WILDLIFE MANAGEMENT PRACTICES IN SOUTH AFRICA DRIVE CREATION OF HYBRID ZONES

Nicole Benjamin-Fink & Brian Reilly

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The problem.. Historically....

- Re-establishing sp' in areas of extinction

- Ironically….. extinction of pure genetic lineages via hy
- Impacting endangered, indigenous, & rare sp

Traditional Ag. & cattle farming

↓

Wildlife ranching within the private

- Diminished economic profitability & increase in stock theft

- 9,000 private wildlife ranches (>20.5 m ha)
- +15,000 domestic livestock & wildlife

Conservation constrains ..

1. Natural process may not occur

(e.g., dispersal, emigration, colonization, and prey-predator dynamics due to small, isolated, and enclosed areas)

2. Private ranches struggle to balance economic profitability & genetic concerns

(e.g., inbreeding and bottlenecks)

3. Intensified wildlife management practices

Market drivers for WTPs

- hunting (67%), game trading (28%), game meat production (>20%) trophy hunting, ecotourism

WTP shape ecosystem dynamics

- Commercialized wildlife ranching promotes WTP amongst private landowners > 50 countries

- USA & SA have the highest utilization

WTP promotes conservation

- Historically, an effective conservation tool
  bringing sp back from the brink of extinction
  via rewilding and reintroductions

Southern white rhinoceros (*Ceratotherium simum simum*)

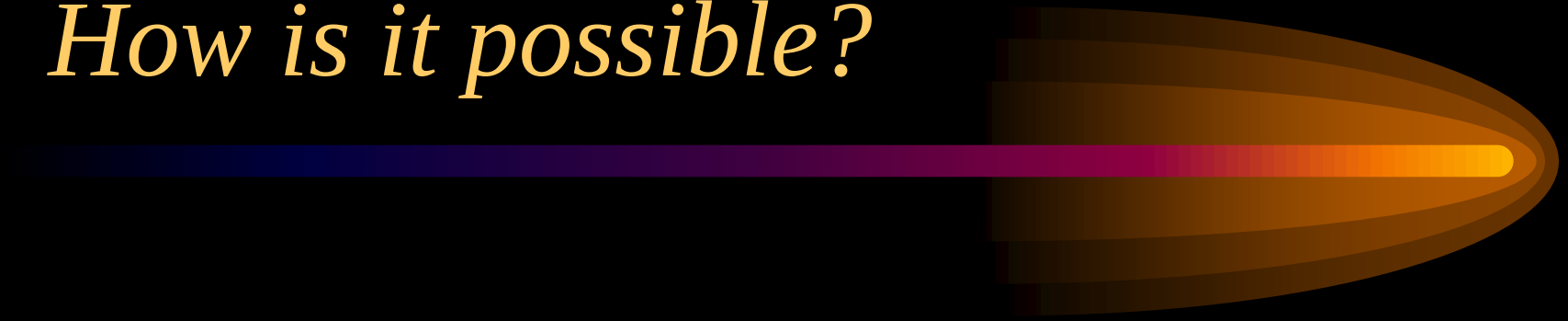
Black wildebeest (*Connochaetes gnou*)

Bontebok (*Damaliscus dorcas*)

Cape mountain zebra (*Equus zebra zebra)*

Ironically, genetic integrity jeopardized

How is it possible?



- W/B lineage diverged from a shared ancestor merely 1.8 myr
- Sort evolutionary scale for reproductive barrier when sympatric

- Hy’ on Abe Bailey reserve = pop culled

Social structures & niche occupancy

- Female herd
- Bachelor herds
- Territorial or solitary bulls

- B W/B ---------- woodlands & grasslands
- B W/B ---------- regions with trees

- WB hy' focus of a number of prominent papers (Corbet & Robinson 1991; Ackermann *et al.* 2010; Grobler *et al. 2005*, 2011; Roed et al. 2011)

- Alarmingly, a significant proportion of game translocations may involve wildebeest
- no comprehensive database indicating the location, or even existence, of pure black WB.

What is hybridization and how is it possible

- Hy' is one of the most important conservation challenges facing wildlife worldwide in the 21st century
- Threatens endangered, indigenous, rare sp', & hence ecosystems
- Reduced genotypic variance and phenotypic resilience
- Accelerating at an alarming rate

What we did ?

(1) Analyze dispersal patterns

(2) Identify which species is primarily translocated

(3) Asses sustainability of the translocation practice

(4) Identify implications of this practice on the function of provincial protected areas protected (PPAs)

(5) Offer a feasible framework; employ Bayesian modeling

How we did it

- 6,929 translocated W/B
- 275 private ranches & 3 PPAs
- over 5 years

We defined WTP

(1) A game capture company is hired to translocate game

(2) Official permits obtained via gov`

(3) Process included: (i) capture, (ii) handling, (iii) relocation, & (iv) release.

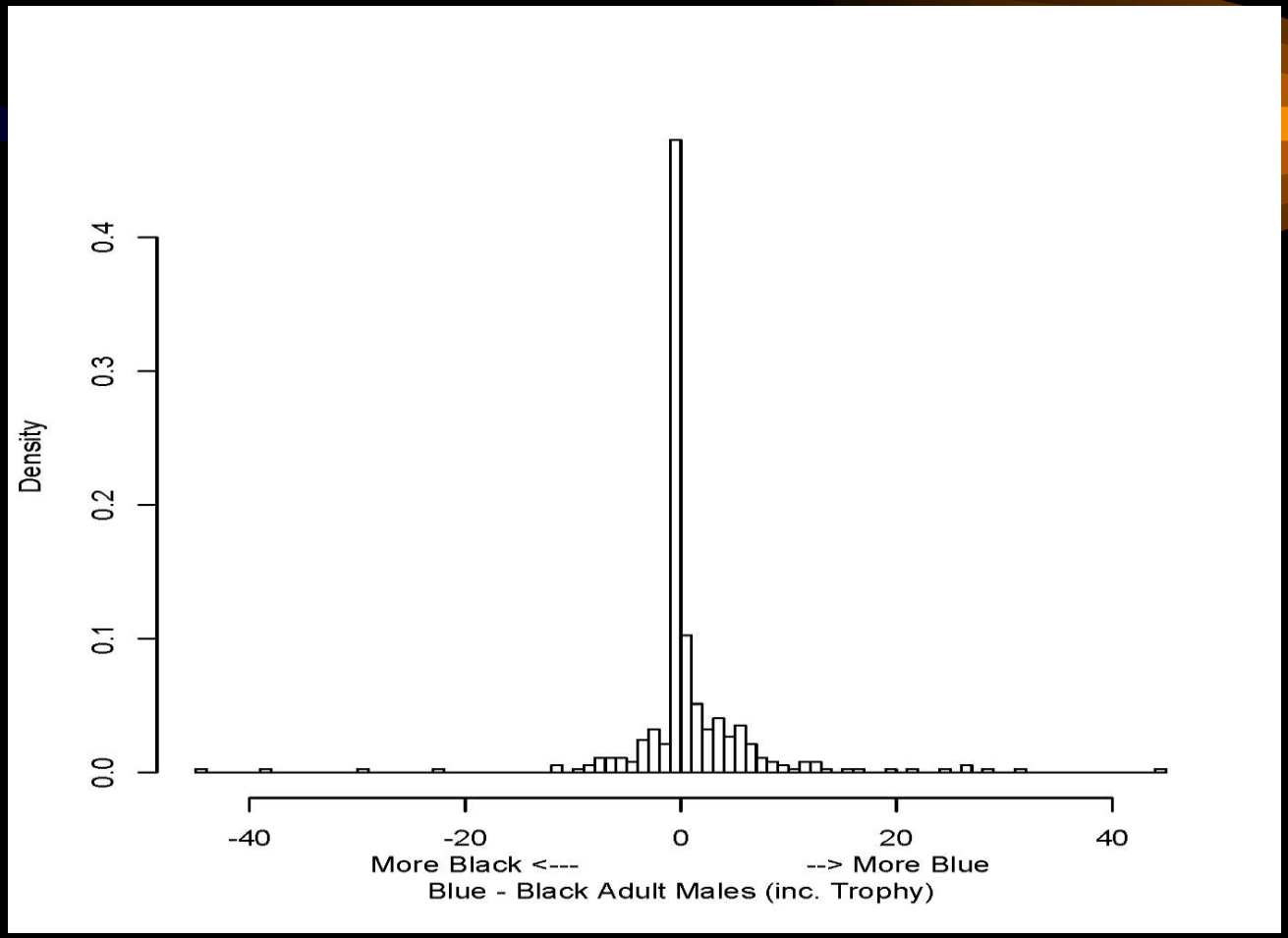
(excluding public auctions)


ZS-RTS

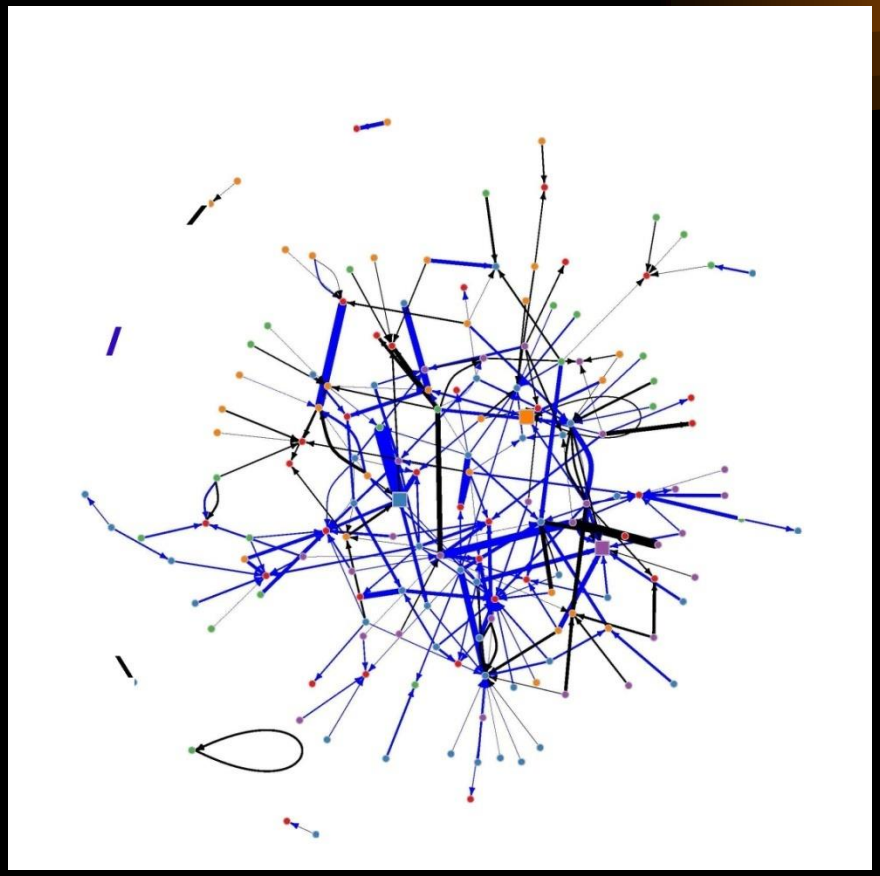
- Identifiable genetic markers are none exsistant
- extrapolate the impact of barriers to gene flow on potential hybridization occurrences, (suggestive of a potential hybrid zone).

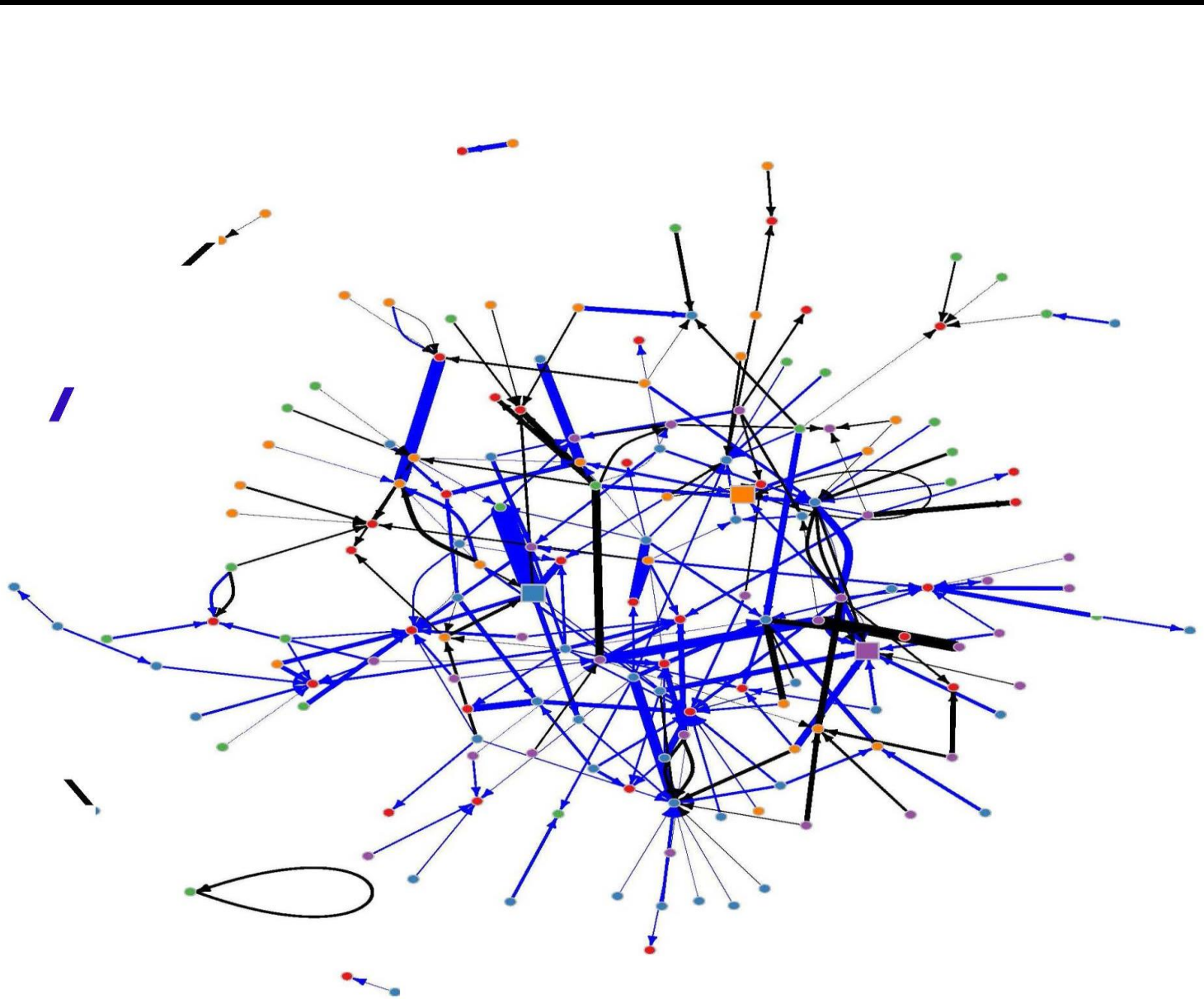
- response variable (i.e., presence of overlapping wildebeest).

Translocation efforts alter interspecies and intraspecies dynamics



Translocation occur amongst multiple PPAs and private ranches within and across provincial borders





Black & blue WB translocation account for a sustainable & profitable market sector

Revenue generated from WB translocation	% of revenue generated from WB translocations	Revenue generated from all game translocations
16.8	17.99	93.7
18.9	15.65	120.8
18.5	17.27	107.4
19.9	18.48	107.8
32.8	34.83	94.3

Policy interventions and hybridization rates

Management Practice	T test	
fences	10.6373	0.001108 **
waterholes	0.0204	0.886472
feeding grounds	9.8327	0.020043*

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Findings

(1) W/B are introduced to the private and commercial industry from **multiple sources**

(2) Black W/B males of reproductive age are primarily translocated

(3) Revenue from W/B accounted for 20.8% of WTs

Expert knowledge generated

- (1) identify the appropriate factors
- (2) widest possible range of realistic probability for each node, in addition to that of input links and output states
- (3) predict posterior consequences & provide reasoning;
- (4) determine feasibility of various mgt plans

$$p(\theta|D) = \frac{\mathrm{p(D|\theta)p(\theta)}}{\mathrm{p(D)}} \qquad (1)$$

This relationship indicates that the posterior is proportional to the likelihood of a priori data:

$$p(\theta|D) \propto p(D|\theta)p(\theta) \qquad (2)$$

Parameterization

-Netica

monitoring sampling runs in real time

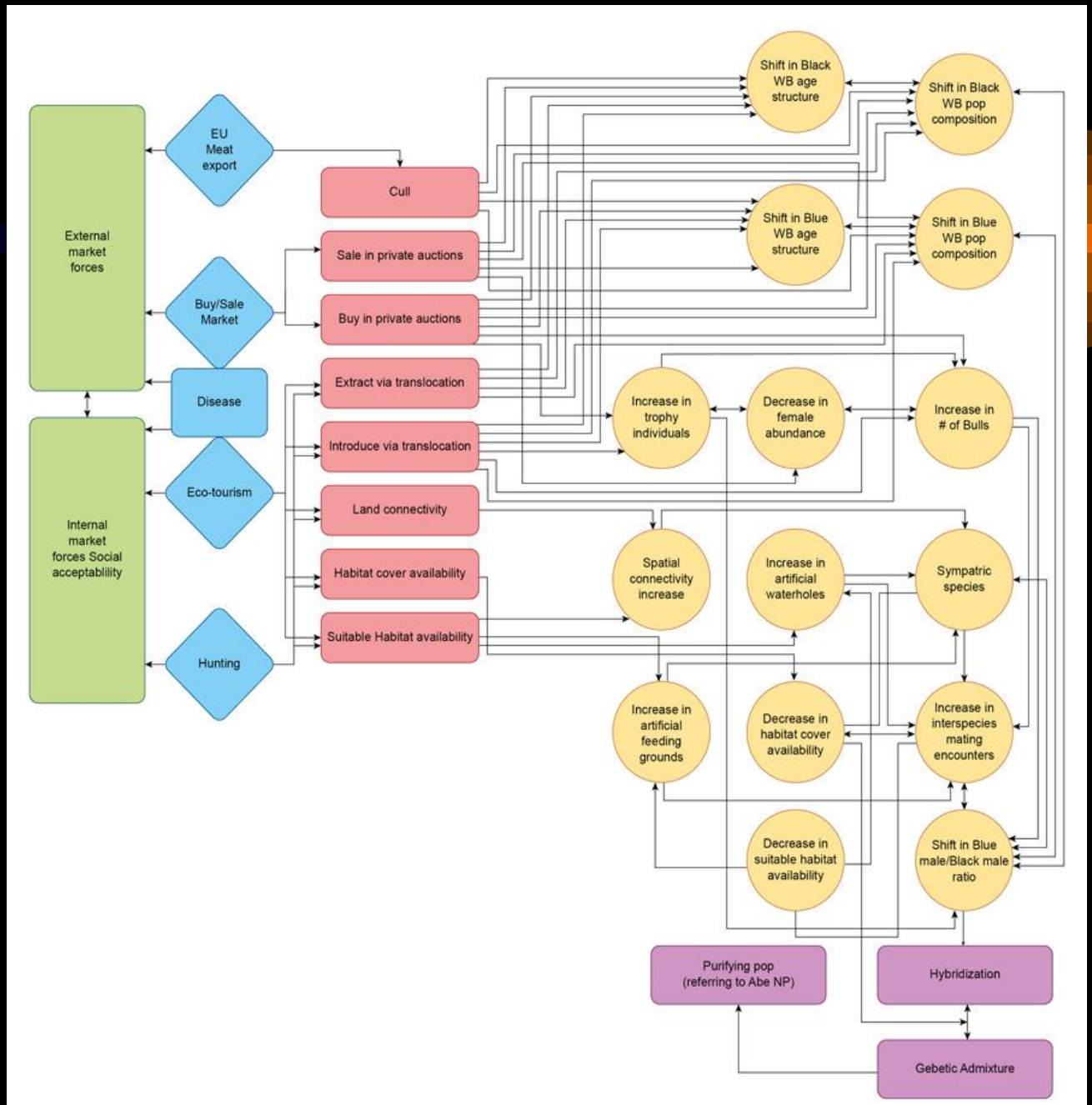
-Prior to parameterization, all variables were discredited into states

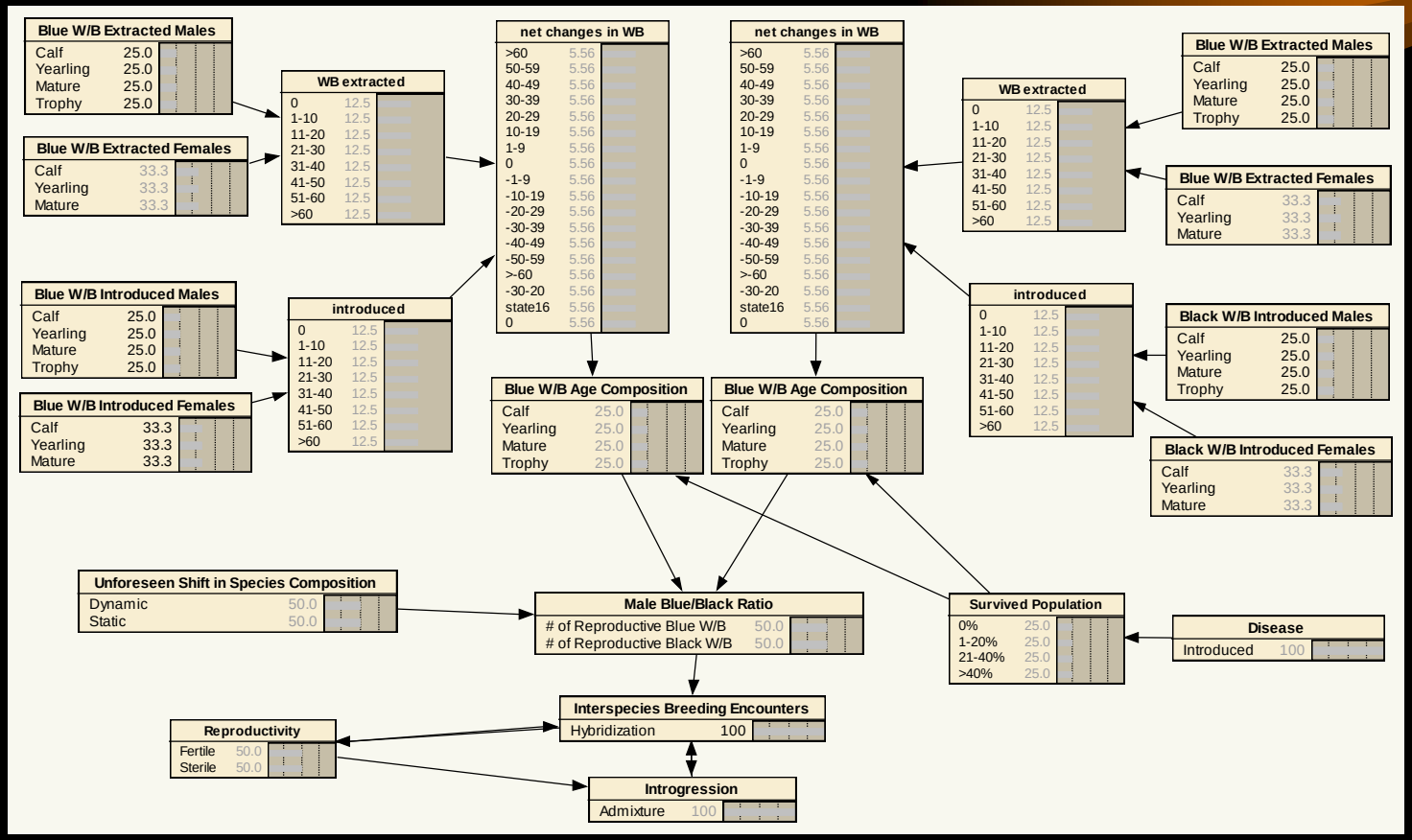
-Stochasticity lies in the distribution rather than the production of a single value

-nonlinear mixed effects = fixed effects

- Expert knowledge = fixed data

- Experts were asked to generate the widest possible range of realistic probabilities and to predict posterior consequences
- Experts and stakeholders were treated as one group (objs)


External market forces
Internal market forces Social acceptablility
EU Meat export
Buy/Sale Market
Disease
Eco-tourism
Hunting
Cull
Sale in private auctions
Buy in private auctions
Extract via translocation
Introduce via translocation
Land connectivity
Habitat cover availability
Suitable Habitat availability
Shift in Black WB age structure
Shift in Black WB pop composition
Shift in Blue WB age structure
Shift in Blue WB pop composition
Increase in trophy individuals
Decrease in female abundance
Increase in # of Bulls
Spatial connectivity increase
Increase in artificial waterholes
Sympatric species
Increase in artificial feeding grounds
Decrease in habitat cover availability
Increase in interspecies mating encounters
Decrease in suitable habitat availability
Shift in Blue male/Black male ratio
Purifying pop (referring to Abe NP)
Hybridization
Gebetic Admixture


Blue W/B Extracted Males
Calf 25.0
Yearling 25.0
Mature 25.0
Trophy 25.0
Blue W/B Extracted Females
Calf 33.3
Yearling 33.3
Mature 33.3
WB extracted
0 12.5
1-10 12.5
11-20 12.5
21-30 12.5
31-40 12.5
41-50 12.5
51-60 12.5
>60 12.5
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Yearling 25.0
Mature 25.0
Trophy 25.0
Blue W/B Introduced Females
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1-10 12.5
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31-40 12.5
41-50 12.5
51-60 12.5
>60 12.5
net changes in WB
>60 5.56
50-59 5.56
40-49 5.56
30-39 5.56
20-29 5.56
10-19 5.56
1-9 5.56
0 5.56
-1-9 5.56
-10-19 5.56
-20-29 5.56
-30-39 5.56
-40-49 5.56
-50-59 5.56
>-60 5.56
-30-20 5.56
state16 5.56
0 5.56
Blue W/B Age Composition
Calf 25.0
Yearling 25.0
Mature 25.0
Trophy 25.0
Unforeseen Shift in Species Composition
Dynamic 50.0
Static 50.0
Male Blue/Black Ratio
# of Reproductive Blue W/B 50.0
# of Reproductive Black W/B 50.0
Reproductivity
Fertile 50.0
Sterile 50.0
Interspecies Breeding Encounters
Hybridization 100
Introgression
Admixture 100
net changes in WB
>60 5.56
50-59 5.56
40-49 5.56
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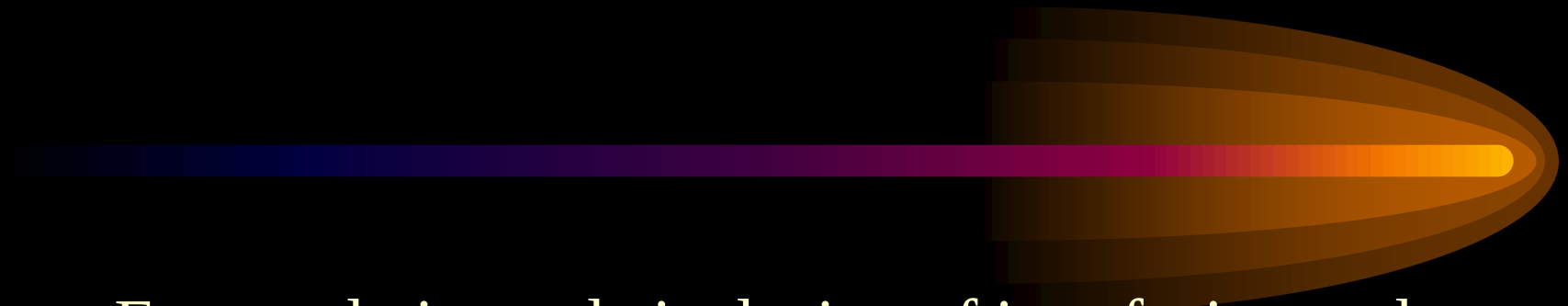
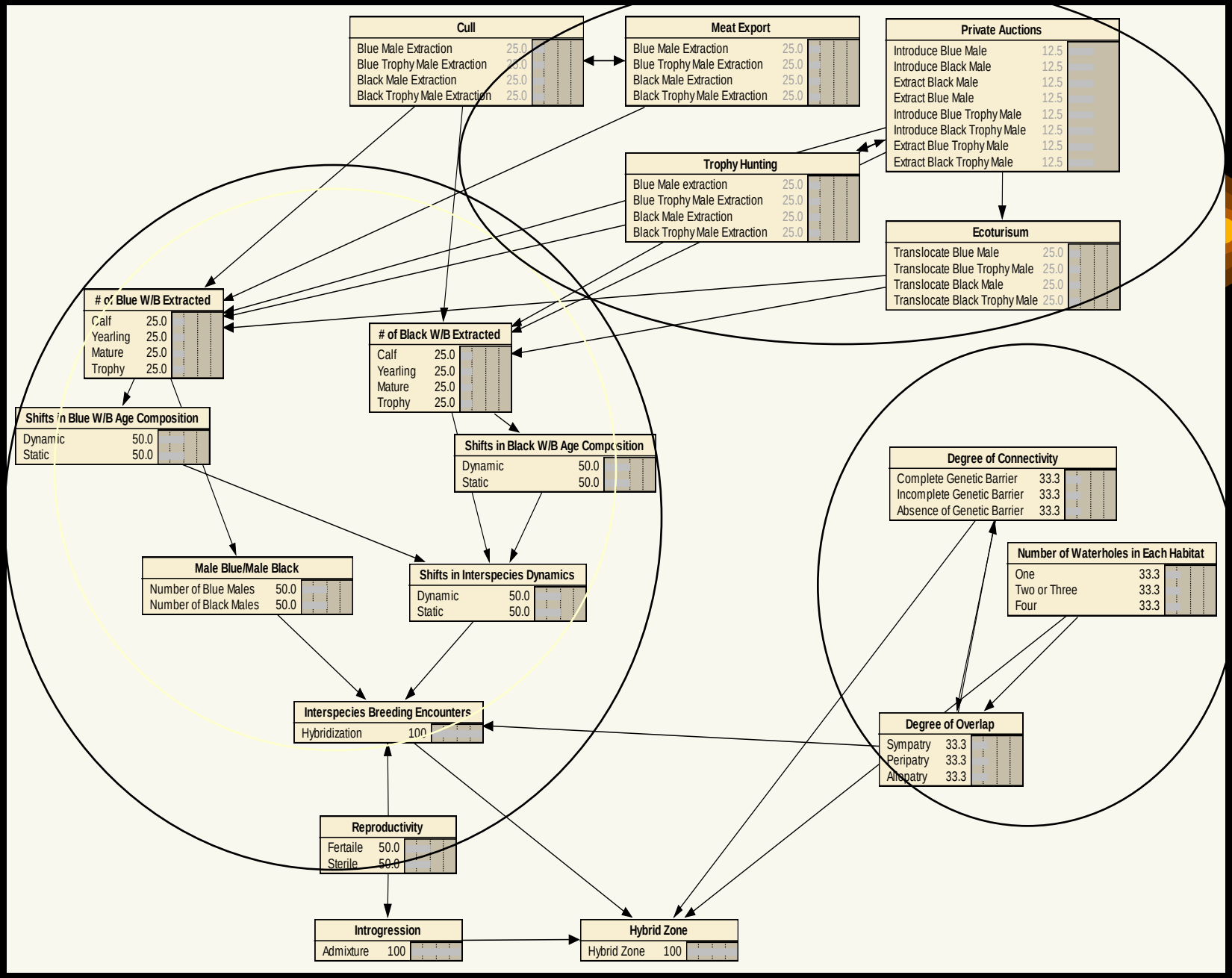
Mature 33.3
introduced
0 12.5
1-10 12.5
11-20 12.5
21-30 12.5
31-40 12.5
41-50 12.5
51-60 12.5
>60 12.5
Black W/B Introduced Males
Calf 25.0
Yearling 25.0
Mature 25.0
Trophy 25.0
Black W/B Introduced Females
Calf 33.3
Yearling 33.3
Mature 33.3
Survived Population
0% 25.0
1-20% 25.0
21-40% 25.0
>40% 25.0
Disease
Introduced 100

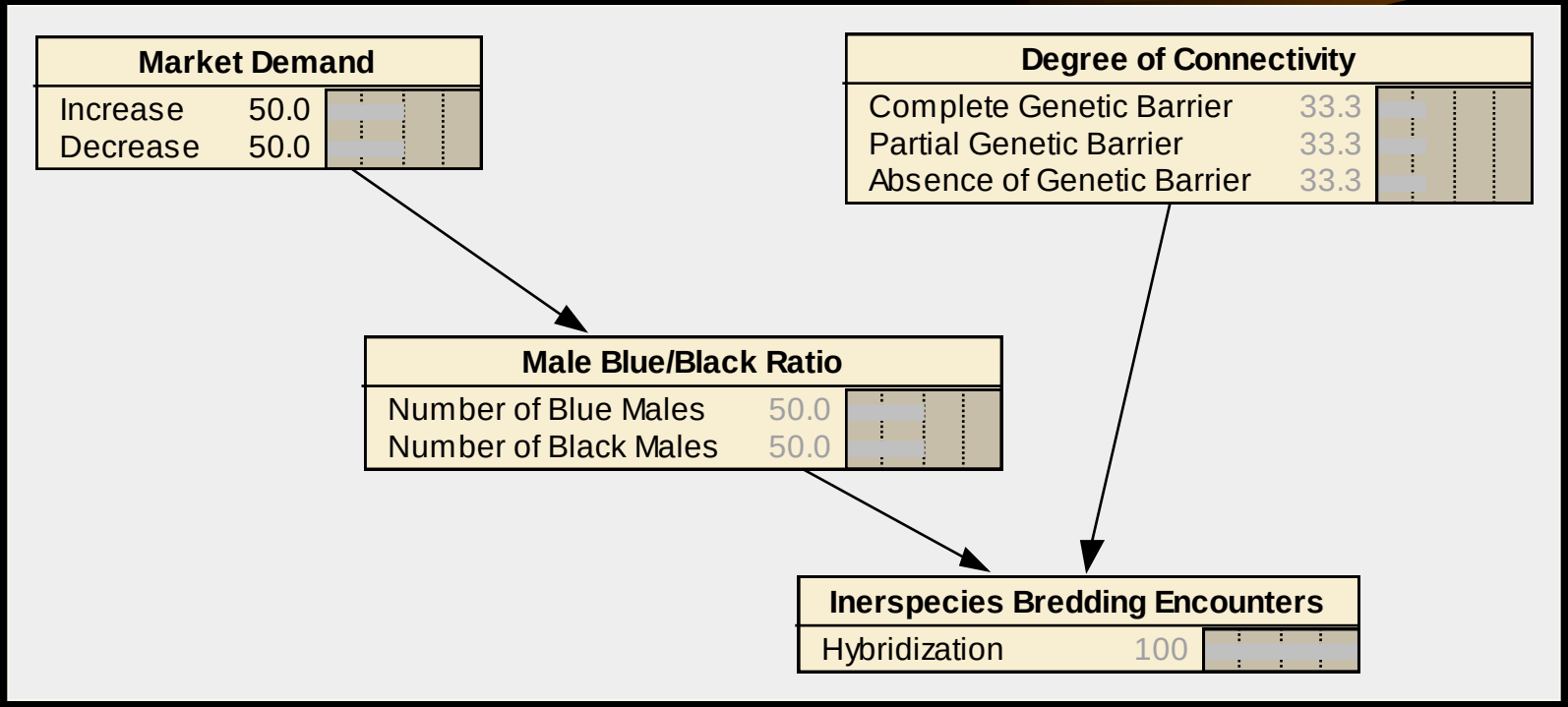
Encapsulation, inheritance, polymorphism, and abstraction

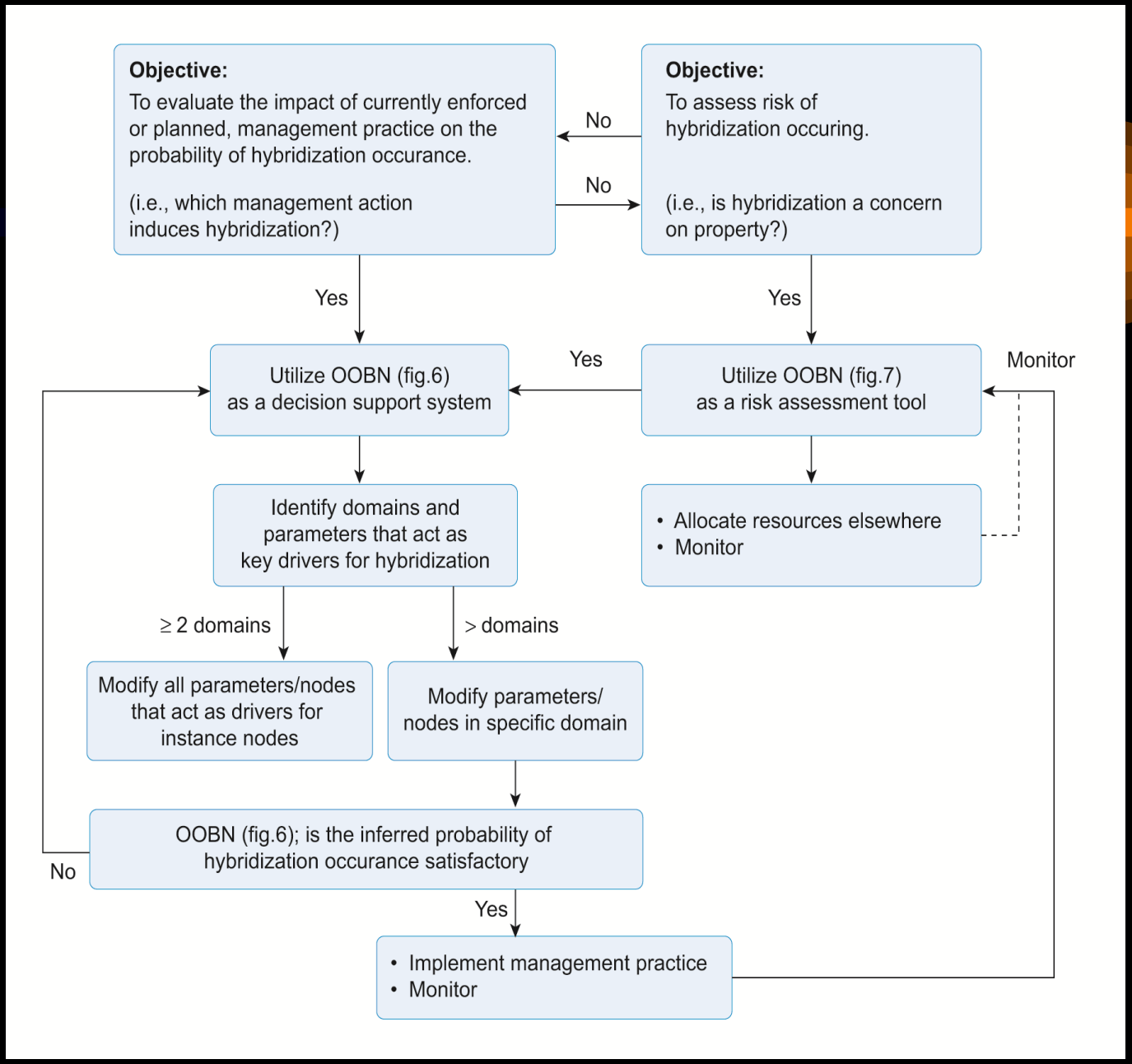


- Encapsulation-sole inclusion of interfacing nodes while hiding others (complexity is broken down)
- Inheritance- shared code between networks, maximizing programming efficacy.
- hierarchical structure- scope, definition, implementation, and relevance


Cull
Blue Male Extraction 25.0
Blue Trophy Male Extraction 25.0
Black Male Extraction 25.0
Black Trophy Male Extraction 25.0
Meat Export
Blue Male Extraction 25.0
Blue Trophy Male Extraction 25.0
Black Male Extraction 25.0
Black Trophy Male Extraction 25.0
Private Auctions
Introduce Blue Male 12.5
Introduce Black Male 12.5
Extract Black Male 12.5
Extract Blue Male 12.5
Introduce Blue Trophy Male 12.5
Introduce Black Trophy Male 12.5
Extract Blue Trophy Male 12.5
Extract Black Trophy Male 12.5
Trophy Hunting
Blue Male extraction 25.0
Blue Trophy Male Extraction 25.0
Black Male Extraction 25.0
Black Trophy Male Extraction 25.0
Ecoturisum
Translocate Blue Male 25.0
Translocate Blue Trophy Male 25.0
Translocate Black Male 25.0
Translocate Black Trophy Male 25.0
# of Blue W/B Extracted
Calf 25.0
Yearling 25.0
Mature 25.0
Trophy 25.0
# of Black W/B Extracted
Calf 25.0
Yearling 25.0
Mature 25.0
Trophy 25.0
Shifts in Blue W/B Age Composition
Dynamic 50.0
Static 50.0
Shifts in Black W/B Age Composition
Dynamic 50.0
Static 50.0
Degree of Connectivity
Complete Genetic Barrier 33.3
Incomplete Genetic Barrier 33.3
Absence of Genetic Barrier 33.3
Number of Waterholes in Each Habitat
One 33.3
Two or Three 33.3
Four 33.3
Male Blue/Male Black
Number of Blue Males 50.0
Number of Black Males 50.0
Shifts in Interspecies Dynamics
Dynamic 50.0
Static 50.0
Interspecies Breeding Encounters
Hybridization 100
Degree of Overlap
Sympatry 33.3
Peripatry 33.3
Allopatry 33.3
Reproductivity
Fertaile 50.0
Sterile 50.0
Introgression
Admixture 100
Hybrid Zone
Hybrid Zone 100

Risk assessment




Objective:
To evaluate the impact of currently enforced or planned, management practice on the probability of hybridization occurance.
(i.e., which management action induces hybridization?)
No
Objective:
To assess risk of hybridization occuring.
(i.e., is hybridization a concern on property?)
No
Yes
Yes
Utilize OOBN (fig.6) as a decision support system
Yes
Utilize OOBN (fig.7) as a risk assessment tool
Monitor
Identify domains and parameters that act as key drivers for hybridization
• Allocate resources elsewhere
• Monitor
≥ 2 domains
> domains
Modify all parameters/nodes that act as drivers for instance nodes
Modify parameters/ nodes in specific domain
OOBN (fig.6); is the inferred probability of hybridization occurance satisfactory
No
Yes
• Implement management practice
• Monitor

- T. Klagsbrun, S. Vrahimis.

- Many SA game owners, managers, scientists, & gov` officials who generously donated their time and knowledge