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Leopard (*Panthera pardus*) Population & Habitat Viability Assessment 2005

LEOPARDS IN SOUTH AFRICA

- Incomplete knowledge of Leopard life history & distribution;
- Difficulties in censusing;
- No data to support sustainable harvesting;
- Illegal killing not recorded;
- Inaccurate Leopard numbers and subpopulations are small & localised;
- Fragmented habitat & distribution;
- Ongoing conflict with farmers;

LEOPARDS IN SOUTH AFRICA

- Loss of habitat and prey base;
- Perception & incorrect identification (94%) as livestock killer;
- Impact of current Leopard losses is impossible to determine;
- Insufficient ecological information to guide appropriate decisions on Leopard utilisation;
- Poor implementation of current legislation;
- YET, in 2004, South Africa & Namibia had an approved increase in Leopard CITES quotas from 75 – 150 animals pa.

THE POPULATION & HABITAT VIABILITY ASSESSMENT (PHVA)

- Process developed by the Conservation Breeding Specialist Group (CBSG) of the IUCN Species Survival Commission.
- Powerful tool for developing strategic recovery/ conservation plans for threatened species & their habitats globally.
- Data on population status & trends, distribution, genetics, health status, biology, threats & ecology of the species integrated with estimates of threats like land-use & utilisation patterns.

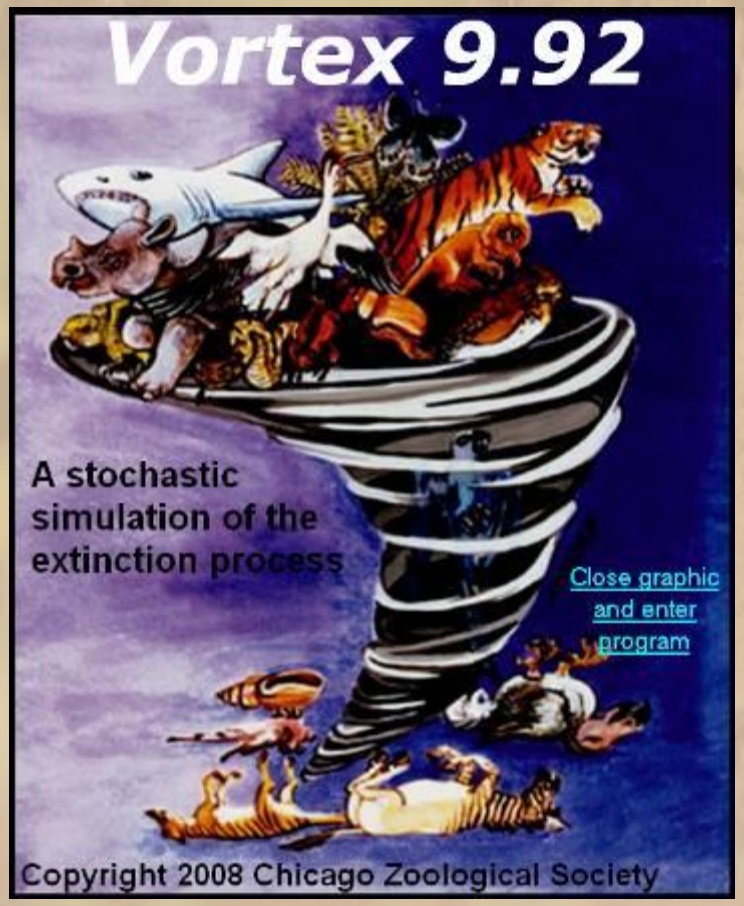
LEOPARD PHVA APRIL 2005

- PHVA comprises plenary & working group sessions;
- Established 5 working groups:
  - Population Biology Working Group
  - Habitat & Movement Working Group
  - Conflict Management Working Group
  - Utilisation & Policy Working Group
  - Population Modelling & Dynamics Group
- Each group developed situation overview, problem statements, prioritised solutions / goals & detailed action plans with steps to achieve goals identified.

POPULATION MODELLING & DYNAMICS WORKING GROUP

- Developed a stochastic population model for best-guess projections of long-term population viability for leopards in South Africa.
- Tested management scenarios to determine if, where & how increased utilisation quotas can be implemented without risking the survival of individual subpopulations.
- Participants felt input data were not accurate but agreed that modelling could highlight critical problems & provide insight into the species' situation and persistence.

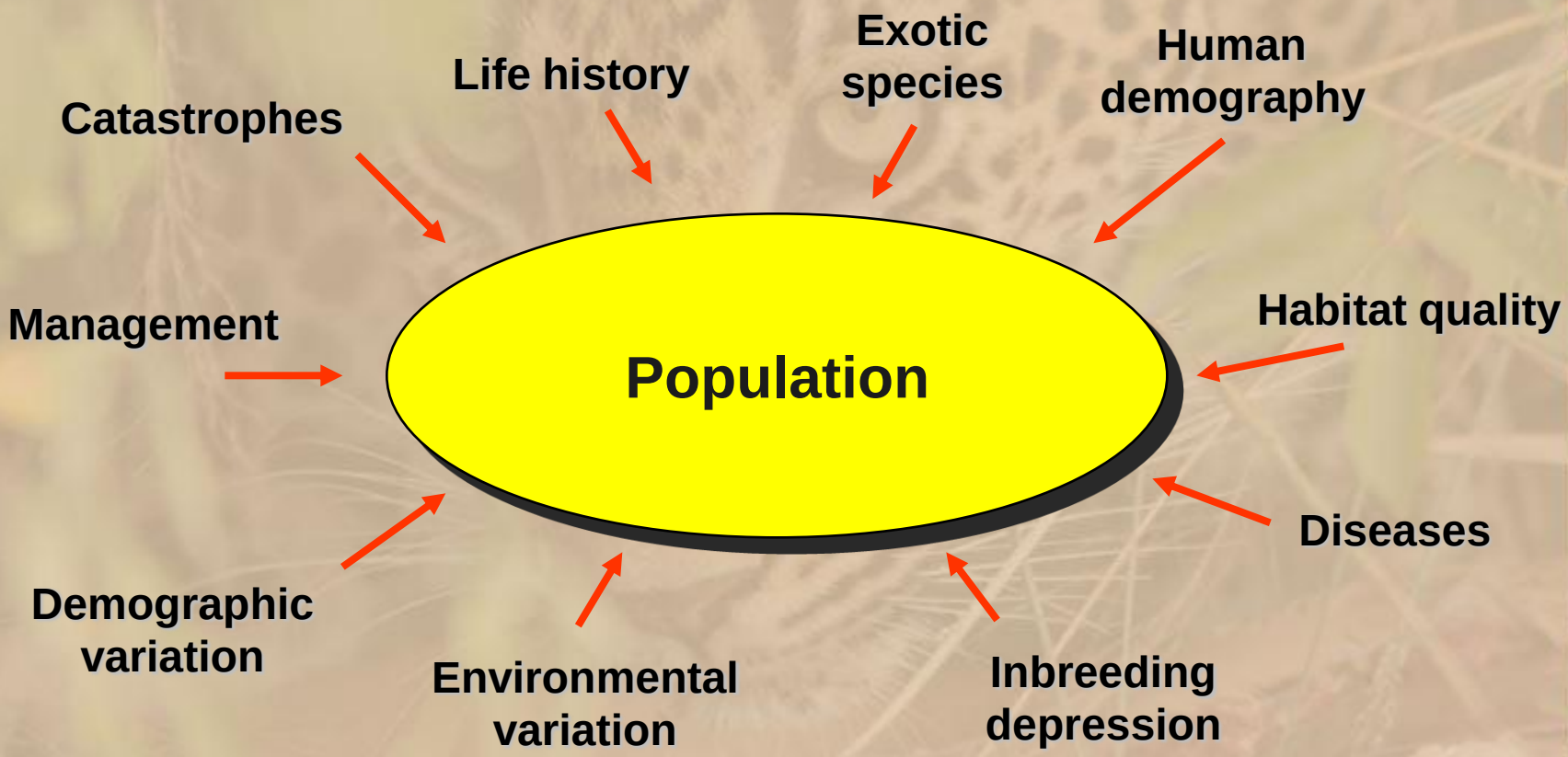
VORTEX SIMULATION MODEL



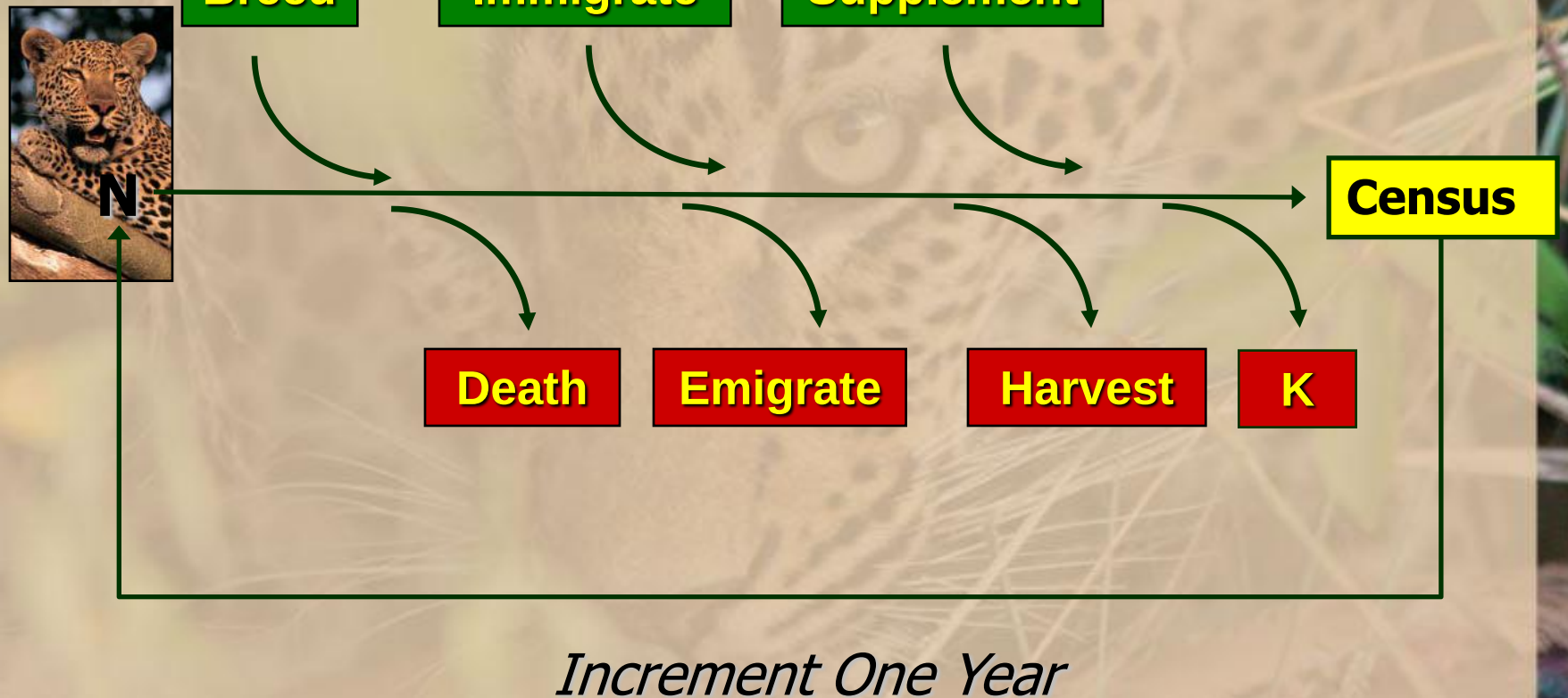
- Individual-based, stochastic population model
- Best suited for relatively small, diploid, vertebrate populations
- Used in PVAs for over 150 species
- Simulate life history events, trends, external factors & management actions
- Assess risk of extinction
- Primary threats to population viability
- Relative impacts of alternative management scenarios
- Identify gaps in knowledge

POPULATION VIABILITY ANALYSIS:

Evaluation of Interacting Factors Affecting Population Extinction

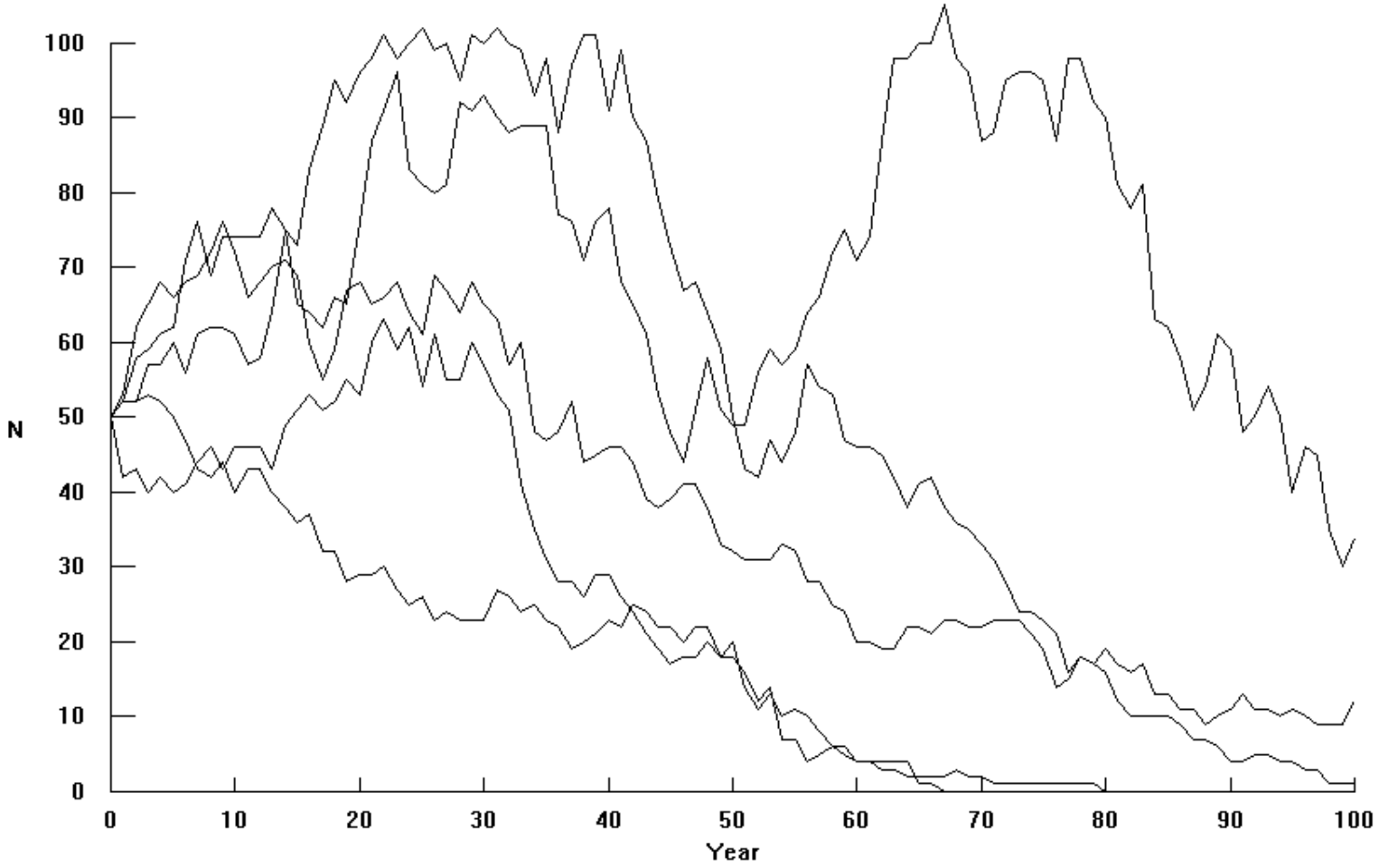


VORTEX MODEL TIMELINE



Vortex simulation

Final statistics: r= -0.020, SD(r)= 0.113, PE= 0.60, N= 23, H= 76



Project:Ogasawara Wood Pigeon Scenario:Sample

Iteration 5

SIMULATION MODEL RESULTS

Distribution of outcomes across large number of runs (iterations)

- Mean population size
- Trend (population growth or decline)
- Probability of extinction
- Loss of genetic variation

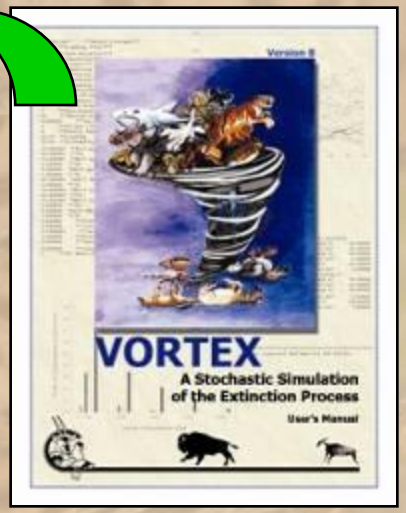
Sample outcome: 15% probability of extinction in 100 years

Compare to population goals

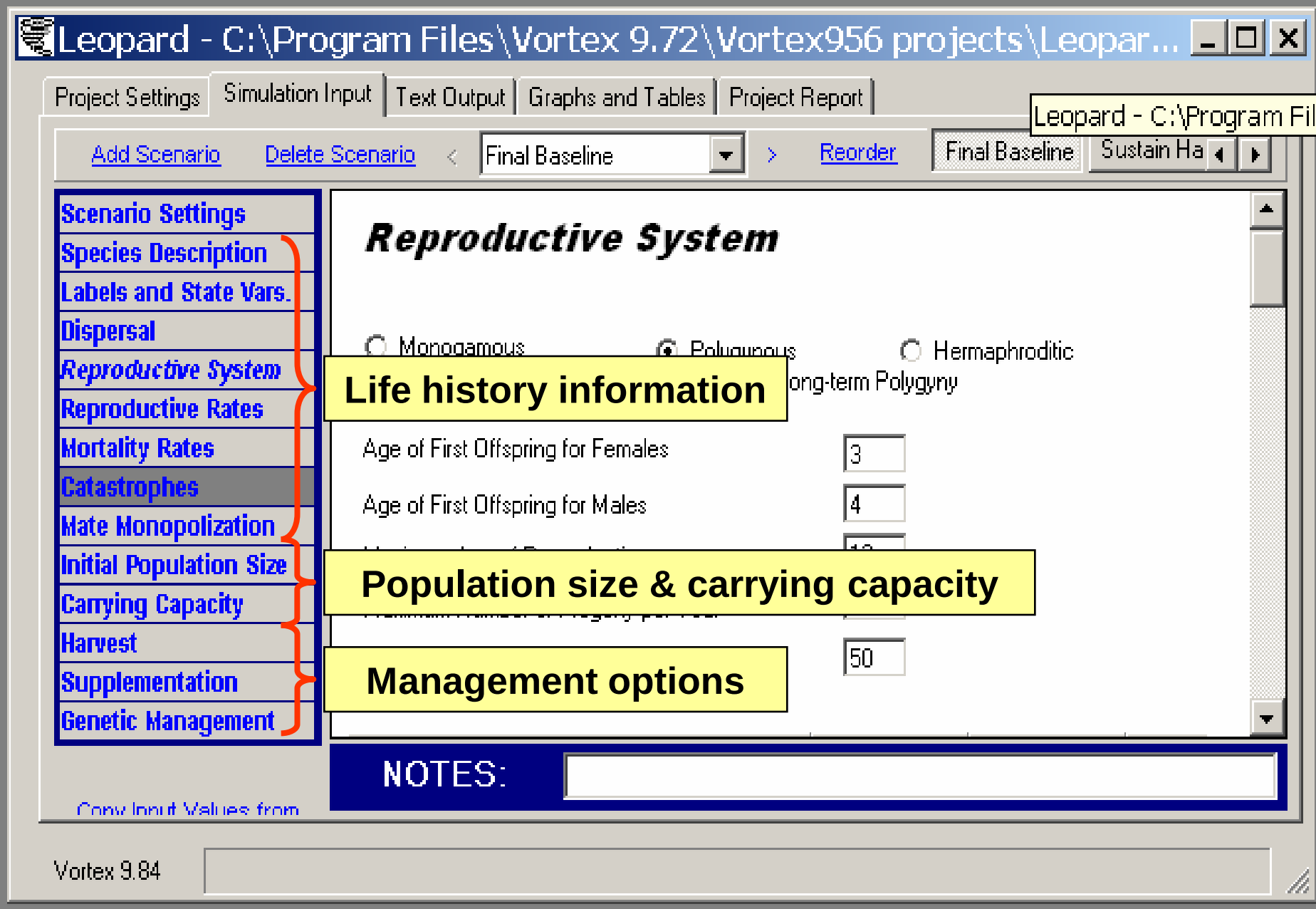
Population and Habitat Viability Assessment (PHVA)

Vortex Simulation Model

Topic-based Working Groups



Development of research and management strategy for the species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Project Report
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Add Scenario
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Scenario Settings
Species Description
Labels and State Vars.
Dispersal
Reproductive System
Reproductive Rates
Mortality Rates
Catastrophes
Mate Monopolization
Initial Population Size
Carrying Capacity
Harvest
Supplementation
Genetic Management
Reproductive System
Monogamous
Polygynous
Hermaphroditic
ong-term Polygyny
Age of First Offspring for Females
3
Age of First Offspring for Males
4
50
Life history information
Population size & carrying capacity
Management options
NOTES:
Copy Input Values from
Vortex 9.84

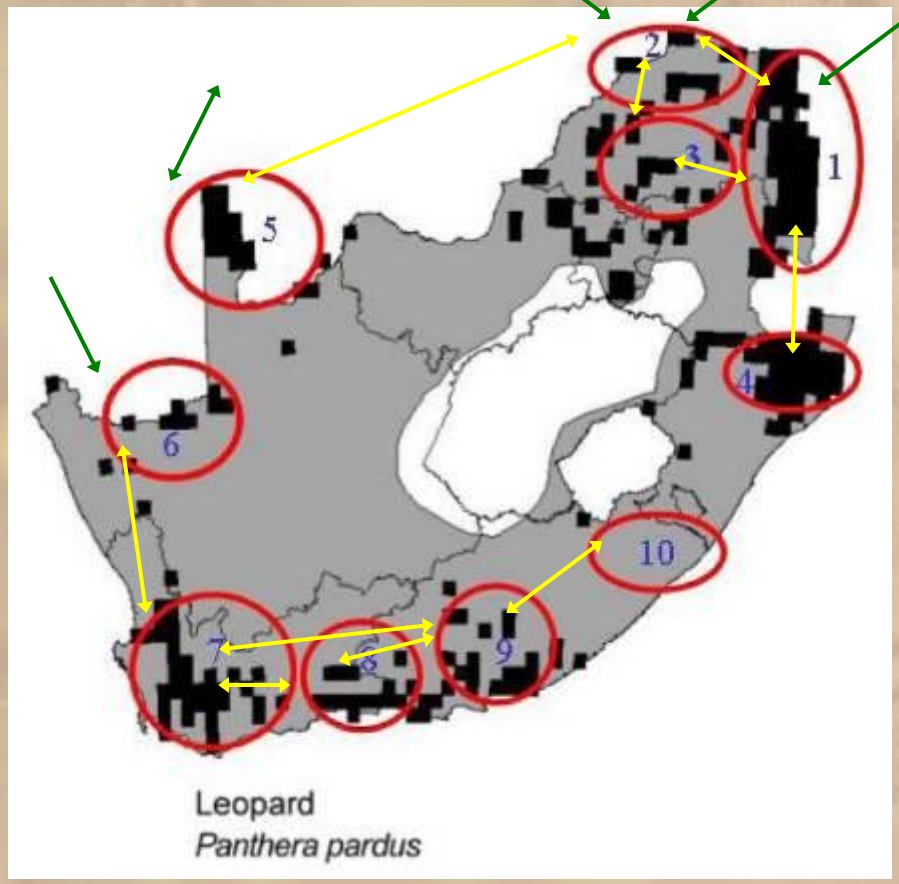
BASELINE MODEL PARAMETERS

- 500 iterations over 100 years
- Age of first offspring: 3 yrs / 4 yrs
- Interbirth interval: 2 years (50% ♀♀ breeding)
- Mean litter size: 1.92 cubs (1-4 cubs/litter)
- Maximum age: 12 yrs
- Annual mortality: 40% (juvenile); 10-14% (subadult); 5-7% (adult); 15-20% (10+ years)
- Incorporated inbreeding depression (3.14 LE)
- Incorporated annual environmental variation (20% COV) and demographic stochasticity

ATTEMPTS AT DETERMINING LEOPARD NUMBERS IN SA

Martin and de Meulenaer (1988)	23,472	Linking densities with annual rainfall
Norton (1988)	2,390	Individual populations for each habitat type
Bailey (1993)	900	Density at 3.5 adults per 100 km^2, Kruger National Park
Friedmann & Daly (2004)	Between 2,500 and 10,000	For the purposes of assessing IUCN Red List Status only

TEN SUBPOPULATIONS OF LEOPARDS IN SOUTH AFRICA



1. Greater Kruger Area
2. Northern Limpopo Area
3. Waterberg & Mpumalanga Area
4. Northern KZN
5. Kalahari Area
6. Orange River
7. Western Cape
8. Eastern Cape Mountain
9. Eastern Cape Valley
10. Wild Coast

POPULATION AND CARRYING CAPACITY ESTIMATES FOR THE 10 SUBPOPULATIONS

Population Area	Est. Population Size			Saturation Level	Est. K_{Best}
	Min.	Best	Max.		
Great Kruger	750	1200	1500	100%	1200
Northern Limpopo	500	1250	2000	80%	1563
Waterberg & Mpumalanga	400	850	1600	80%	1063
Northern KwaZulu-Natal	200	400	600	90%	444
Kalahari	30	50	70	90%	56
Orange River	20	30	60	50%	60
Western Cape	200	350	600	80%	438
Eastern Cape Mountain	35	40	80	65%	62
Eastern Cape Valley	30	50	150	70%	71
Wild Coast	20	30	120	100%	30
Total	***2185***	***4250***	***6780***	***86%***	***4987***

LEOPARD REMOVAL / LOSSES

- Total Leopards lost annually estimated to be **281** (only 61/75 current CITES quota utilised):
  - trophy hunting
  - legal & illegal local hunting
  - removal of problem animals
  - emigration from Greater Kruger & Kalahari populations to Mozambique & Botswana.
- Estimated 28 animals supplementing pop from Mozambique, Zimbabwe & Botswana.

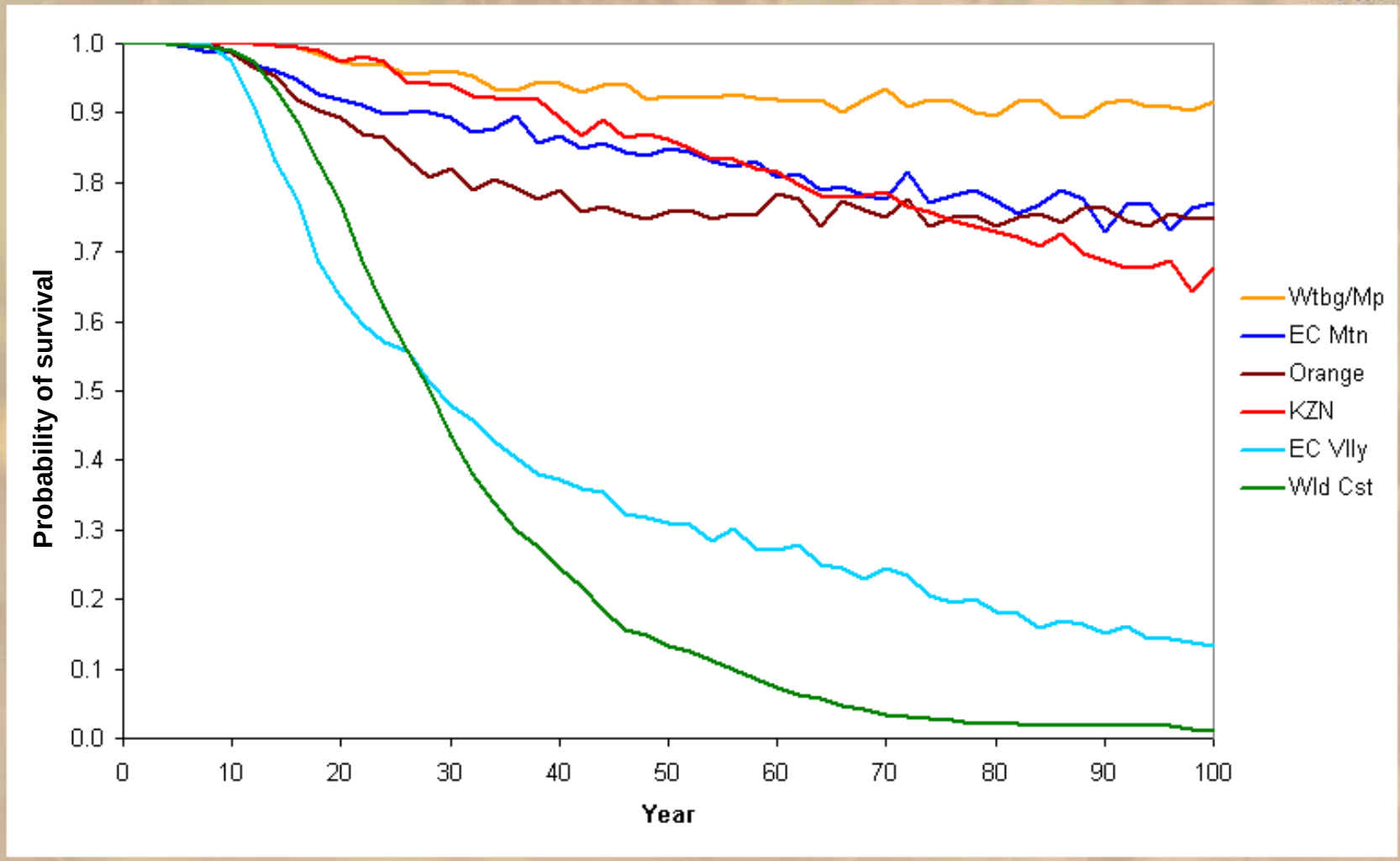
ANNUAL HARVEST MODELLED IN EACH SUBPOPULATION

Population Area	Trophy hunting	Local Hunting		Problem animals	Emigrants	Total
		Legal	Illegal			
Kruger	6	0	2	2	20	30
N Limpopo	25	10	40	15	0	90
Waterbg / Mpl	25	10	40	15	0	90
KZN	5	2	20	10	0	37
Kalahari	0	0	2	0	5	7
Orange River	0	0	2	2	0	4
Western Cape	0	0	3	4	0	7
E Cape Mtn	0	0	6	2	0	8
E Cape Valley	0	0	4	2	0	6
Wild Coast	0	0	2	0	0	2
Total	*61*	*22*	*121*	*52*	*25*	*281*

BASELINE MODEL RESULTS

- SA Leopard *metapopulation* persists over next 100 years
- Little loss in numbers or genetic diversity.
- HOWEVER fate of *individual* populations is shaky:
  - 4 populations (Kruger, Limpopo, Western Cape & Kalahari) fare well (PE=0; positive growth; high GD)
  - 4 populations (Waterberg/Mpl, KZN, Orange River & E Capt Mtn) have moderate risk of extinction and reduced population size
  - 2 populations (E Cape Valley & Wild Coast) have high risk of extinction, population decline and low GD
  - Sensitivity testing suggests that uncertainty in demographic rates only affects viability of those populations with moderate risk

BASELINE FOR 6 DECLINING POPS



Management Options: *Development*

- Development modelled with estimated loss in K of 15% & increase in illegal harvest of 5%.
- Results indicate increase in PE of local pop from 8% - 13% over 100 years & decrease in mean size of surviving pop from 619 to 460.
- Remaining pops & metapop relatively unaffected.

Management Options: *Corridors*

- Corridors modelled by doubling dispersal rate. Had little effect on metapop or bigger pops.
- Corridors between Orange River & W Cape & 3 pops of W & E Cape lowers extinction risk of Orange River & E Cape pops.
- Impact of corridors depends on movement through these areas & mortality associated with dispersal.

Management Options: *Removing Illegal Harvest*

- Illegal local hunting estimated to account for 43% of annual harvest & affects all pops.
- Eliminating illegal hunting significantly improves persistence of local pops; all have zero risk of extinction in next 100 years.
- Results suggest that even small pops can withstand the removal of occasional problem animals if illegal hunting is eliminated.
- Estimates of illegal hunting are uncertain & efforts to document and reduce/eliminate illegal Leopard removal are recommended.

Management Options:

Effect of removing illegal harvest

Population Area	PE_{100}		Mean Pop. Size	
	Baseline	No Illegal Harvest	Baseline	No Illegal Harvest
Kruger	0	0	1184	1182
N Limpopo	0	0	1512	1545
Waterbg / Mp	0.08	0	619	1042
KwaZulu-Natal	0.32	0	322	436
Kalahari	0	0	56	56
Orange River	0.25	0	50	58
W Cape	0	0	425	429
E Cape Mountain	0.23	0	29	61
E Cape Valley	0.87	0	27	69
Wild Coast	0.99	0.01	19	28
Metapopulation	**0**	**0**	**4025**	**4909**

Management Options: CITES quotas

Quota distribution among populations used in Vortex model

Population	Base	0	75	90	105	120	135	150
Kruger	6	0	6	8	10	12	14	16
N Limpopo	25	0	30	36	42	48	54	60
Waterbg / Mp	25	0	30	36	42	48	54	60
KwaZulu-Natal	5	0	5	6	7	8	9	10
E Cape Mtn	0	0	4	4	4	4	4	4
Total removed	61	0	75	90	105	120	135	150

Only tested CITES quota offtake for populations likely to be utilised: Kruger, Limpopo, Waterberg/Mpl, KZN & E Cape

Management Options: CITES quotas

Throughout range (0 to 150 annually):

- no effect on pops in Kruger, Limpopo, Kalahari & W Cape;
- Limpopo numbers decline slightly;
- Orange River, E Cape Valley & Wild Coast pops relatively unaffected, as no Leopards removed via trophy hunting from these pops;
- E Cape mnts = extinction risk increases from 28% - 60% in 100 yrs) with utlisation of 4 permits pa;
- Waterberg/Mpl pop increases extinction risk from 16% - 25%
- KZN pop increases extinction risk from 11% - 62%
- Metapop: 4631 Leopards (0 quota) – 3844 Leopards (75 quota) – 3196 (150 quota) and drop in saturation from 93% - 64%.

Effect of sex ratio and inclusion of problem animals in trophy hunting takes on Leopard populations

	Kruger	Limpopo	Water/Mp	KZN	ECape M	Metapop
PROBABILITY OF EXTINCTION						
60% male	0	0	0.25	0.62	0.62	0
100% male	0	0	0.19	0.37	0.51	0
Incl. 30 prob.	0	0	0.24	0.14	0.59	0

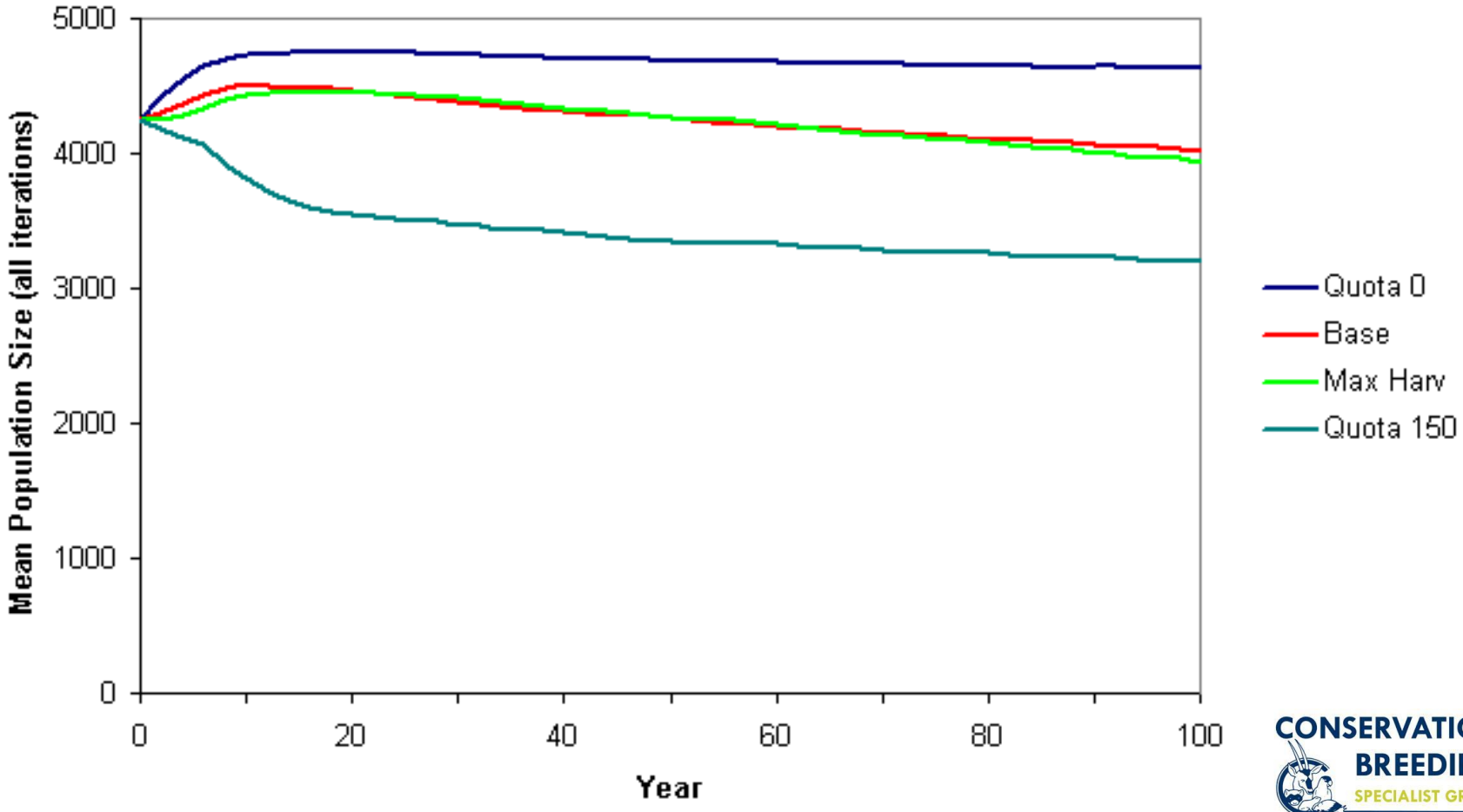
SUSTAINABLE HARVEST FOR LOCAL POPS

- Varied annual harvest levels in each pop to estimate max level of harvest that meets pop goals of *0 extinction risk* for Kruger, KZN, Kalahari & W Cape populations & PE $\leq$ 5% for remaining 6 pops.
- Harvest includes loss from all sources outside of normal mortality,
- It is estimated that **absolute max of 350** adult Leopards (53% males) can be removed pa without unacceptable risk to the metapop.
- Current estimates include annual loss of 77 animals through emigration & problem animal removal, 143 Leopards removed through legal & illegal local hunting, leaving approx 130 available for trophy hunting.
- Of remaining 130, 61 Leopards are currently taken pa under CITES quota of 75. Thus a **maximum** of another 69 animals may be hunted before extinction risks become unacceptable.

SUSTAINABLE HARVEST FOR LOCAL POPS

- This assumes that estimates of current Leopard losses are correct at 281
- If figure of actual losses is higher the no. of Leopards “available” must be reduced.
- With no off-take through trophy hunting, the metapop size remains relatively stable at current baseline model values.
- Any CITES quota off-takes will result on average in overall pop reduction, through local declines & extinctions.
- Max harvest level emphasises importance of careful selection of the geographic area from which Leopards are harvested.
- Imperative that these figures are treated with caution due to paucity of reliable data.
- Recommended that adequate resources are committed to filling data gaps & modelling revision is undertaken before quota increases are implemented.

MEAN METAPOPULATION SIZE WITH CITES QUOTAS



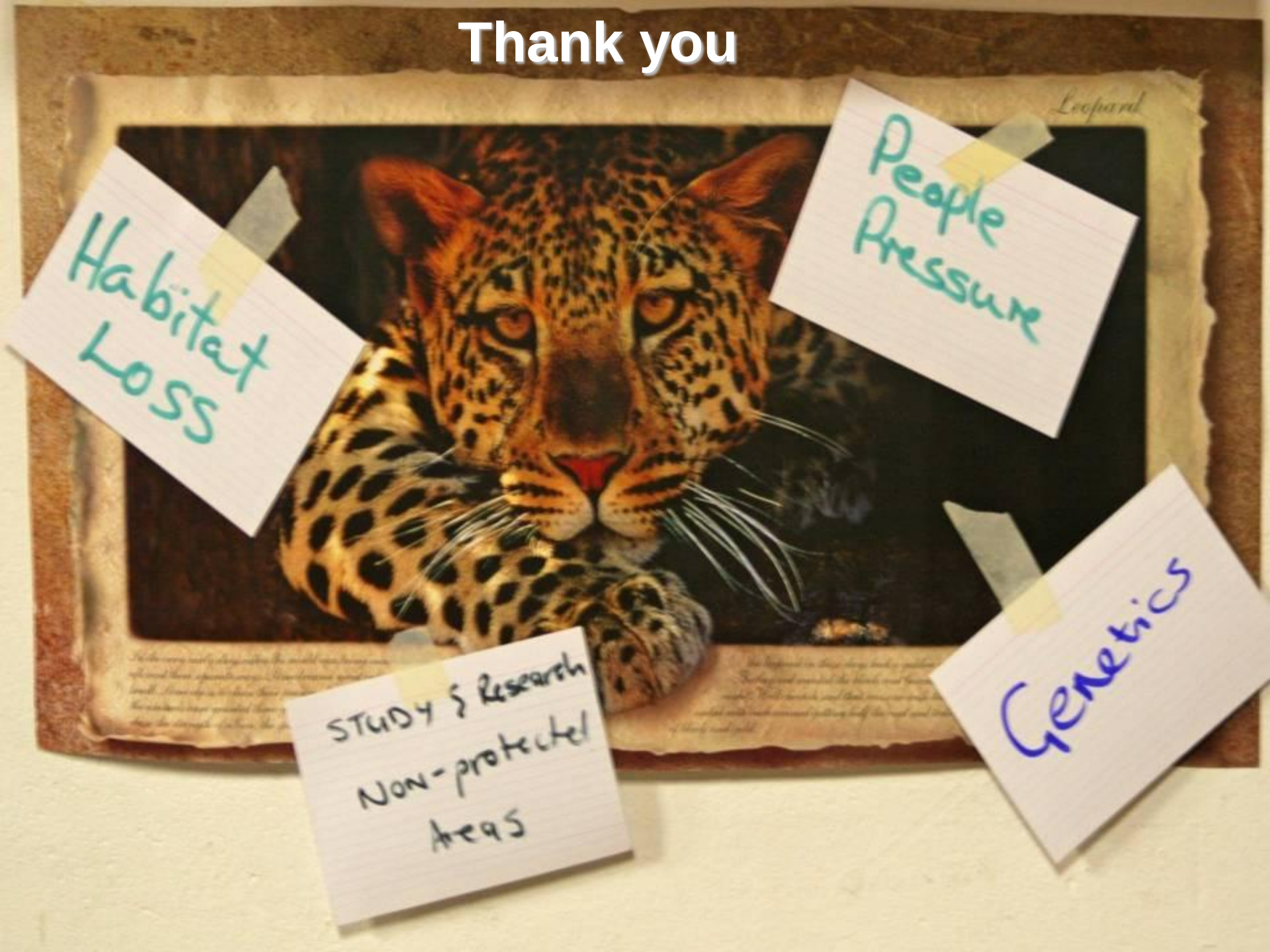
CONCLUSION

- Current estimated rates of Leopard harvest indicate low risk of extinction in Kruger, Limpopo, W Cape & Kalahari.
- No risk of extirpation of Leopards from South Africa.
- Pops in Waterberg/Mpl, KZN, Orange River, E Cape Mnt & Valley & Wild Coast are at some risk of extinction
- E Cape Valley & Wild Coast pops are highly vulnerable to extinction in next few decades.
- Strategies to promote persistence of VU 6 pops include natural corridors among adjacent popns & minimizing harvest.
- Some controlled harvest can be sustained without extreme risk to the metapop but data too poor to be exact.

CONCLUSION

- Max harvest model suggests that MAX additional 69 (MSY) Leopards can be removed from the SA metapop.
- Eliminating illegal hunting positively impacts survival of all local pops, all have zero risk of extinction in next 100 years.
- Improved protection of Leopards may allow increased legal hunting quotas.
- Illegal hunting in all areas must be reduced or stopped.
- Increased pop monitoring & data gathering is imperative to assess the impact of harvesting & allow harvesting rates to be adjusted as needed.
- As better data on Leopard biology & pops become available, models should be revised to better project the impact of harvesting on Leopard populations throughout SA.

Thank you


Leopard
Habitat Loss
People Pressure
Study & Research Non-protected Areas
Genetics