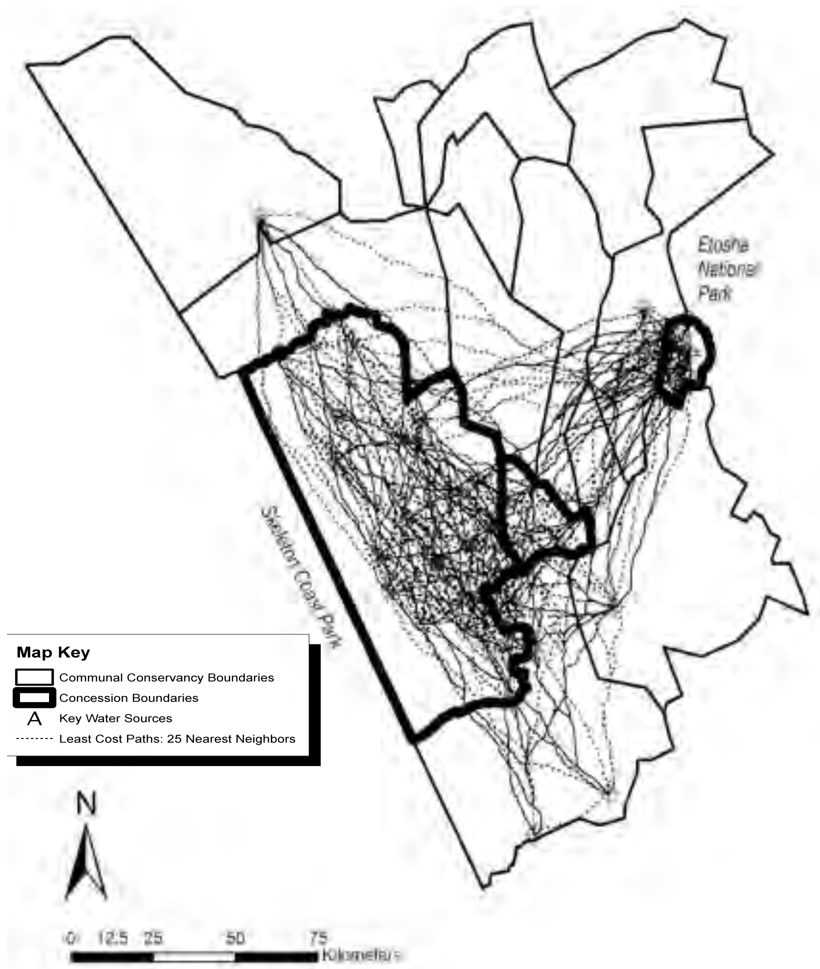


Mid-range Landscape Connectivity
Key Water to 10 Nearest Neighbours



Regional Landscape Connectivity

Key Water to 25 Nearest Neighbours

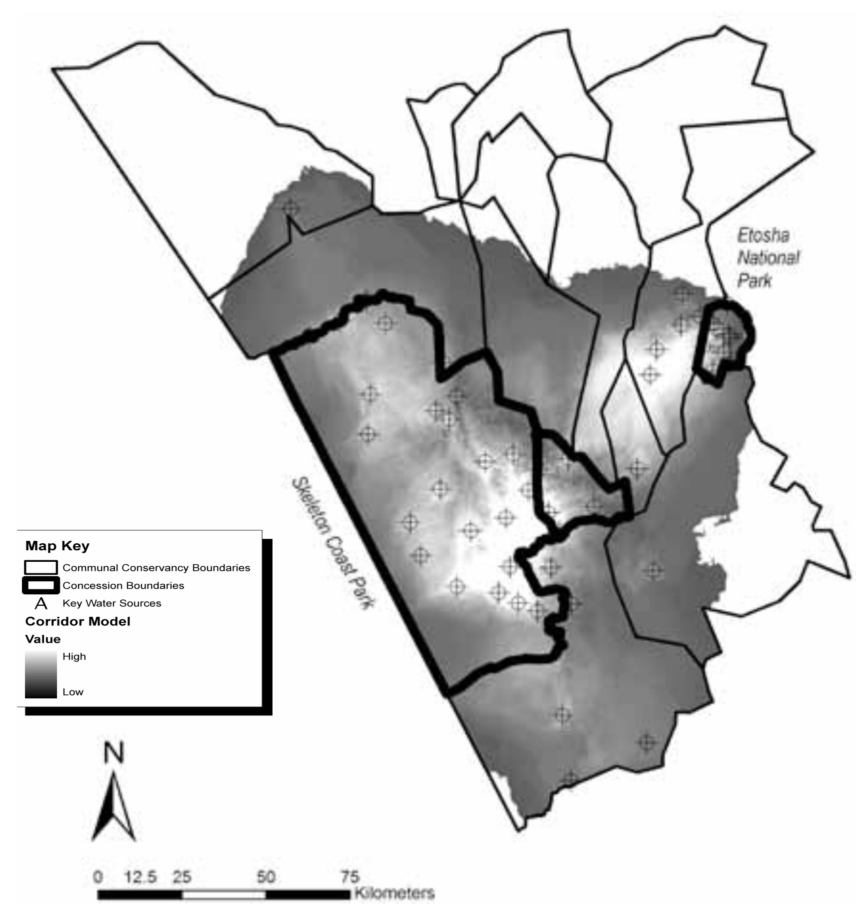


Landscape Corridors

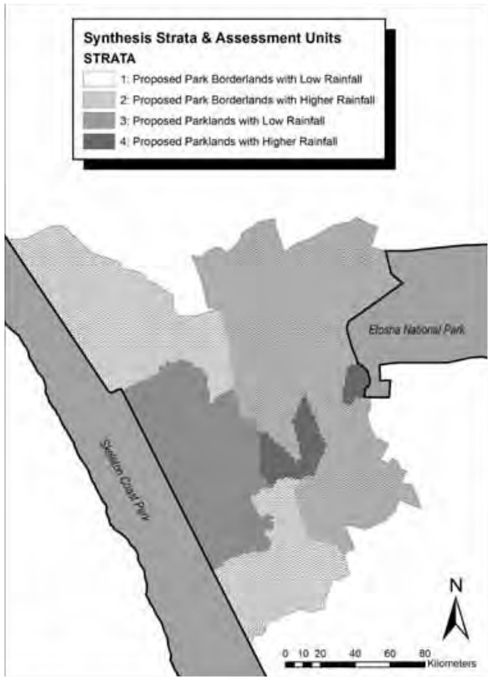
Defining regional-scale wildlife corridors

Corridor modeling identifies all areas between 2 sources that can be reached with equal or less effort as is recognized to travel the entire distance between the 2 sources.

All corridors are then summed spatially to produce a map that dipicts the numbers of unique modeled corridors that intersect each location in space.



Synthesis



	Planning Region	# of Planning Units	Total Area (ha)
	Proposed People's Park	**3584**	**716800**
	Conservancy	**11422**	**2284400**
Strata	Conservancy with lower rainfall	4928	985600
	Conservancy with higher rainfall	6495	1299000
	Proposed park with lower rainfall	2943	588600
	Proposed park with higher rainfall	640	128000
Planning Area	Palmwag	2943	588600
	Etendeka	250	50000
	Hobatere	147	29400
	Dispute Area	244	48800
	Torra	1808	361600
	#Khoadi //Hoas	1743	348600
	Anabeb	783	156600
	Sesfontein	1253	250600
	Purros	1867	373400
	Omatendeka	810	162000
	Ehirovipuka	1022	204400
	Okangundumba	586	117200
	Ozondundu	370	74000
	Orupupa	980	196000
	Otjambangu	199	39800

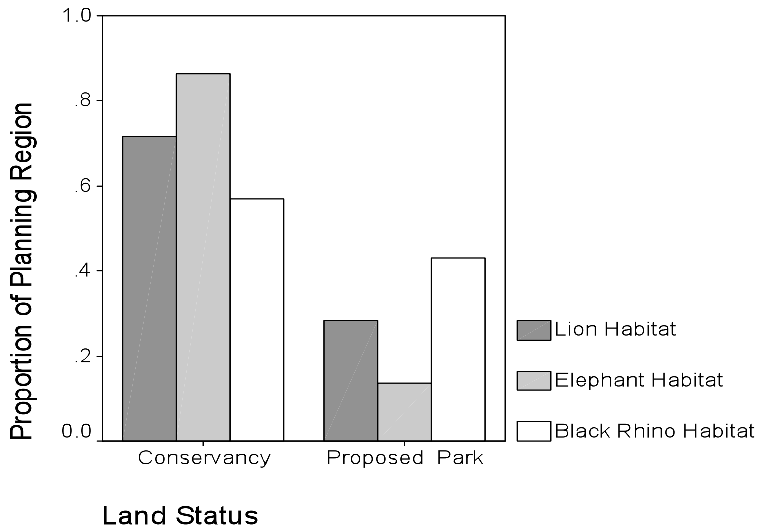
Conservation and Social Value Summaries

Each map product and summary information for focal species, connectivity and ecological land units/special elements described above attempts to address the various conservation and social objectives endorsed and stated above for the Kunene People's Park. Each are thus useful in and of themselves. However, because each of these components and objectives ultimately compliment each other by combining both biodiversity pattern (focal species, ELU) and process (connectivity) to achieve overall biodiversity conservation, it is critical to also integrate each into a synthesis that can provide decision-makers with a suite of broader conservation options across the landscape. These conservation options should be characterized and evaluated by a specified set of measurable goals.

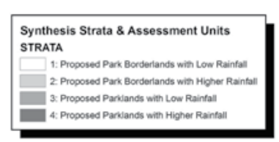
Once all the ecological and social feature data were assembled, the first step in the synthesis process requires packaging these features in assessment units or 'planning units' across a defined 'planning region'. Our planning region consisted of 15,006 planning units which were 200 ha each in size for a total of 3,001,200 ha. The planning region was further stratified to enable separation and comparisons across and between 1) Two 'Land Status' categories – proposed parklands or conservancy lands, 2) Four Land Status and Rainfall categories – land status + lower or higher rainfall, 3) Eight Planning Areas – individual conservancies and current concessions. Producing various levels of stratification also allowed more conservation options to be explored during the representation analysis since the users could set more unique combinations of representation goals across the planning region. It also illustrates where conservation and social value priorities exist at multiple potential planning scales across the landscape. These are mapped and summarized below. Summary descriptive statistics are presented below for each level of stratification that illustrate comparisons for:

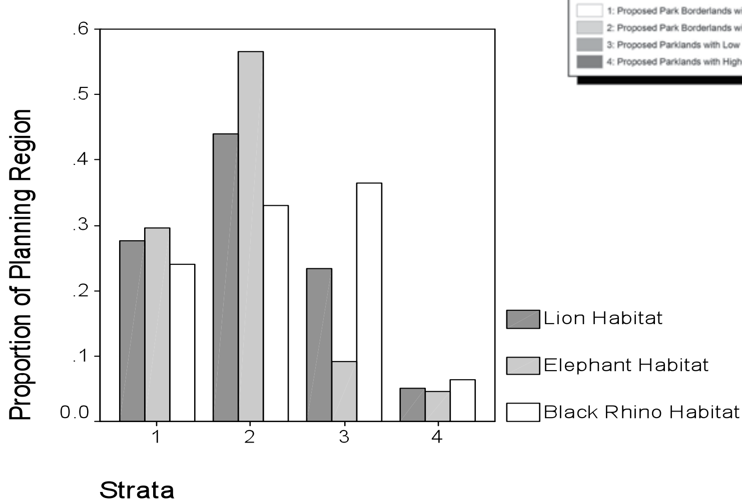
1. Overall area across the planning region
2. Overall amount of focal species habitat
3. Overall Ecological Land Unit diversity and density
4. Overall amount of social values (seasonal livestock distribution)

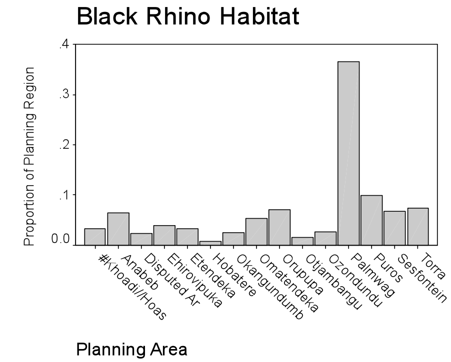
Overall amount (proportion) of focal species habitat across the Planning Region by 1) Land Status, 2) Strata and 3) Planning Area.

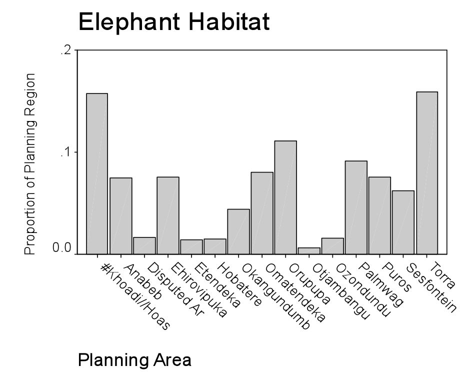


Although the density of focal species habitat is higher in the proposed parklands, the majority of Focal Species Habitat for the entire Planning Region lies in the adjacent conservancy areas.

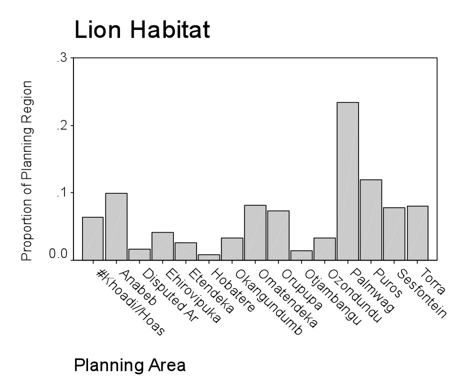






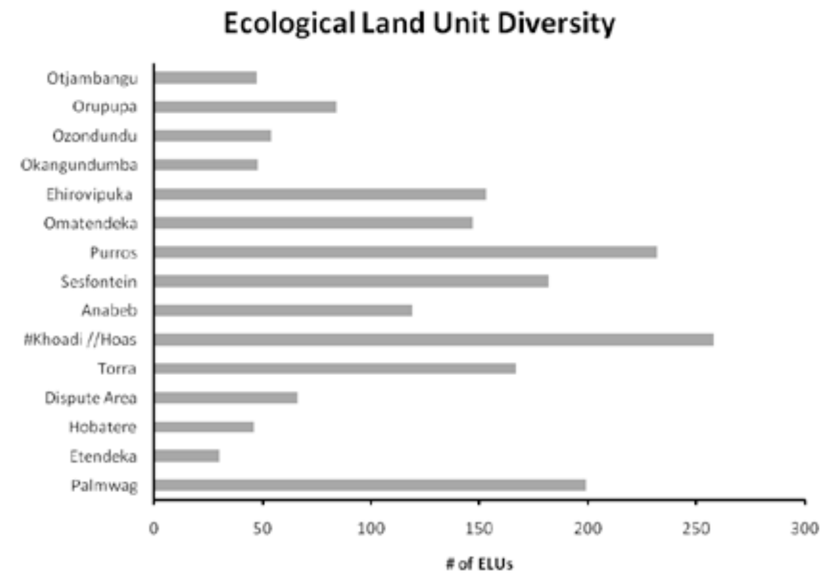


Palmwag provides critical core breeding areas and refugia for the Kunene's Desert Black Rhino. #Khoadi //Hoas & Torra conservancy contain the bulk of key Elephant Habitat. The highest amount of Lion Habitat is represented within Palmwag and Purros.

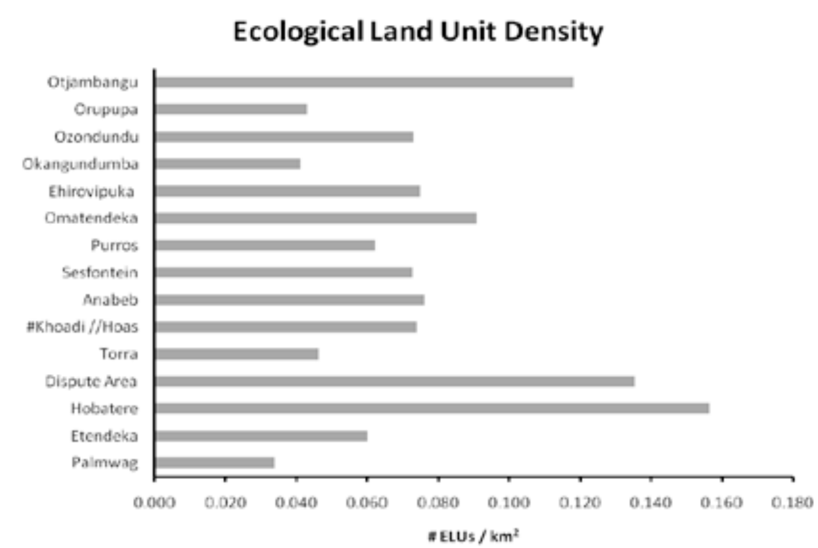


Overall diversity and density of Ecological Land Units across the Planning Region by 1) Land Status, 2) Strata, and 3) Planning Area.

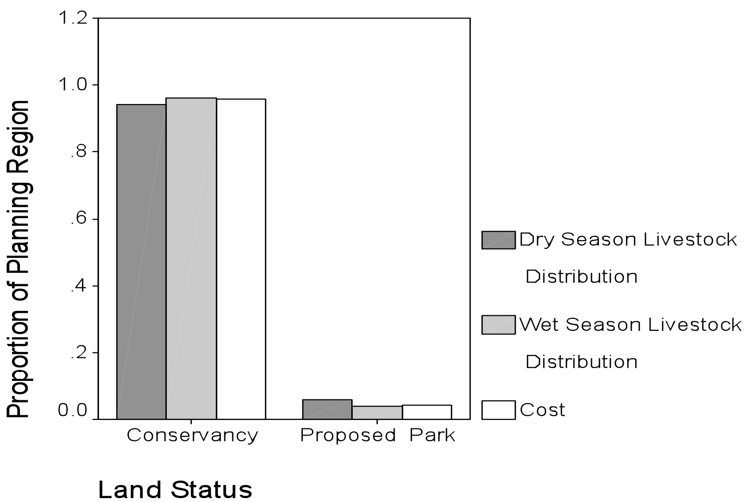
	Planning Region	# of ELU Classes	Total Area (km2)	ELU Density (/km2)
	TOTAL	**814**	**30012**	**0.027**
	Proposed People's Park	**289**	**7168**	0.040
	Conservancy	**791**	**22844**	0.035
Strata	Conservancy with lower rainfall	409	9856	0.041
Strata	Conservancy with higher rainfall	473	12990	0.036
Strata	Proposed park with lower rainfall	199	5886	0.034
Strata	Proposed park with higher rainfall	124	1280	0.097
Planning Area	Palmwag	199	5886	0.034
Planning Area	Etendeka	30	500	0.060
Planning Area	Hobatere	46	294	0.156
Planning Area	Dispute Area	66	488	0.135
Planning Area	Torra	167	3616	0.046
Planning Area	#Khoadi //Hoas	258	3486	0.074
Planning Area	Anabeb	119	1566	0.076
Planning Area	Sesfontein	182	2506	0.073
Planning Area	Purros	232	3734	0.062
Planning Area	Omatendeka	147	1620	0.091
Planning Area	Ehirovipuka	153	2044	0.075
Planning Area	Okangundumba	48	1172	0.041
Planning Area	Ozondundu	54	740	0.073
Planning Area	Orupupa	84	1960	0.043
Planning Area	Otjambangu	47	398	0.118



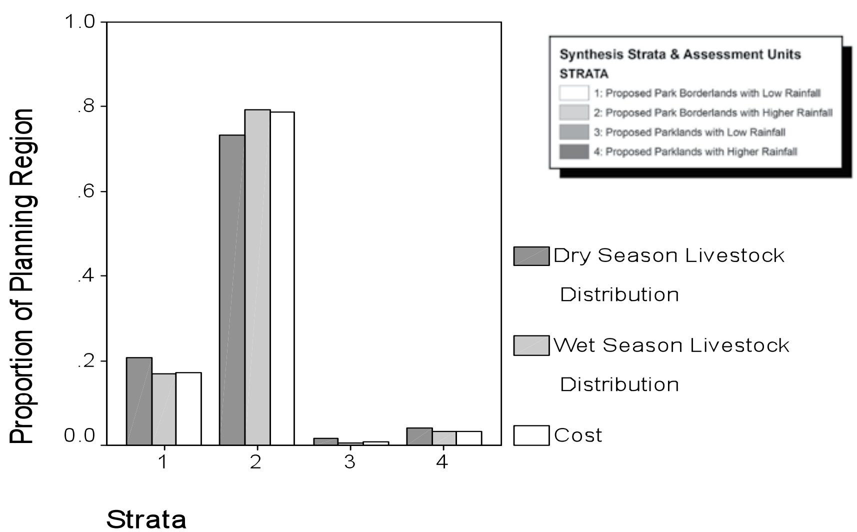
#Khoadi //Hoas has the highest level of ELU diversity across the Planning Region, followed by Purros and Palmwag. Yet, Hobatere and the Dispute Area hold the highest ELU density.

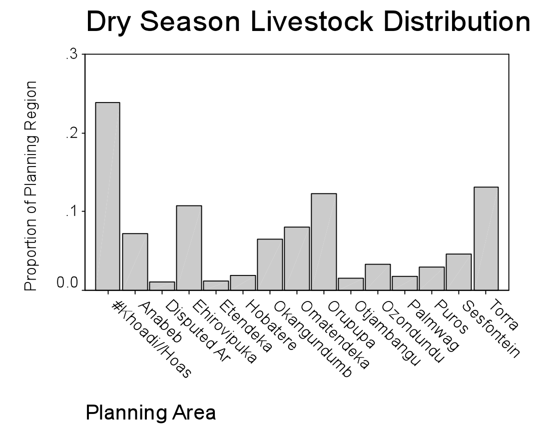


Overall Social Values (Dry and Wet Season Grazing Distribution and Overall Cost) across the Planning Region by 1) Land Status, 2) Strata, and 3) Planning Area.

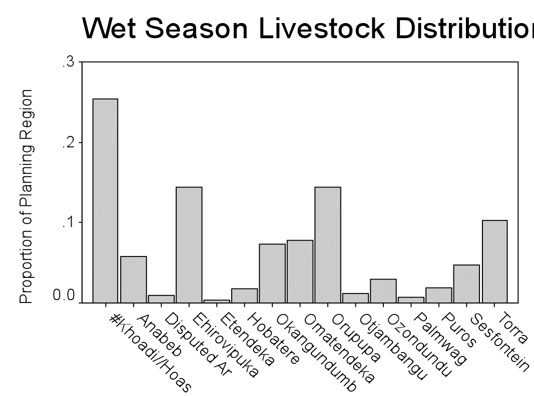


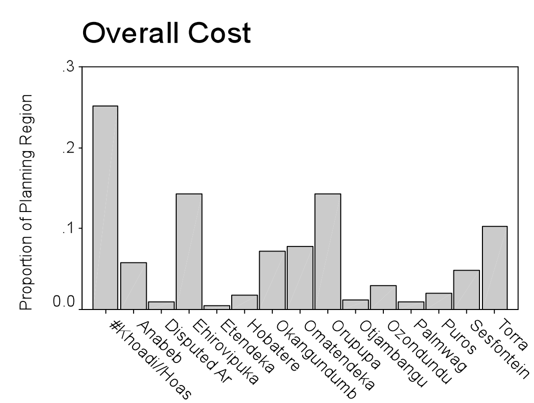
Very little livestock grazing currently is predicted to occur in the Proposed Park Area. The vast majority of dry and wet season grazing (and overall cost) currently exists in the Park Borderlands with > 150mm of annual rainfall.





#Khoadi //Hoas sustains the majority of livestock distribution for both dry and wet seasons relative to the other Planning Areas.





Representation Analysis: Assessing Conservation Options

A series of marxan solutions (areas that achieve specified conservation & social goals as defined in the methods) were run to illustrate the utility of the approach as well as enable decision-makers to identify areas across the planning region that are relatively more/less critical for maintaining both the conservation and social objectives for the proposed park and surrounding conservancy lands. These included identifying and comparing solutions for specific representation goals of conservation values (i.e. 30% and 50% representation goals), as well as combining multiple solutions across a range of goals as an approach to identify and prioitize core conservation and social value areas across the landscape to inform land use planning.

Here, we first present the most efficient solutions for 30, 50, and 70% representation goals as well as the associated planning unit selection frequency score (how many times out of 100 solutions each planning unit was selected as part of the optimal solution) for each set of solutions under each goal. The solutions for the 30% representation goals can be interpreted as the most critical areas to maintain minimal biodiversity representation, whereas solutions for 50 and 70% highlight additional areas that contribute to or buffer these more critical areas. When assessed spatially, some clear priority areas across different scales within the planning region emerge. At the broadest scale (Land Status), the proposed People's Park contains over 50% of the selected area needed to maintain the minimal (30% representation) goal for conservation values even though it constitutes less than 1/3 of the area within the Planning Region. However, as the representation goals increase, the conservancy lands become relatively much more critical in maintaining conservation goals. For example, to achieve 70% representation goals, the proposed People's Park contains only 30% of the selected area. At a finer scale (Planning Area), the majority of area identified for minimal representation goals appear to be contained within Palmwag, Torra, and #Khoadi //Hoas which also appears to hold constant as representation goals increase, except for Puros becoming relatively more critical for maintaining higher representation goals. Planning unit selection frequencies for 30, 50 and 70% representation goals, as described in the methods, are also mapped below.

Additionally, key conservation areas that remain in conflict (spatial overlap) with mapped livestock distribution (even though an important goal in the representation analysis also included minimized conflict), are identified below. This summary information can assist decision-makers, both regional and local, in determining where critical conservation values persist across the planning region, as well as important buffer areas. Through assessing the relative contributions towards maintaining representation goals by different planning areas across different scales, conservation action and targeted conservation planning efforts could be priorities accordingly.

Area selected (ha) in most efficient solution to achieve...

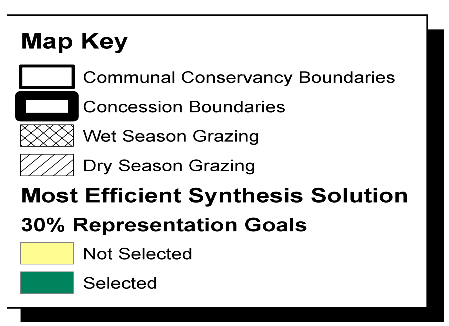
	Planning Region	30% representation	50% representation	70% representation
	TOTAL	**955000**	**1428800**	**1984200**
	Proposed People's Park	**341000**	**431200**	544200
	Conservancy	**614000**	**997600**	1440000
Strata	Conservancy with lower rainfall	248600	417600	629600
	Conservancy with higher rainfall	365400	580000	810400
	Proposed park with lower rainfall	274600	344000	443800
	Proposed park with higher rainfall	66400	87200	100400
Planning Area	#Khoadi //Hoas	102200	167200	238000
	Anabeb	64400	94400	126800
	Disputed Area	18200	31400	37600
	Ehirovipuka	47000	72200	95600
	Etendeka	32800	38200	43000
	Hobatere	15400	17600	19800
	Okangundumba	28400	46000	68800
	Omatendeka	64200	98000	130800
	Orupupa	30800	50000	76200
	Otjambangu	5800	15000	24800
	Ozondundu	22600	37200	49200
	Palmwag	274600	344000	443800
	Puros	42400	112800	214400
	Sesfontein	97200	131200	185000
	Torra	109000	173600	230200

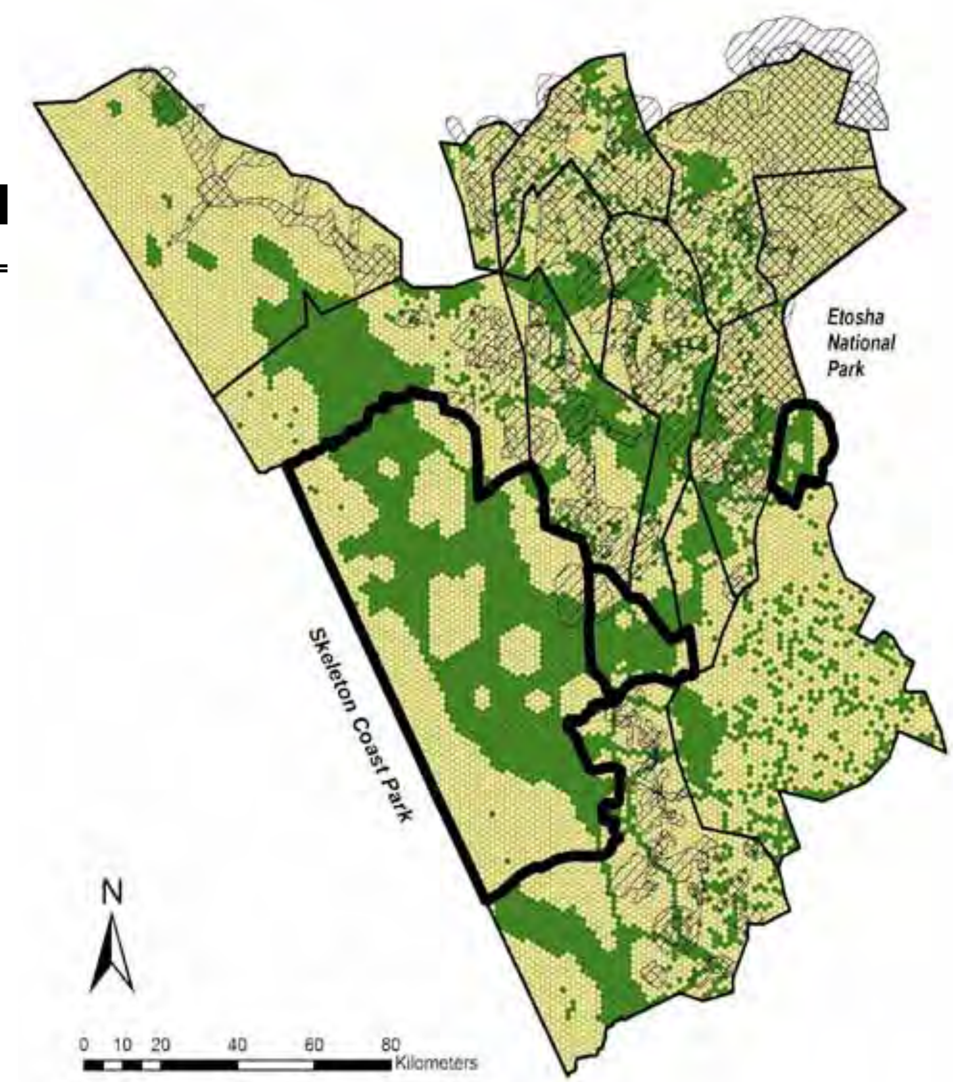
30% Overall Representation Synthesis Scenario
'most efficient solution'

- **30% Representation of all Conservation features across each Strata**
- **Solution which met all representation goals with the least amount of cumulative cost (such as overlap with livestock distribution, least amount of fragmentation, etc.)**

Predicted Spatial Interactions of Representation Goals and Livestock Distribution

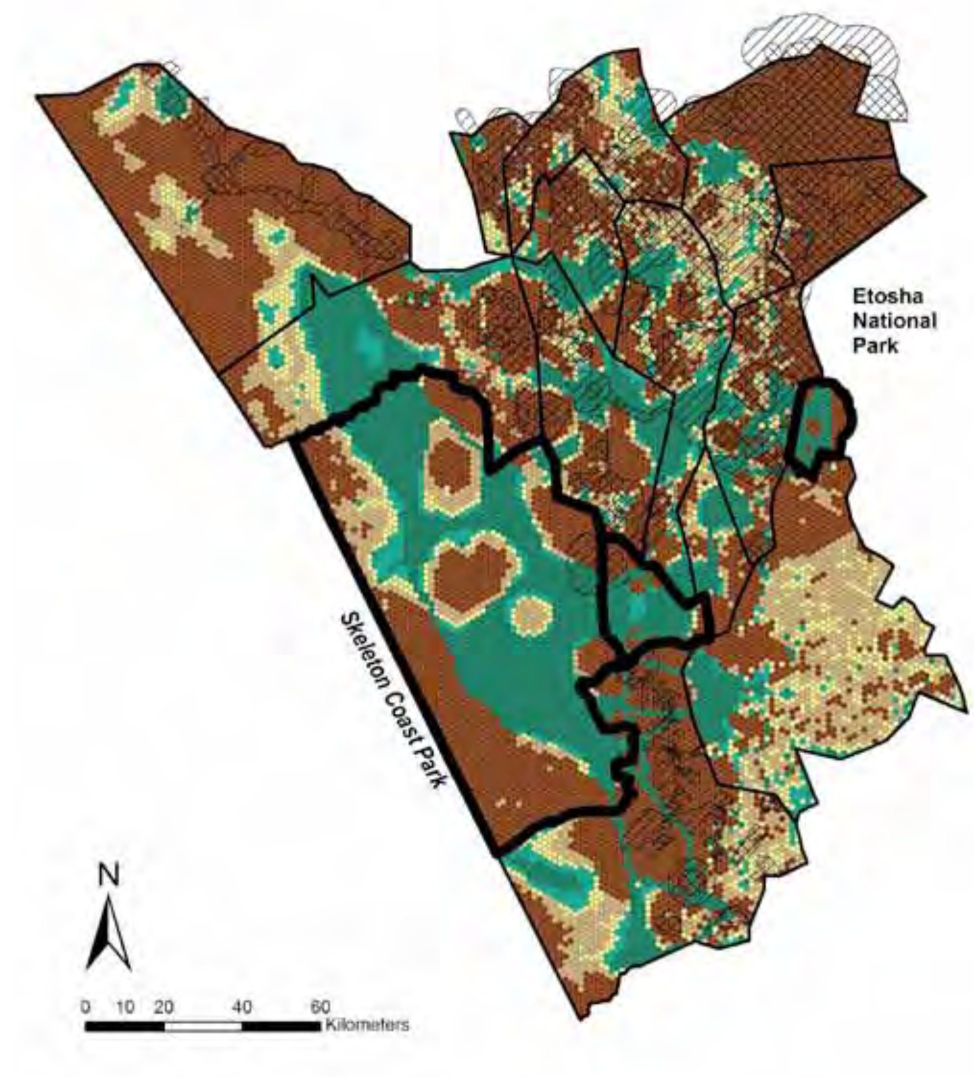
Location	*Season*	*Rainfall*	*% Overlap*
Borderlands	Dry	Dry	16.7
Borderlands	Dry	Wet	21.6
Park	Dry	Dry	27.2
Park	Dry	Wet	43.4
Borderlands	Wet	Dry	16.2
Borderlands	Wet	Wet	17.9
Park	Wet	Dry	16.9
Park	Wet	Wet	43.0
Borderlands	Annual	Dry	16.1
Borderlands	Annual	Wet	17.0
Park	Annual	Dry	18.9
Park	Annual	Wet	45.0





30% Overall Representation Synthesis Scenario

- **30% Representation of all Conservation features across each Strata**
- **Minimized Conflict with Livestock Grazing**
- **Count the number of times each assessment unit was selected out of 100 runs as part of the most 'efficient solution'**
- **Divided into 5 Rankings**

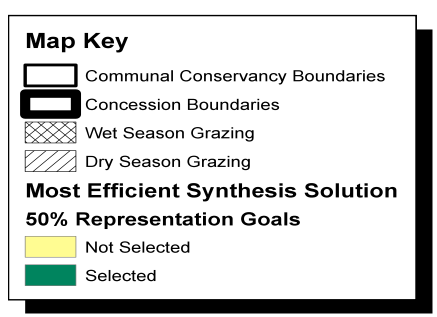


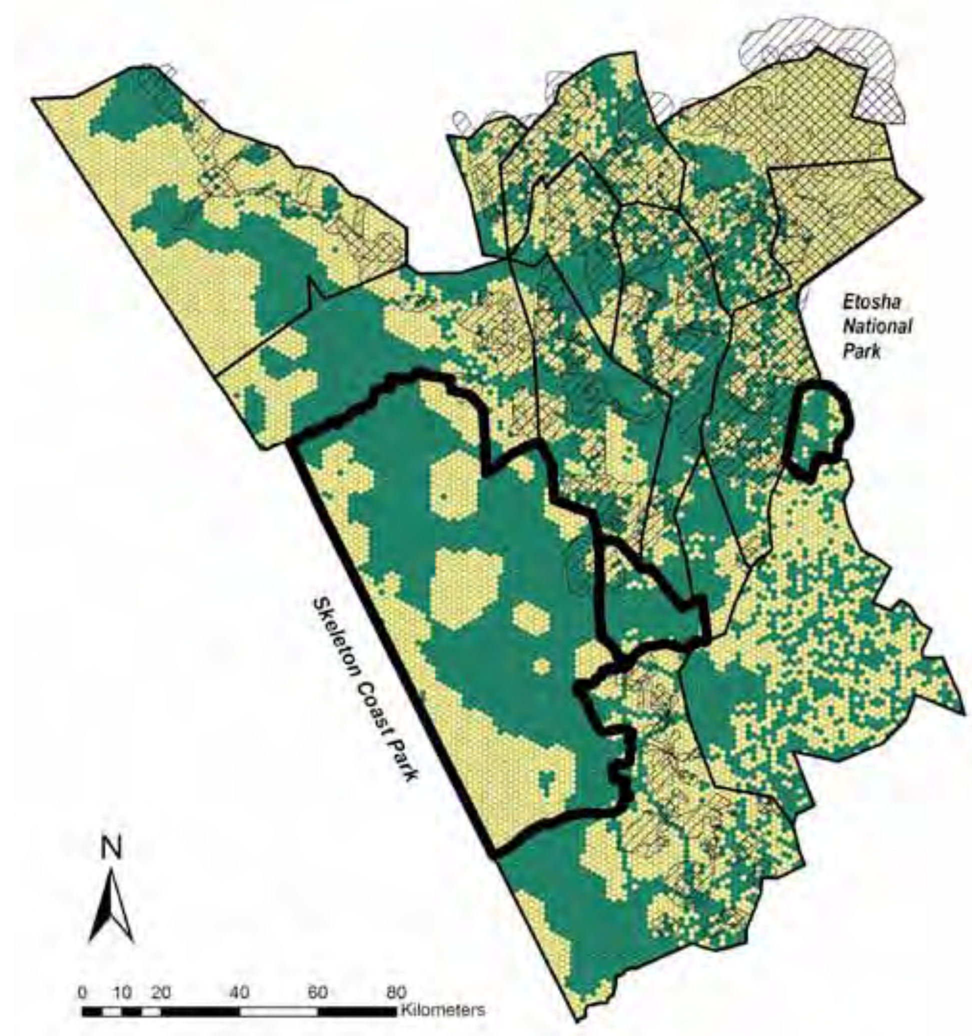
50% Overall Representation Synthesis Scenario
'most efficient solution'

- 50% Representation of all Conservation features across each Strata
- Solution which met all representation goals with the least amount of cumulative cost (such as overlap with livestock distribution, least amount of fragmentation, etc.)

Predicted Spatial Interactions of Representation Goals and Livestock Distribution

Location	*Season*	*Rainfall*	*% Overlap*
Borderlands	Dry	Dry	26.9
Borderlands	Dry	Wet	37.9
Park	Dry	Dry	41.4
Park	Dry	Wet	55.3
Borderlands	Wet	Dry	24.9
Borderlands	Wet	Wet	33.5
Park	Wet	Dry	20.6
Park	Wet	Wet	51.6
Borderlands	Annual	Dry	24.0
Borderlands	Annual	Wet	32.5
Park	Annual	Dry	21.2
Park	Annual	Wet	51.2



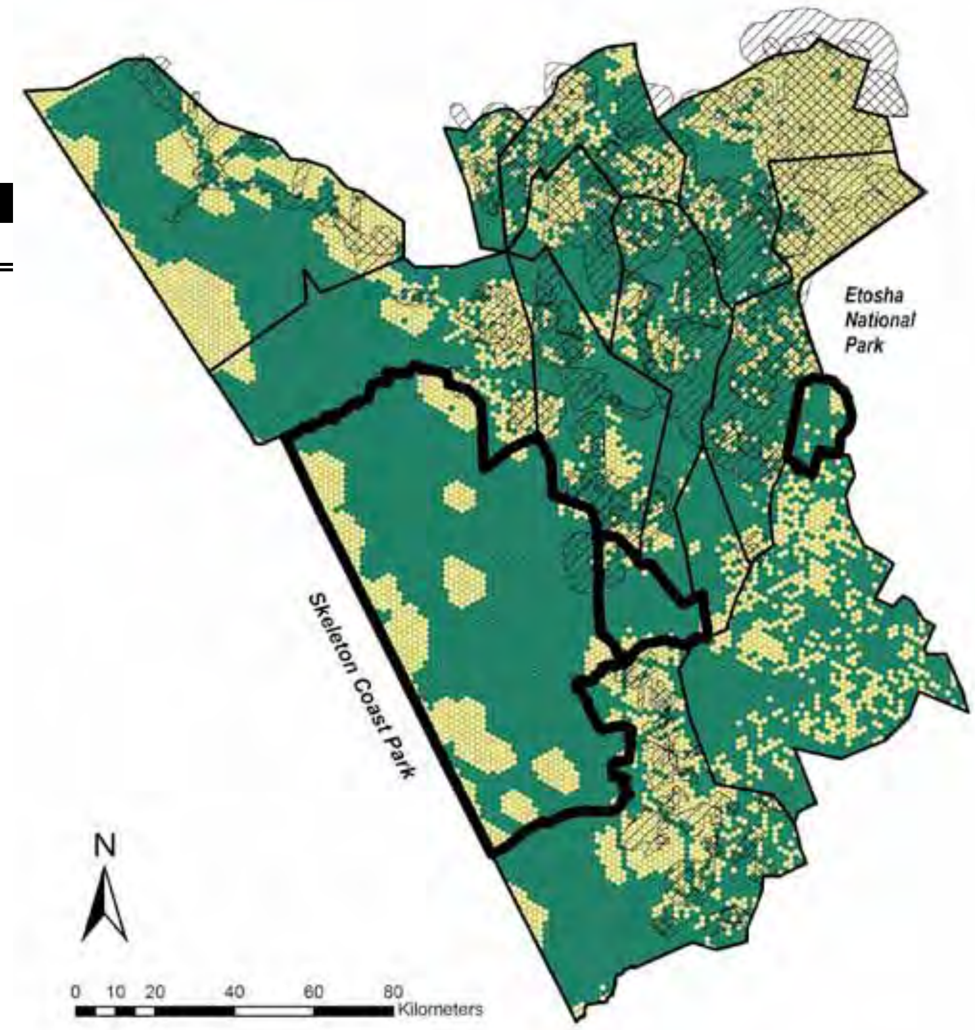


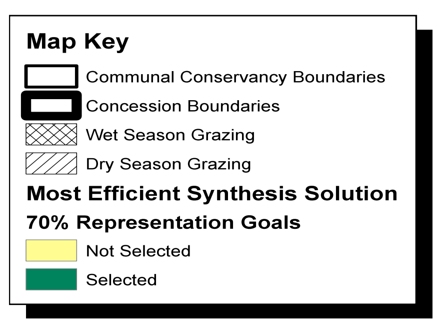
70% Overall Representation Synthesis Scenario
‘most efficient solution’

- 70% Representation of all Conservation features across each Strata
- Solution which met all representation goals with the least amount of cumulative cost (such as overlap with livestock distribution, least amount of boundary length, etc.)

Predicted Spatial Interactions of Representation Goals and Livestock Distribution

Location	*Season*	*Rainfall*	*% Overlap*
Borderlands	Dry	Dry	41.9
Borderlands	Dry	Wet	57.3
Park	Dry	Dry	54.3
Park	Dry	Wet	65.3
Borderlands	Wet	Dry	38.5
Borderlands	Wet	Wet	52.9
Park	Wet	Dry	23.4
Park	Wet	Wet	59.8
Borderlands	Annual	Dry	36.0
Borderlands	Annual	Wet	52.1
Park	Annual	Dry	22.0
Park	Annual	Wet	57.3





70% Overall Representation Synthesis Scenario

- 70% Representation of all Ecological Values across each Strata
- Minimized Conflict with Livestock Grazing
- Count the number of times each assessment unit was selected out of 100 runs as part of the most ‘efficient solution’
- Divided into 5 Rankings

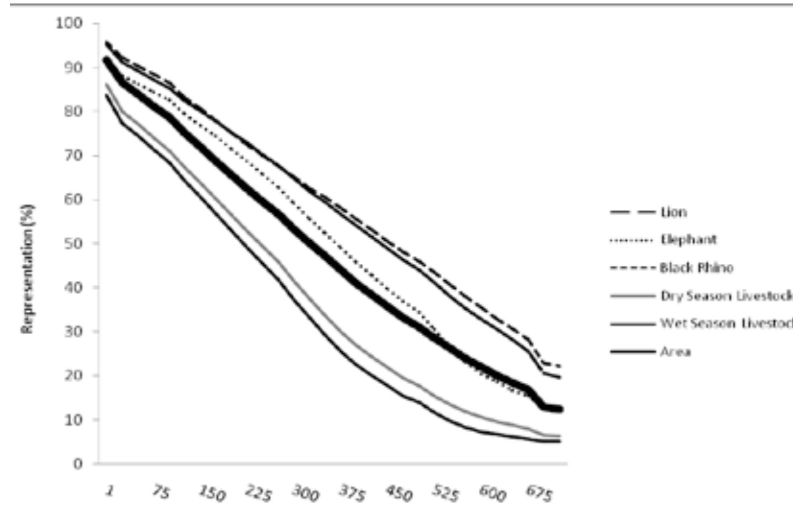
Cumulative Conservation Value (CCV) Index: a Threshold Analysis

Summarizing conservation and social values across the landscape for individual representation goal scenarios is useful. Yet, very few situations exist where enough quality data is available that can shed light on just how much representation is enough to achieve long term conservation goals. One approach that attempts to address this problem without becoming entangled in the 'how much is enough' debate, is to integrate a suite of representation scenarios that ranges from relatively low to high representation goals. This can be accomplished by combining the overall selection frequencies (x of 100) for each planning unit across multiple representation scenarios. In other words, instead of having one option that defines one representation goal, we can combine a suite of near optimal scenarios across multiple goals that quantifies how many times each planning unit was selected as being part of the near optimal solution for a range of representation goals. This can be interpreted as a 'cumulative conservation value index'. Planning units that are selected relatively more across the region and across multiple representation scenarios can be thought of as being relatively more important for meeting conservation goals or more irreplaceable.

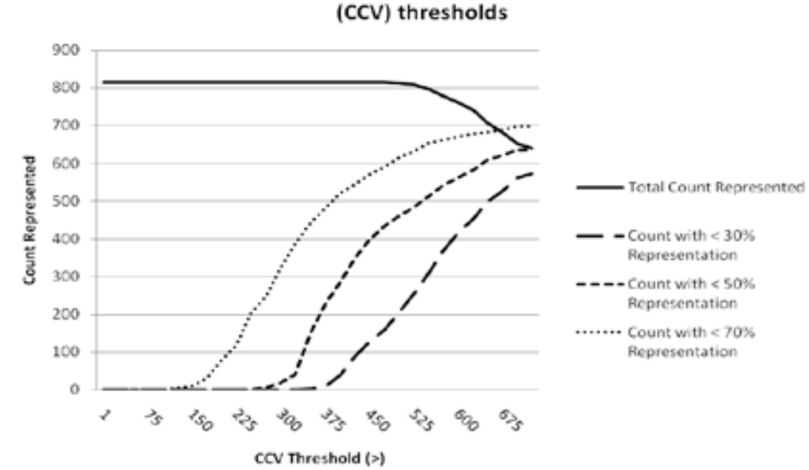
Once Marxan has counted the number of times each assessment unit was selected as part of the 'near optimal' solution under the established biodiversity representation goals and cost factors, further analysis can refine how to threshold the selection frequency gradient to characterize a suite of CCV classes that represent conservation 'hotspots' or 'core' conservation areas, key buffer zones, and areas where social values can be maintained with minimal conflict with conservation. One approach is to explore at what CCV cut-levels retain a gradient of acceptable representation goals for your conservation values with minimal conflict with social values. Moreover, these classes may form the transitional product from the assessment to regional and local planning activities.

We chose to threshold the CCV index into two classes that maintained relatively higher leveles of conservation or biodiversity representation and two classes that maintained higher levels of social values (such as traditional land use for livestock). This dualistic approach seemed reasonable and strategic since land use compatibility and resulting benefits from key emerging and traditional livelihoods in the region, mainly the emerging premium tourism market and traditional livestock grazing would be maximized for stakeholders (communities, government, private investors). This concept is elaborated on in the Discussion Section.

Our highest conservation priority class or 'conservation cores' were all planning units that that were needed to maintain a minimum of 30% representation for all focal species (1a) and had each ELU represented (1b) when selection frequencies where merged across all scenarios (20-80%). To maintain these goals for both focal species and ELUs, we found we needed to include each planning unit that was selected 525 times or greater out of 700. These areas may be considered 'core conservation areas'. The next class would identify additional planning units that would be needed to maintain 50% of focal species habitat (2a) and where each ELU had a minimum of 30% area representation (2b). We found this threshold to be planning units that were selected 350 or more times out of 700. These additional areas may be considered conservation buffer areas.



ELU Class Representation by Cummulative Conservation Value (CCV) thresholds

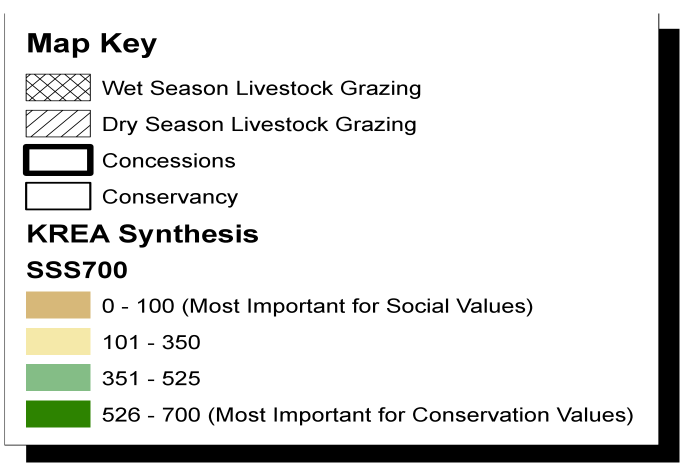


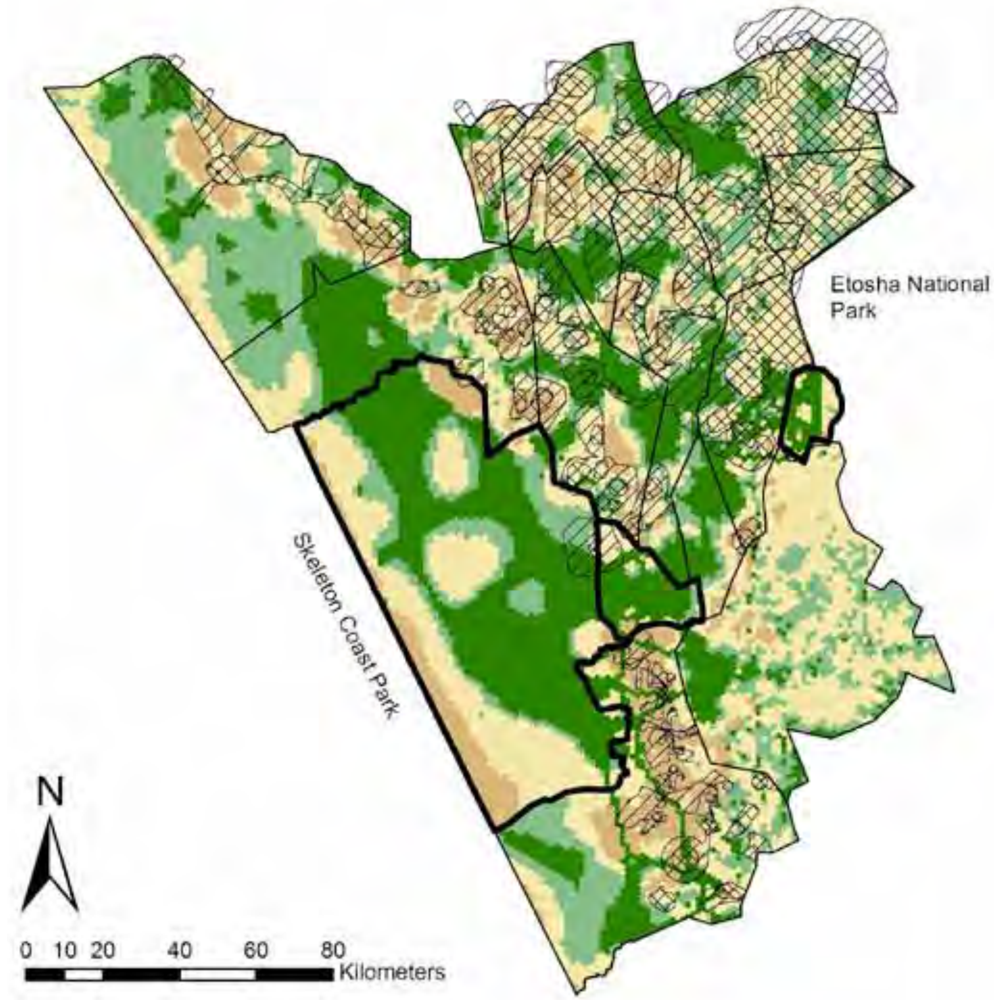
Cumulative Conservation Values

- Integrated Representation Selection Frequencies for 20, 30, 40, 50, 60 70, and 80% Goal Scenarios
- Count the number of times each planning unit was selected out of 700 runs as part of the most 'efficient solution' across all Goal Scenarios
- Divided into 4 Rankings:

Planning units selected greater than 526 (core) and 350 (buffer) times are relatively much more important for maintaining conservation values with minimal spatial overlap with competing social values

Planning units selected less than 100 and 350 times are relatively much more important for maintaining social values (i.e. livestock) while conservation value goals are maintained elsewhere.





Conservation Core & Buffer Zone Summaries

Overall, the identified 'core conservation areas' amount to 28.6% of the total planning region or 859,400 hectares. This includes 46% (329600 ha) of the proposed People's Park but only 23% (529800 ha) of the bordering conservancy lands. Similar trends are evident across strata with the majority of proposed Parklands carrying core conservation areas relative to conservancy lands. Within planning areas, 44.8%, 66.4 % and 51.7% of the current concessions that constitute the proposed People's Park, Palmwag, Etendeka and Hobatere respectively, support core conservation areas. Over 30% of the Dispute Area, Anabeb, Sesfontein and Omatendeka support core conservation areas. Half of the conservancies have less than 20% of their land classed as conservation priority.

Integrating the second 'conservation or biodiversity priority' class, which may be interpreted as a buffer zone for the core conservation areas, covers less than 50% of the planning area (47%) which translates into approximately 1,415,000 hectares. The majority of the proposed People's Park (59%) includes core and buffer areas but the bordering conservancy lands become much more important for maintaining these additional buffer areas as 43.4% (an increase of 20% from only core areas) of the conservancy lands carry these additional conservation priority areas. For planning areas, #Khoadi //Hoas shows the largest proportional increase (34%) in area needed to support additional buffer areas and Anabeb, the Dispute Area, Okangundumba, Omatendeka, Ozondundu, Purros and Torra each require more than an additional 20% increase in area for buffers. Yet only Anabeb, the Dispute Area, Omatendeka, and Sesfontein have over half of their conservancy classed as conservation priority.

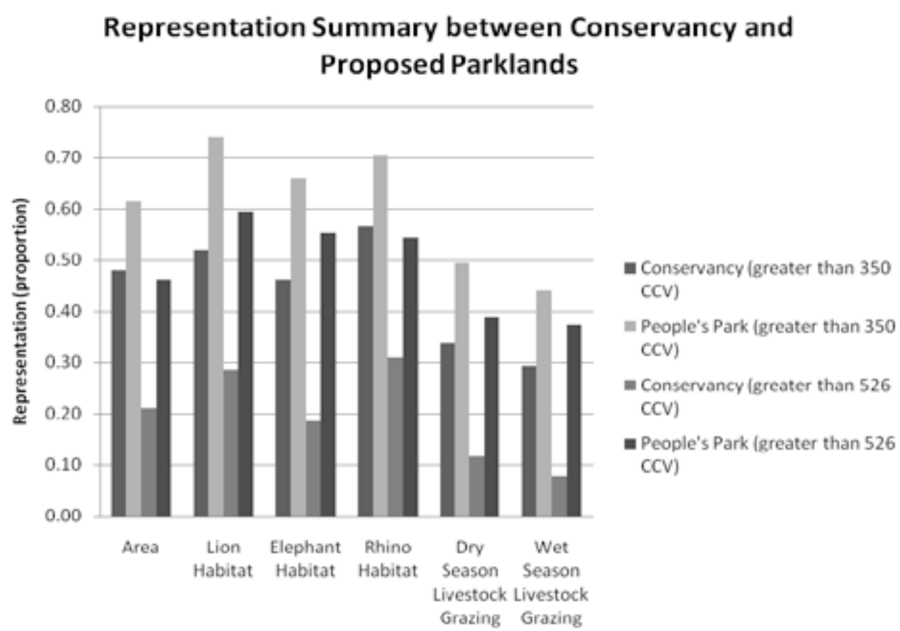
Spatial Distribution of Conservation-priority Cumulative Conservation Value (CCV) Planning Units

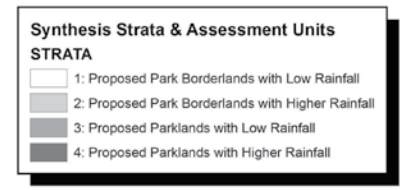
	Planning Region	Top Class (CCV > 526) # Planning Units	Top Class (CCV > 526) Total Area (ha)	Top Class (CCV > 526) % of Total Area	Top 2 Classes (CCV > 350) # Planning Units	Top 2 Classes (CCV > 350) Total Area (ha)	Top 2 Classes (CCV > 350) % of Total Area
	TOTAL	**4297**	**859400**	**28.6**	**7075**	**1415000**	**47.1**
	Proposed People's Park	**1648**	**329600**	**46.0**	**2119**	**423800**	**59.1**
	Conservancy	**2649**	**529800**	**23.2**	**4956**	**991200**	**43.4**
Strata	Conservancy with lower rainfall	1191	238200	**24.2**	2194	438800	**44.5**
Strata	Conservancy with higher rainfall	1458	291600	**22.4**	2762	552400	**42.5**
Strata	Proposed park with lower rainfall	1317	263400	**44.8**	1706	341200	**58.0**
Strata	Proposed park with higher rainfall	331	66200	**51.7**	413	82600	**64.5**
Planning Area	Ehirovipuka	202	40400	**19.8**	315	63000	**30.8**
Planning Area	#Khoadi //Hoas	282	56400	**16.2**	751	150200	**43.1**
Planning Area	Anabeb	315	63000	**40.2**	480	96000	**61.3**
Planning Area	Dispute Area	89	17800	**36.5**	144	28800	**59.0**
Planning Area	Etendeka	166	33200	**66.4**	192	38400	**76.8**
Planning Area	Hobatere	76	15200	**51.7**	77	15400	**52.4**
Planning Area	Okangundumba	90	18000	**15.4**	219	43800	**37.4**
Planning Area	Omatendeka	303	60600	**37.4**	496	99200	**61.2**
Planning Area	Orupupa	130	26000	**13.3**	261	52200	**26.6**
Planning Area	Otjambangu	32	6400	**16.1**	62	12400	**31.2**
Planning Area	Ozondundu	104	20800	**28.1**	178	35600	**48.1**
Planning Area	Palmwag	1317	263400	**44.8**	1706	341200	**58.0**
Planning Area	Purros	232	46400	**12.4**	611	122200	**32.7**
Planning Area	Sesfontein	477	95400	**38.1**	723	144600	**57.7**
Planning Area	Torra	482	96400	**26.7**	860	172000	**47.6**

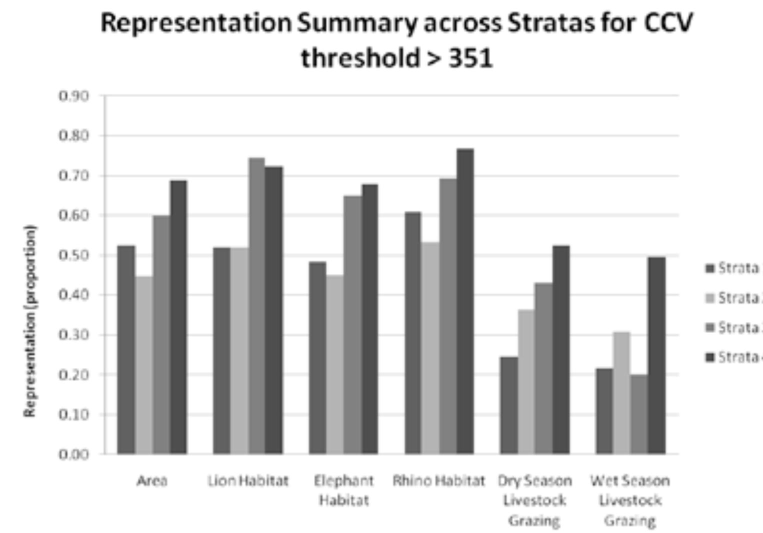
Representation Analysis summaries for Focal Species and Social Values — within the top 2 classes of Cumulative Conservation Value across the Planning Region by Land Status, and Strata (summaries for Planning Areas are presented in Appendix 5)

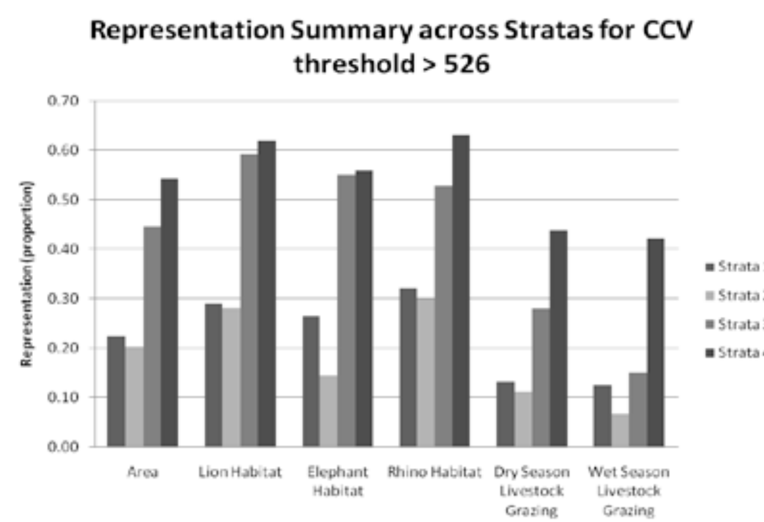
It is clear that within the conservation priority classes (top two classes of planning unit selection frequency across representation goals), focal species exhibit much higher levels of representation relative to social values (seasonal livestock grazing). This is not surprising since one of the qualitative goals in the synthesis stipulated marxan to identify areas that meet conservation value representation goals while minimized overlap with high social (livestock) values. Again, this strategy was determined not only to minimize ecological competition between wildlife and livestock, but also to provide spatial values priorities that would maximize benefits from land use practices, i.e. premium tourism and livestock ranching.

For both proposed People's Park and conservancy lands across Land Status and Strata, focal species representation for both conservation-priority classes are significantly higher relative to wet and dry season livestock grazing potential.





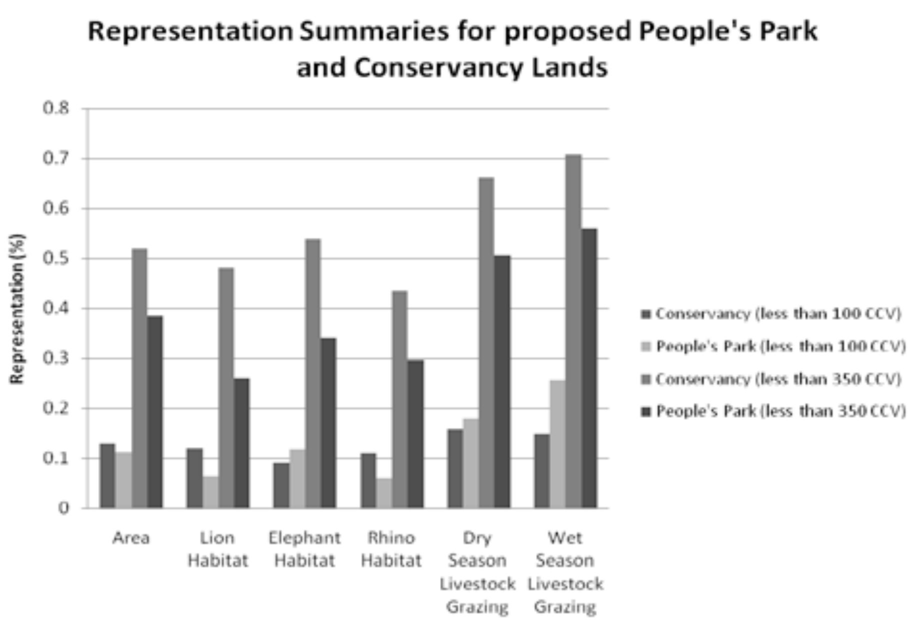


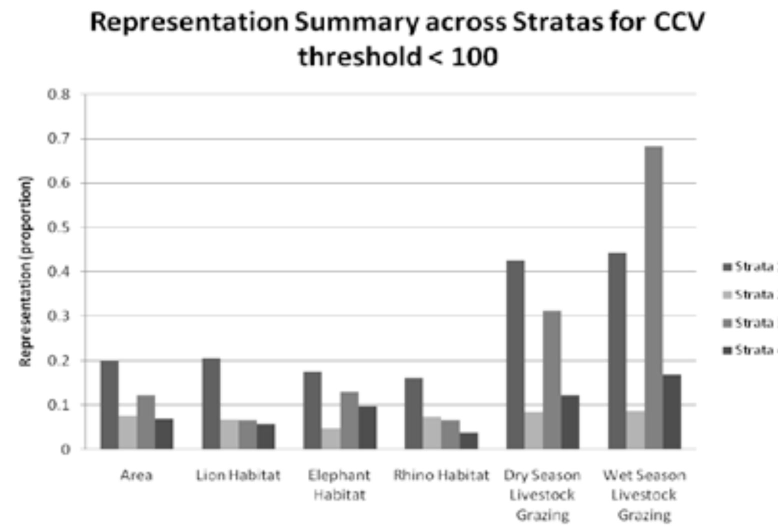


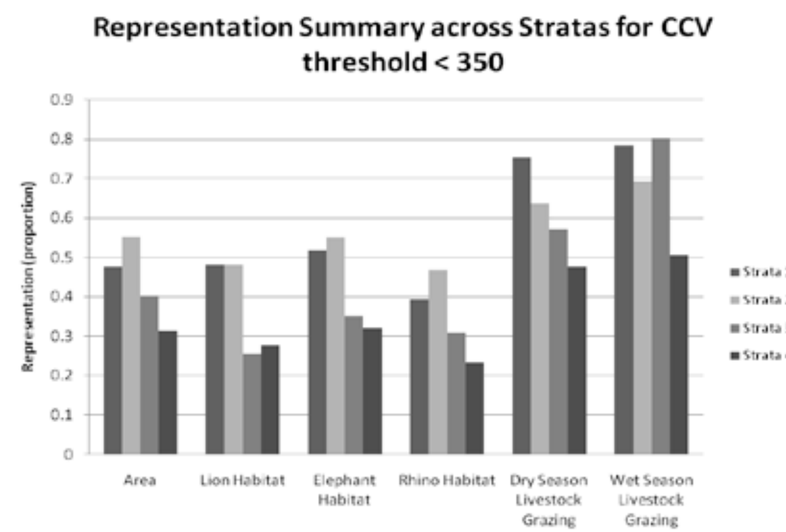
Representation Analysis summaries for Focal Species and Social Values — within the Social or Livestock Priority classes of Cumulative Conservation Value across the Planning Region by Land Status, and Strata (summaries for Planning Areas are presented in Appendix 5)

It is clear that within the lower CCV classes (two classes with planning unit selection frequency less than 100 and 350 across representation goals), seasonal livestock grazing exhibit much higher levels of representation relative to focal species values. Again, this is not surprising since one of the qualitative goals in the synthesis stipulated marxan to identify areas that meet conservation value representation goals while minimized overlap with high social (livestock) values. Again, this stratgey was determined not only to minimize ecological competition between wildlife and livestock, but also to provide spatial values priorities that would maximize benefits from land use practices, i.e. premium tourism and livestock ranching.

For both proposed People's Park and conservancy lands across Land Status and Strata, seasonal livestock representation for both lower CCV classes are significantly higher realative to focal species representation with overall livestock grazing suitability maintaining over 65% representation in areas selected as lower CCV classes across land classes and over 50% across strata (which includes proposed People's Park).





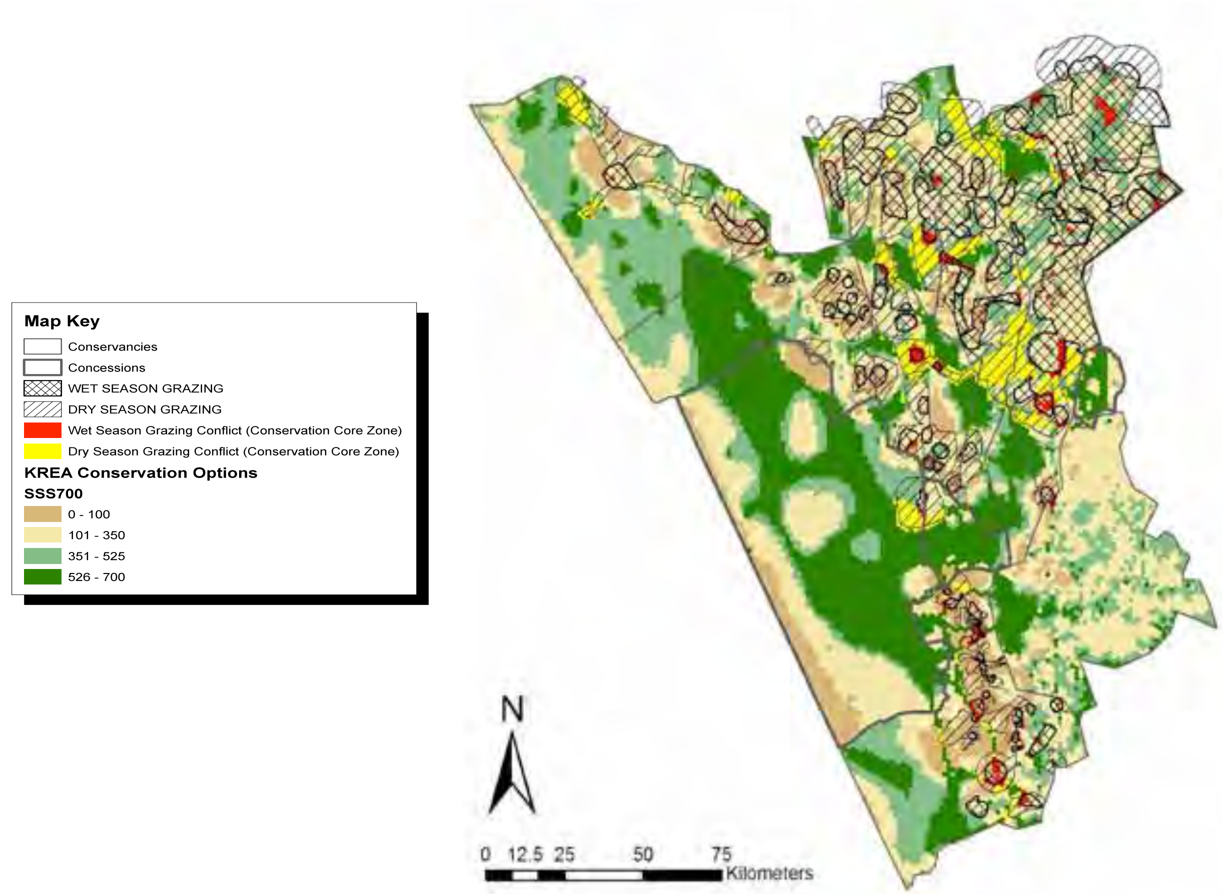


Identifying areas of probable conflict (spatial overlap) between social (livestock grazing) and key conservation core areas

Once we thresholded the CCV index into the 4 respective classes with the higher CCV classes representing areas of relatively higher conservation value (core and buffer areas), we assessed how much and where any outstanding areas of overlap remain between these key conservation core and/or buffer areas and areas regarded as currently important for social values (seasonal livestock grazing – as determined through the community livestock mapping activities).

- Overall, only 8% and 17% of Conservation Core and Areas overlaped with areas utilized for wet and dry season livestock grazing, respectively, across the planning region totally 44200 ha and 174600 ha.

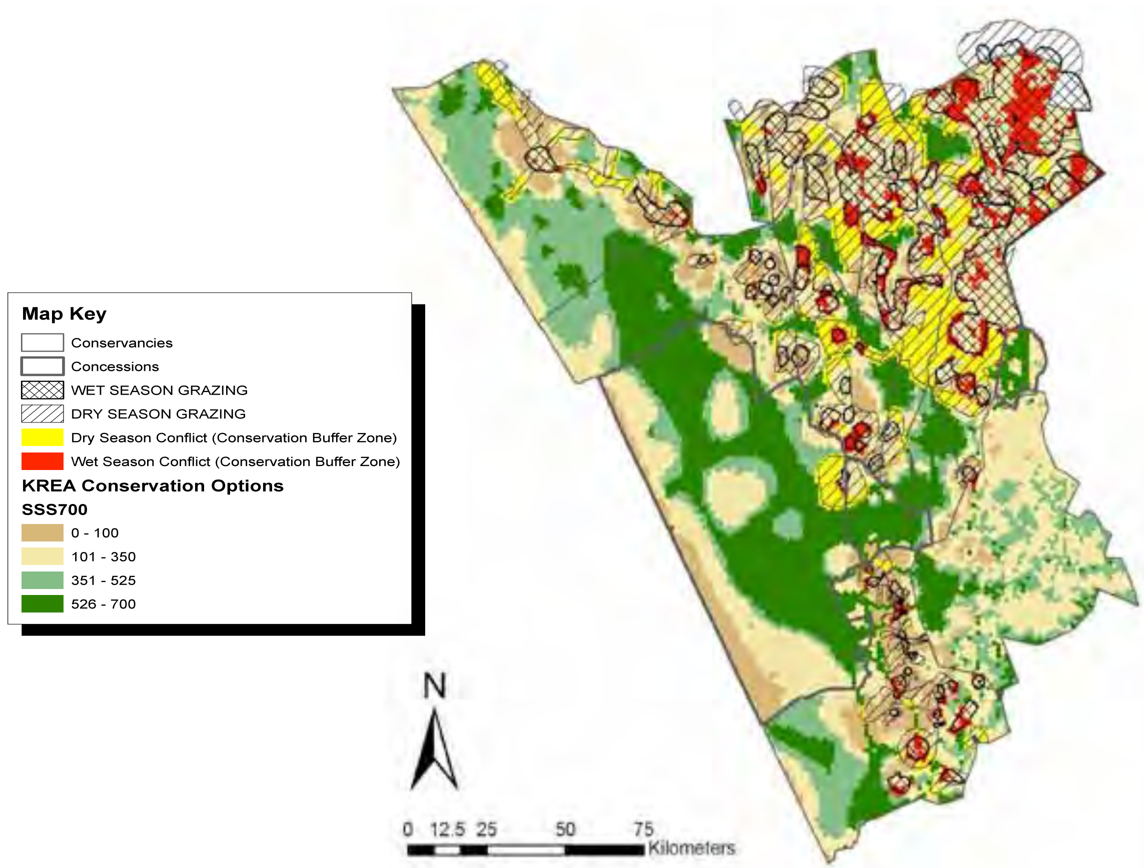
PLANNING AREA	TOTAL		CCV > 525			
	Wet	Dry	Wet		Dry	
	Area (ha)	Area (ha)	Area (ha)	% of Total	Area (ha)	% of Total
Palmwag	2800	20200	600	21%	7600	38%
Etendeka	1000	9200	0	0%	2600	28%
Hobatere	400	1000	400	100%	1000	100%
Dispute Area	800	2200	0	0%	200	9%
Torra	50800	97600	8200	16%	15000	15%
Anabeb	38400	99400	5600	15%	26400	27%
Sesfontein	20400	51600	600	3%	2200	4%
Purros	22000	73200	1000	5%	14600	20%
Omatendeka	58400	121400	4200	7%	27000	22%
Ehirovipuka	136200	181400	11800	9%	32400	18%
Okangundumba	51000	95800	1200	2%	12800	13%
Ozondundu	25600	56400	2600	10%	11200	20%
Orupupa	118600	175400	7800	7%	19800	11%
Otjambangu	12800	26600	200	2%	1800	7%
TOTALS	539200	1011400	44200	8%	174600	17%



- The largest proportional areas of overlap existed in the Proposed People's Park planning areas (Palmwag, Etendeka, and Hobatere), but the actual amount of areas was relatively small at 11200 ha, with only 1000 ha wet season overlap.
- Only four (Torra, Anabeb, Purros, Omatendeka) of the planning areas had relatively high overlap between Core and Buffer Conservation Areas and areas utlized for wet and dry season livestock grazing, yet only Torra and Anabeb had more than 10% overlap during the wet season.
- There appears to be the least amount of potential conflict in the Dispute Area (0% and 9%, wet and dry season livestock grazing overlap), Sesfontein (3% and 4% wet and dry season livestock grazing overlap).
- Key areas of concern are located within Anabeb (especially the Khowarib Schluct), Omatendeka and Ehirovipuka near the Ombonde River area, and key movement areas in Torra near Poacher's Camp and areas around Damaraland Camp.

Identifying areas of probable conflict (spatial overlap) between social (livestock grazing) and key conservation core and buffer areas

- Overall, only 30% and 39% of Conservation Core and Buffer Areas overlaped with areas utilized for wet and dry season livestock grazing, respectively, across the planning region totally 162200 ha and 390400 ha.
- The largest proportional areas of overlap existed in the Proposed People's Park planning areas (Palmwag and Hobatere), but the actual amount of areas was relatively small at 15000 ha, with only 1400 ha wet season overlap.
- Six (Torra, Anabeb, Purros, Omatendeka, Ehirovu-pia, Orupupa) of the planning areas had relatively high overlap between Core and Buffer Conservation Areas and areas utlized for wet and dry season livestock grazing.
- There appeared to be the least amount of potential conflict in the Dispute Area (0% and 9%, wet and dry season livestock grazing overlap), Sesfontein (7%, 13% wet and dry season livestock grazing overlap), and Purros (16% wet season livestock grazing overlap).



PLANNING AREA	TOTAL		CCV > 350			
	Wet	Dry	Wet		Dry	
	Area (ha)	Area (ha)	Area (ha)	% of Total	Area (ha)	% of Total
Palmwag	2800	20200	1000	36%	14000	69%
Etendeka	1000	9200	0	0%	3200	35%
Hobatere	400	1000	400	100%	1000	100%
Dispute Area	800	2200	0	0%	200	9%
Torra	**50800**	**97600**	**13600**	**27%**	**19400**	**20%**
Anabeb	**38400**	**99400**	**15800**	**41%**	**46000**	**46%**
Sesfontein	20400	51600	1400	7%	6600	13%
Purros	22000	73200	3600	16%	**30200**	**41%**
Omatendeka	**58400**	**121400**	**17400**	**30%**	**57200**	**47%**
Ehirovipuka	**136200**	**181400**	**39800**	**29%**	**71000**	**39%**
Okangundumba	51000	95800	7000	14%	30000	31%
Ozondundu	25600	56400	7000	27%	21600	38%
Orupupa	**118600**	**175400**	**53000**	**45%**	**84000**	**48%**
Otjambangu	12800	26600	2200	17%	6000	23%
TOTALS	539200	1011400	162200	30%	390400	39%

Discussion

A regional ecological assessment identifies broad areas important for conservation. This work, in progress, has hopefully yielded useful products and unveiled some interesting results. More specifically, provides a systematic, objective, and scientifically defensible assessment to address the Conservation Objectives endorsed by the Kunene People's Park Technical Committee. Our approach is a series of stages that integrates multiple levels of engagement and collaboration with the actual assessment (data compilation and analysis) and includes presentation of preliminary products to help inform shared decision-making. Here, we briefly present key issues and findings within the assessment stage.

Data Compilation
A critical and useful component of the assessment was the initial data compilation stage. This required locating and bringing together the existing spatial data and knowledge for the region from the community livestock herders to field government and organziation scientists. Where key data gaps were identified, such as the mapping and characterizing important natural and man-made water sources and important seasonal livestock ranging areas, activities were undertaken to fill these gaps. This effort resulted in the most comprehensive, up-to-date database on key spatial information across the region and it will be made accessible in a variety of formats (see appendix 4).

Fostering Collaboration
The initial data compilation activities provided the team with opportunities to engage with multiple stakeholders to clearly present the assessments objectives, obtain feedback and integrate and involve many people in the initial assessment process. This proved to be an extremely important process, particularly since this type of assessment approach was novel to the region and many stakeholders initially were a bit unclear exactly how the information would be used to help decision-making. Through the staged process of engagement and step wise data collection, presenting of draft products for review and refinements, stakeholders slowly gained more confidence and trust in the utility of the assessment approach and its results. These focused engagements were conducted with individual conservancies and local farmers, regionally with the Regional Council, Regional Land Board, Kunene Regional Conservancy Association, and the People's Park Technical Committee, and nationally with various stakeholders in the MET (including the deputy minister), and other NGOs.

Complete a Regional Ecological Assessment
This is the first ecological assessment for the region employing a systematic approach to identify priority areas to guide conservation action. It is set within a broader conceptual and operational framework to integrate key ingredients to bridge the assessment – planning gap (Knight et. al., 2005) to specifically addresses stakeholder objectives at multiple scales (i.e. People's Park and individual conservancies).

Although the assessment products are draft stages and require further review and refinement during the implementation and planning phase, components offer interesting insights presented in the results section. Utilizing the newly compiled database, each analytical component (focal species habitat, ecological land units, connectivity and livestock grazing) provide an assessment identifying each components' key driver variables as well as mapping spatial values for each component across the planning region.

Individual Analytical Components

Focal Species Habitat
To assess, identify and 'protect core wildlife habitat' as endorsed by the Kunene People's Park Technical Committee, we created a suite of key focal species models. The RSF approach utilized has two important utilities. Firstly it provides an objective, data-driven means to identify the key variables influencing habitat selection for each focal species. Secondly, it allows for spatial mapping of quantitative habitat values helping to illustrate where and how much important habitats exists. Through local informant interviews, we integrated expert knowledge to better understand which habitat characteristics were most likely to be important for consideration in the analysis. This helped us develop the suite of underlying base data that characterized the landscape. It is no surprise that in the arid Kunene region, springs (water) and drainages (food and cover), and relatively low laying areas (ease of movement) constituted the key attraction variables for focal species. Interestingly, only black rhino showed clear avoidance of any human variable (livestock) at the regional scale. This level of observed sensitivity to human disturbance is not surprising for black rhino, and has been clearly documented elsewhere in Africa (Wapole, 2003). It is interesting that tourism, assessed as proximity from tourism features (camps, lodges) variable, had no major influence upon rhino habitat selection. This is likely due to the scale of the habitat selection assessment; where rhino distribution is currently not displaced because of tourism features, where as, space use within their home ranges may well be affected. No significant avoidance variables were observed for lion and elephant, illustrating their relatively higher capacity to adapt to human influences across the region, and in some cases actually select areas near human development such as bore holes and tracks (elephants). The coverage assessments for each focal species also illustrated patterns with black rhino providing the best surrogacy for the majority of other data-deficient native wildlife (particularly mountain zebra), with elephant and lion providing less coverage but possibly capturing important movement routes that are used less frequently by other wide-ranging

game yet of critical importance. It is also interesting to note that although the proposed People's Park carried the highest density of focal species habitat values, the surrounding conservancy lands supported overall more suitable habitat. This emphasizes the importance of a regional perspective to inform future land planning as the areas within the proposed People's Park, albeit extensive, are likely not be able to support viable populations of focal species on its own.

Ecological Land Units & Special Elements

Mapping ecological land units provided an additional course-filter to pick up outstanding key conservation areas that may have been missed by our suite of focal species habitat models. This component also specifically addresses the Kunene People's Park Technical Committee objective to 'maintain biodiversity and natural beauty' and 'conserve rare and endangered species'. Important areas for endemic plants are known to be the flat top etendekas, that were not identified as high quality habitat for any of our focal species. Thus without including this component in the assessment, these key areas would be overlooked. Again, we directly integrated local ecological knowledge from community members and local wildlife experts to identify the key biotic and abiotic variables that likely drive the unique ecosystems in the region at scale. The range of unique combinations (814) of these driver variables such as landforms (topography), geology, rainfall and moisture accumulation illustrated the diversity of the unique ecological systems across the region. The inclusion of an 'enduring' landscape feature such as landforms also addresses climate change as areas with higher topographical diversity could be considered to exhibit more resilience to changes in regional and local climate over time. The mapping of unique ELU identified areas containing the most density and diversity of ecosystems. These key areas (namely within Hobatere, #Khoadi //Hoas) most likely support the highest levels of overall biodiversity representation across all taxa.

Connectivity

The final ecological component in the assessment specifically addressed the importance of identifying key regional movement areas, particularly between Skeleton Coast and Etosha National Park. With guidance from local experts, key water sources were identified and our assessment evaluated where the most likely areas would be that provided the most favourable conditions (assuming that most wildlife would prefer to select the easiest and shortest paths between key core areas) for multi-scale movement. Key water sources were used as the 'resource base' for the connectivity models since permanent springs featured as a consist driving factor in the habitat models and thus were assumed to highly spatially correlated with core wildlife areas. Key movement corridors were identified for both north-south as well as east-west directions and mapped probably connection areas between key core wildlife areas. These predicted corridors were also compared with general estimations of key movement routes for wildlife as mapped by local experts. There was a high degree of overlap particularly areas that connect the western concession areas with areas east of the Grootberg Range.

Livestock

Livestock distribution was used as a measure of traditional land use values (and human-induced pressure on biodiversity) across the landscape. We created a seasonal livestock distribution model from community mapping activities and found a high spatial correlation between livestock presence and human features (proximity to settlements, proximity to bore holes, and proximity to roads). This created a specific input variable used to assess trade-offs (opportunity and conflict) between conservation and traditional land use values in the context of land use planning.

Integrating the KREA into an accessible Data Management System for Decision Support

Potential products generated from this data source have far reaching applications; utilized in raw form (i.e. simple spreadsheets and tables of information), simple maps of specific spatial data (i.e. a map showing an areas topography and human infrastructure and resource locations to help guide future land use planning), as well as analysis maps (i.e. locating best black rhino habitat may persist in an area to help inform future management).

Synthesis Approach

Individual Scenarios

Each individual scenario produced a unique perspective on where key areas currently exist that maintain stated conservation objectives (ecological representation goals) while also incorporating ecological theory (minimizing fragmentation) and sociological reality (minimizing conflict with traditional land use such as livestock). An approach that attempts to synthesize multiple components and multiple goals provides a more comprehensive perspective on overall biodiversity priority areas than any component on its own. The decision-support tool, Marxan, proved to a valuable asset to integrate these quantitative and qualitative goals in a systematic, transparent manner to produce a series of conservation options that serve as foundational sets of information to guide management planning discussions. Evaluating solutions for lower levels of representation identified the relatively more vital 'refugia' for conservation in the area while evaluating progressively higher levels of representation goals identified additional areas that would add the most conservation value by area. The outstanding issue with using individual scenarios as planning products is the problem with deciding what quantitative goals are appropriate or enough to ensure long-term persistence. The historic flat goal of 10% representation set by the IUCN has been highly debated in the literature and deemed to under-represent biodiversity pattern and process (Pressey et. al. 2003). Solomon et. al. (2003) recommended that a 50% representation goal would be required to maintain population persistence for native game species in Kruger Park, South Africa. Answering these questions requires long term data on species population persistence and space use or species-area relationship assessments (Desmet and Cowling, 2004). To date, this level of species data analysis has not been conducted for the region and thus representation goals for individual scenarios should be interpreted as relative measures (i.e. 50% representation goals will give better long-term insurance than 40%).

Cumulative Conservation Value Index

In the absence of more detailed information to help inform data-driven goal setting for representation, we chose to combine a range of representation scenarios into one cumulative solution that illustrated where areas of relatively more conservation importance persist while maintaining the additional goals that minimize fragmentation and preferentially select areas that minimize spatial overlap with important, less compatible traditional land use values across the region. This approach, that quantified a selection frequency score for each assessment unit, produced a mapped surface of continuous values. These values are then classed into appropriate categories that could be designed to better match stakeholders' potential land use objectives to maximize benefits. For example, since our focal species models literally predicted the relative likelihood of occupancy, identifying areas of relatively high values for focal species (also major tourism drawcards) may help identify across the region where premium tourism concessions may best operate that maximize both ecological (securing the best habitat) and economical (high priced tourism revenue through offering a better safari product). These areas may be situated within buffer areas that could allow low levels of consumptive tourism (such as trophy hunting) and traditional land use (emergency or some dry seasonal grazing) to maintain the capacity for the key core areas to be spatially and temporally dynamic under potentially changing conditions. In a dualistic sense, other classes observed with relatively lower levels of cumulative conservation value could be interpreted as being more appropriate for human and traditional land use such as settlements, higher frequency wet season livestock grazing, consumptive and problem animal hunting and higher impact tourism. Conservation Core and Buffer Areas were thresholded by retaining all key connectivity paths, maintaining minimum representation goals of 30% and 50% respectively for focal species, and maintaining presence of each ELU in core areas and minimum of 30% representation for the buffers. These two classes maintained these goals over 28% and 47% of the planning region respectively. The two classes characterizing areas relatively more suitable for higher level of utilization and human pressure supported well over 50% of the seasonal livestock grazing values with many of the conservancies maintaining over 70% of their areas with higher potential for livestock grazing.

Assessing potential areas of conflict between conservation core and buffer areas and seasonal livestock areas Another useful analysis could investigate areas that were identified as key conservation core and buffer areas but still overlapped with current areas utilized by seasonal livestock grazing. Since one of the qualitative goals in the marxan solutions was to preferentially select areas for conservation importance that have lower value for livestock potential, these persisting areas of spatial overlap indicate key conflict sites, or areas that may be relatively more irreplaceable. Our assessment revealed that for the most part, especially within the core conservation areas, there was very little overlap with these competing values. Areas that were identified were mainly the Khowarib Schluct and areas further up the Ombonde River between the Serengeti and Otjivasandu. Even so, these areas were mainly conflicting with dry season grazing, much less of a pressure than wet season grazing. Conservation Buffer Areas showed higher levels of conflict mainly in the eastern conservancies and their high levels of livestock distribution, and the western major river drainages such as the Hoaruseb and Hoanib.

Assessing Trade-offs

It should be noted that each individual scenario and also any combination thereof is simply one possible solution that attempts to solve for stated quantitative and qualitative goals. Some areas identified by Marxan for conservation priority may be politically of socially unrealistic and unacceptable for certain designation. In such cases, one of the most useful attributes of Marxan can be employed. Used in an iterative fashion, Marxan can re-assess spatial representation once certain areas are decided to be 'locked in' or 'locked out' of the assessment. If areas are 'locked out' Marxan will evaluate whether representation goals can be maintained by selecting areas elsewhere. This is where trade-offs can be recognized and illustrated between spatial values and competing land uses. For example, the Khowarib Schluct in Anabeb is constantly selected as a key conservation area. Yet, settlements restrict/deter wildlife movement in and out of the gorge from both entrances. Thus, it may be prudent to remove this area from the representation analysis to see if our goals can be maintained elsewhere with less conflict. Alternatively, the Torra conservancy may want to maintain larger conservation core representation in Poacher's Camp area in which case other areas currently classified as key conservation core area may be reduced or 'traded' for the additional sites set aside in Poacher's Camp. This concept of trade-offs is very important when situated in a land use planning context as certain areas will be less negotiable that others (areas that are identified as key core conservation areas under minimal representation goals – 30%), while certain sites could be negotiated for political or social reasons and other options suggested.

Implications for Management Direction Regional Perspective (Transboundary People's Park & Conservancy Planning)

The initial impetus for conducting this assessment was to provide a regional perspective on conservation values to identify and set priorities for key areas to achieve for biodiversity conservation. Thus, it was vital that the assessment was seen as being situated in a regional land use planning context from the very beginning. Through initial engagements with regional decision-making bodies such as the Kunene Regional Conservancy Association, Regional Land Board, Regional Council and of course the Kunene People's Park Technical Committee, we began to discuss potential uses and relevant products from the assessment. By removing the political boundaries from the planning region, individual scenarios and the CCV index revealed fairly consistent patterns in the spatial location of key conservation and traditional land use values. Persistent engagement and sharing of knowledge and map products with regional governing bodies that are universally accepted and acknowledged, may help promote and orchestrate a more effective planning and decision-making approach. Additionally, products can be tailored to address specific needs and/or decisions under discussion by different stakeholder groups under specific timelines. For example, the latest synthesis has focused on producing a suite of products to help inform and guide discussions on the emerging proposed People's Park Management Plan with particular attention towards transboundary land use issues with neighbouring conservancies. The CCV index is one approach that provides a regional perspective to help identify key areas within the park that would maximize its benefits by zoning for premium tourism, areas that could be utilized for emergency grazing with least impact on key conservation core areas, as well as where neighbouring conservancies and the parklands would benefit most from aligning their respective land uses (i.e. premium tourism) with areas of high conservation value (habitat suitability) across the fenceless boundary.

Local Perspective — Conservancy Management Zonations)

Some of the existing conservancies in the region have undergone rudimentary levels of management planning yet only a very few have included land use zonation. As reported by the conservancy committees and MET (who are charged with approving management plans), many of the original plans, and specifically the mapped zonations, have been lost, remain incomplete or unsatisfactory or have yet to be determined. Through targeted engagements, the KREA map products can be integrated within existing conservancy management plans and land use zonations to add value and strength to support the various land management strategies employed. The KREA products provide each conservancy with a regional perspective regarding how their land is situated in a broader context, i.e. how much black rhino habitat does one conservancy have relative to other conservancies? Where do areas of key conservation areas extend across boundaries with our neighbours? Where should we establish exclusive non-consumptive tourism concessions to maximize our benefits that do not produce conflict with less compatible land uses that our neighbors may be planning (hunting or livestock area)? When decision-makers use the same information at the same scale, planning can be accomplished in a much more effective and sustainable manner such that everyone benefits. This is particularly critical in an open system such as the Kunene where everyone shares the resources to some extent, especially the wide-ranging wildlife.

Species data

Each focal species habitat model is based upon a diverse range of data collection methods, frequencies and extent. Without repeating each (they are noted in the results section for each model), it is noteworthy to mention some important considerations when interpreting each focal species models. They are mainly issues of extrapolation and scale. The key issues are:

- Regional elephant habitat suitability model: the model is highly biased towards elephant habitat selection observed in the Hoanib and Hoaruseb river systems and generalized (pooled) between the west and east (Hobatere) as well as between gender (male and female). Thus, elephant habitat quality predicted in the Uniab and Huab catchments assumed these elephants would select for similar habitat characteristics as the sampled elephants in the Hoanib and Hoaruseb. Since we did not have distribution data across the entire range, we were also limited to conducting the suitability assessment at a home-range level – i.e. the elephant habitat selection model predicts areas more likely to be utilized within their home range. This is also limited to only 7 individuals (3 bulls and 4 females) for which we had reliable data. The generalization across the region (model spatial extrapolation) was qualified as a fair assumption (K. Leggett, pers com) although it was highly recommended when additional data was made available to stratify the model by gender as adult bulls likely select for different habitat that breeding females during certain times of the year (K. Leggett and R. Loutit, pers. com.).
- Regional lion habitat suitability model: although the lion model contained training data (data used to develop the model co-efficients) that extended throughout the western range of the assessment area, we had no lion movement data east of the Grootberg Range. Thus we assumed that lion habitat selection east of the Grootberg Range mirrored what we observed from lions west of the range. Additionally, we had far fewer location samples per individual compared with

the elephant data, and were limited to VHF telemetry (we did not want to mix VHF and GPS collar data due to the difference in location frequency). This also meant that all of the data used to build the model characterized diurnal habitat selection (although we validated this model with GPS collar location data which included nighttime movement with very high levels of accuracy). We had a few extra individuals (9) than the elephant data which included 6 breeding females. Like the elephant model, we did not have access to lion regional distribution data and were limited to creating only home-range level suitability models. It was advised that the spatial extrapolation with the current data set was reasonable, yet the model could benefit from stratifying into day and nighttime habitat selection (P. Stander, pers com). Additional GPS collar data could be made available in the near future to help with the refinements.

• Regional Black Rhino Habitat Capability Model: the black rhino model was severely limited by both spatial extrapolation and sample sizes. This is due to the difficulty in obtaining rhino location data in the absence of telemetry equipment (although transmitters were recently deployed in 33 individual rhinos across their current range and provided many of the validation locations). We were thus restricted to sample only breeding females in the basalt landscape since these were the only individuals that had more than 25 locations each (sample effort needed for precise home range estimates). Although this limited the extent of sampling, it did constitute the main and most productive areas for black rhino (supporting about 90% of the region's free-ranging rhinos). Since we were still quite limited by actual locations, we chose to create a population-level model that would predict the relative likelihood of a site being classified as breeding female home range habitat. Again, we were forced to extrapolate the model into new areas not used in the training procedure (there are no rhinos nor historical rhino data east of the Grootberg – even Etosha has no available rhino movement data). These areas outside of the basalt predicted as relatively more likely to be utilized by breeding females should be interpreted with caution, although the validation of some of these sites (i.e. Klip River and Purros) using transmitter data of translocated rhinos was quite successful.

Livestock Mapping

The livestock distribution areas were mapped by local livestock herders during interviews using relatively large-scale maps (roughly 1:150,000). Although the maps contained many key landscape features and landmarks for which to help orientate the informants (such as topography, infrastructure, springs, roads, etc) these livestock polygons are broad-scale estimates of livestock distribution and should not be interpreted down to a fine scale. They were also estimated for typical wet and dry years and thus did not attempt to identify emergency areas in drought years. To help with the model accuracy, we stratified the area to better characterize Herero free-ranging cattle distribution and the more sedentary Damara small-stock distribution areas. The combination of both actual mapped livestock distribution and modeled livestock distribution probability was useful to utilize under different assessments. Although the models derived from these mapped livestock distribution maps validated quite well (accurate and precise), more confidence could be obtained through additional in-depth field validation methods such as monitoring a random sample of cattle and goats north and south of the veterinary fence through telemetry or GPS technology.

Connectivity

Our connectivity model is based on the assumption that wildlife are generally more likely to move across the landscape between key resources (springs) using the easiest and shortest route. There may be exceptions to this especially when specific human-induced pressures restrict or cause wildlife to use a less preferable route. Without any movement data for wide-ranging ungulates (except for elephant) it is difficult to incorporate these potential avoidance variables. Thus, we were only able to validate this model with rough estimates by local experts on the major movement routes observed for wide-ranging game. Generally, our connectivity model did capture the majority of these key routes. Future GPS collaring of samples of ungulates or mapping of major wildlife trails could be used to strengthen this model or better test our assumptions.

Synthesis Goal Setting

As noted above, choosing appropriate representation goals that ensure long-term biodiversity conservation viability is very difficult. Yet, certain information can yield 'better' estimates and help fine-tune some of the thresholds. Recently, some regional conservation assessments have attempted to link spatial population viability assessment (PVA) results within a representation analysis to help set goals on required representation levels that are linked to predicted numbers of individuals and population persistence (Johnson and Boyce, 2004). Our focal species data may permit further habitat-based population viability analysis, especially for lion and black rhino. This would be an interesting avenue of future analytical work with many applications for management and planning.

Next Steps —Towards an Operational Model

Knight and colleagues (2006) recommend a suite of key ingredients that promote effective implementation of conservation action from lessons learned from conducting coupled systematic conservation assessment and conservation planning in South Africa. Below we state how we have attempted to address each recommendation, although in a much more organic way.

1. Conduct a systematic assessment: this progress report presents the first draft of the KREA and resulting conservation option products.

2. Identification of stakeholders and goals of the

process: through the initial stages of scoping and data compilation, key stakeholders were identified who also provided demand-driven goals that addressed specific objectives for regional conservation (such as the proposed Kunene People's Park Technical Committee).

3. Conduct assessments at multiple scales: a next step for assessment refinement to provide better local scale management recommendations especially within conservancies. These smaller scale assessments (1:50,000) and resulting local priority areas for conservation nested within the broader priority areas identified by the existing regional assessment (1:250,000) could help guide land use planning in the surrounding mosaic of conservancy lands that would complement broader management recommendations.

4. Pay attention to assessment design: ideally, the assessment design would be drafted with full participation from local and regional stakeholders and led by a full time assessment manger and assessment team members with a diverse set of skills. Unfortunately, our small assessment team, limited by time and manpower, had to use more of an opportunistic approach to engage with key individuals both from the technical and practical arenas. Thus at times, keeping communication open and flowing between the ground, national and international level stakeholders and partners was difficult. This sometimes resulted in misunderstandings or simply individuals or institution unaware or uninformed of the KREA's current progress and evolving work plans. Future work would benefit tremendously by introducing additional staff, both with technical and practical expertise, at multiple levels to help streamline communication and jointly develop work plans. Key individual would be local-level champions within conservancies as well as personnel based in Windhoek to assist with national-level strategic engagement and communication.

5. Include implementing organizations in the assessment team: to date, it is still somewhat unclear who exactly the different implementing agencies will be for regional and local development. Thus we have tried to include as many probable implementing institutions in the assessment as could realistically be managed by our limited staff. Regional governing bodies that have been and should continue to be involved in the assessment process that have their own budgets to conduct implementation activities are the Regional Council, Kunene Regional Conservancy Association, IRDNC, ICEMA, and the Kunene People's Park Technical Committee (under the SPAN project of MET).

6. Focused collaboration to address stakeholders' needs: initially the KREA evolved to provide the Kunene People's Park Technical Committee stakeholders with an ecological foundation and regional perspective to help inform the impending management plan. Thus, our contact with these stakeholders has been fairly consistent and focused. However, as word of the KREA spread beyond the Technical Committee, the range of stakeholders interested in our assessment grew tremendously. It has been difficult under the assessment team personnel and time constraints to keep up with various demands for products in a focused manner. A recently re-drafted community consultation framework will help prioritize and focus engagement efforts for future KREA work.

7. Interpretation of assessment outputs and mainstreaming products across other sectors: one of the most challenging and time consuming components of conservation planning involves communicating assessment results and recommendations across a wide range of sectors that also conduct business or operations in the region. In the Kunene, these additional key sectors would be Ministry of Mines and Energy (coastal diamond mining and prospecting for other inland minerals), Ministry of Agriculture (livestock and bore holes), Ministry of Lands and Resettlement (developing Nation-wide resettlement strategies) and the National Planning Commission (responsible for implementing Namibia's Vision 2030). Establishing and maintaining these engagements would require ongoing, in-country efforts if we hope to firmly root the KREA in local and regional-level policies, decisions and daily operations that impact land use. An engagement and collaboration strategy for mainstreaming KREA results and product across these other sectors has yet to be developed.

Monitoring

A very important activity that should follow any land use decision and designation is to design and implement appropriate monitoring strategies that allow periodic evaluation and adaptation. This is especially critical in a highly resource-limited, open and dynamic system such as the arid Kunene. Monitoring activities are already conducted in the region following the Event Book System implemented by WWF and IRDNC. Thus, a foundational system already exists to help evaluate any refined land use across the region. It will therefore be critical to establish future links with individuals and institutions involved in the Event Book System to collaborate on monitoring strategies.

ROUND RIVER
Conservation Studies

284 West 400 North; suite 105
Salt Lake City, Utah 84108 USA
slcoffice@roundriver.org
www.roundriver.org