BLACK RHINO CONSERVATION ECOLOGY PROJECT

Protecting them through Science

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CRITICALLY ENDANGERED
DICEROS BICORNIS

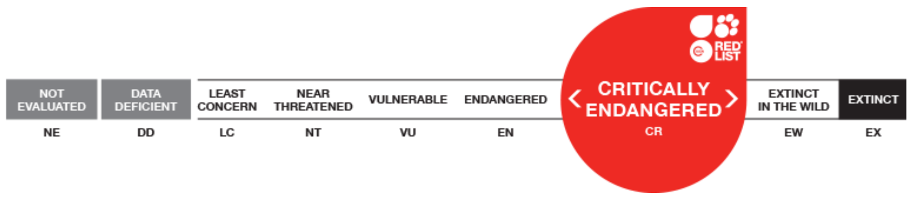
SPECIES IMPORTANCE

Megaherbivores, such as black rhinos, play several fundamental roles in the ecosystem, such as controlling other species through competition and habitat partitioning (Owen-Smith, 1992) (Landman, 2013), habitat modification, and nutrient cycling (Ripple *et al.*, 2015). Accordingly, they have an important impact on their environment. Rhinos also play an essential part in the tourism industry for countries such as South Africa and are valued between US$ 450'000 and US$1'150'000 per rhino alive in the wild (Saayman & Saayman, 2017), making *D. bicornis,* a **species of priority**, in terms of **biodiversity** and **economic targets.**

Mahlasela and her calf in Ithala Game Reserve, ZA

BLACK RHINO CONSERVATION STATUS

Since 1960, the worldwide population of black rhinos *(Diceros bicornis)* has declined by an estimated 98% (Adcock & Emslie, 2016). Extensive hunting of the species as well as loss of habitat by clearance of land for settlement, led to a rapid decline and near extinction. Black rhinos are presently listed as Critically Endangered at a global level (IUCN, 2011).



Threats to the species

Poaching

Poaching for rhino horn is the species' biggest threat and is driven by greed. While in 1993, a kilo of rhino horn was priced on the Asian black market at $4700, in 2012 it was $65'000, making it worth more than gold, diamonds and even cocaine (Biggs *et al.*, 2013). It is sought as a traditional remedy or as ornamentals related to status in the Far East (Biggs et al., 2013). Increasing demand for rhino horn in Asia has led to record high poaching incidents all over Africa.

South Africa holds over 80% of the global rhino population and has lost over 7000 individuals over the past 10 years (Adcock & Emslie, 2016). Of that, 9.5% of poached individuals were black rhinos, white rhinos (*Ceratotherium simum*) bearing the biggest brunt of the loss (Adcock & Emslie, 2016).

If poaching continues at this rate, it is estimated that rhinos will be extinct in the wild within the next 20 years (Ripple et al., 2015).

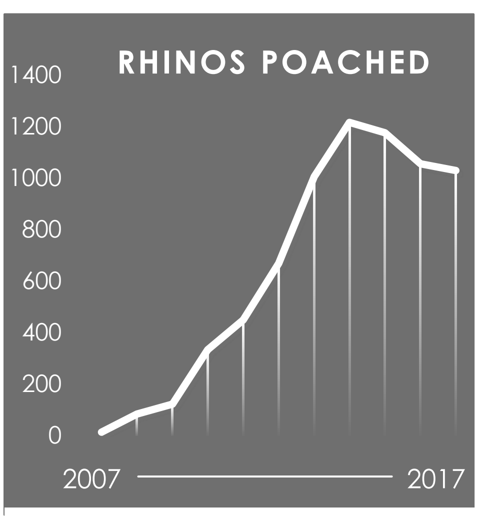
Habitat change

Habitat change is also a threat to the species (Adcock & Emslie, 2016). At present, wild black rhino populations are limited to protected areas which are often enclosed and limit migration (Landman *et al.*, 2013). Therefore, ecosystem degradation and interspecific competition in protected areas can impact and stall their productivity rate.

INCREASING POPULATIONS

REQUISITE MEASURES

In sum, to conserve this highly endangered iconic species, improved security of areas holding individuals, local commitment, enhanced law enforcement and penal actions need to be taken in conjunction with **innovative biological management strategies** that correctly quantify habitat suitably and potential carrying capacity (Ferreira et al., 2017).



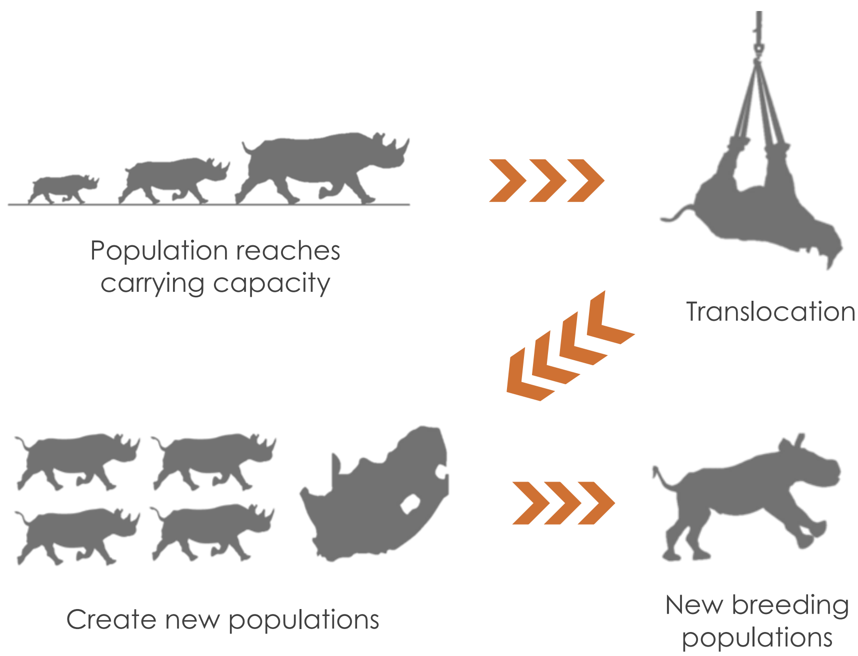
Number of rhinos poached annually in South Africa from 2007 to 2017

INCREASING POPULATION NUMBERS

Thanks to the CITES (Convention on the Trade of Endangered Species) ban on the trade of rhino horn, in place since 1977 (Biggs et al., 2013), followed by investment in conservation strategies and monitoring, the establishment of safe havens and conservation projects such as WWF's Black Rhino Range Expansion project (BRREP), the population has since recuperated from a bottom low of 2410 individuals to recently over 5400 (Adcock & Emslie, 2016).

The Black Rhino Biodiversity Management Plan (Knight, Balfour & Emslie, 2013) aims for **a population growth rate of 5% per annum**.

To maintain a steady growth rate, populations are kept just under carrying capacity. This strategy implies the removal of selected individuals and translocation to new potential areas (Linklater, 2011).



The main challenge of a translocation plan resides in finding habitats that have all components for maximizing the species growth rate, while requiring minimal long-term management (Du Toit, 2006). Many factors intervene in estimating a habitats' potential carrying capacity, including micro- and meso-climatic conditions, substrate fertility, browsing suitability, and topography (Adcock, 2001). While several previous carrying capacity models have been proposed, they often reveal inefficient (Morgan *et al*, 2009). For instance, **carrying capacity is often overestimated** due to inaccurate estimation of plant species preferences (Morgan *et al.*, 2009) and the underestimated inclusion of alien invasive species in their diet (Duthé, 2018).

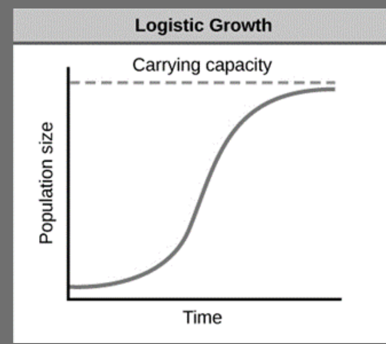
STRATEGY

LOGISTIC GROWTH MODEL

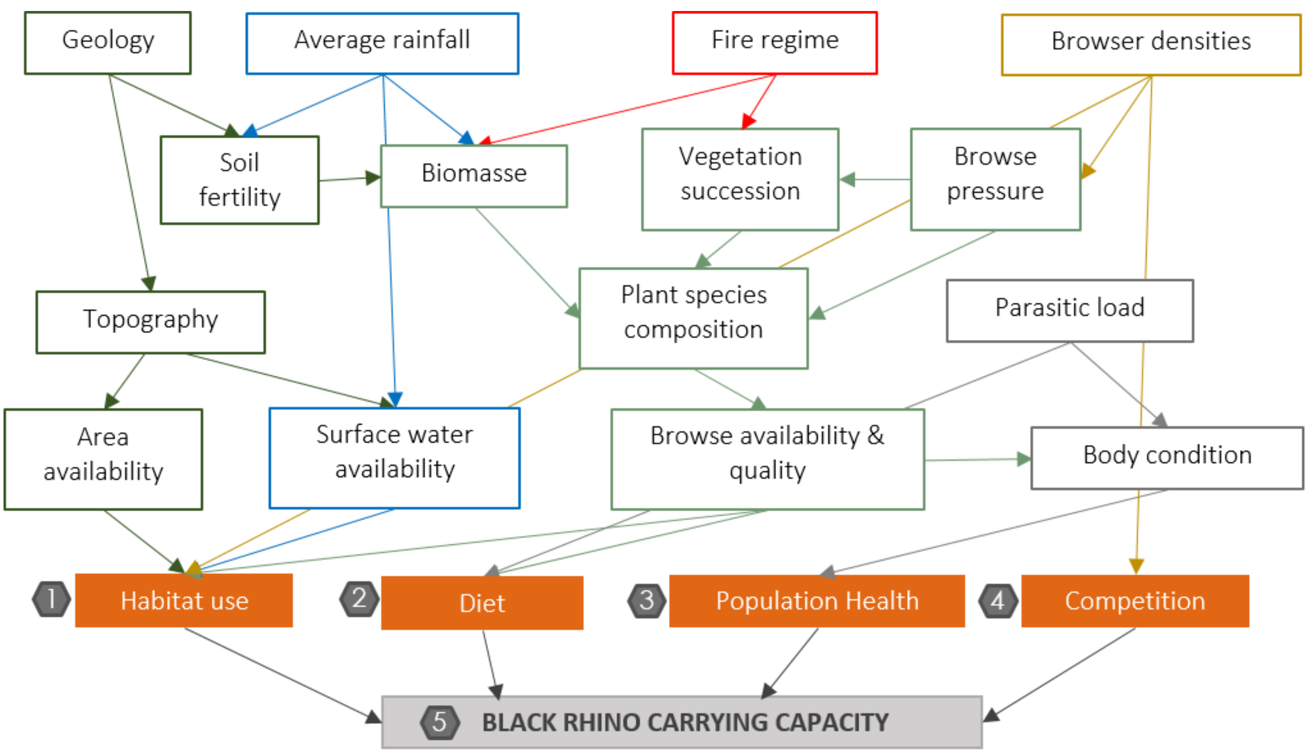
The strategy implies the development of a more accurate logistic growth model through more precise estimation of key parameters: carrying capacity and intrinsic growth rate ***K*** and ***r***.

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right) - hN$$

Where ***h*** is the fraction of the population harvested, in other words, individuals that are removed to be relocated



VARIABLES AFFECTING INTRINSIC GROWTH RATE *r* AND CARRYING CAPACY *K*



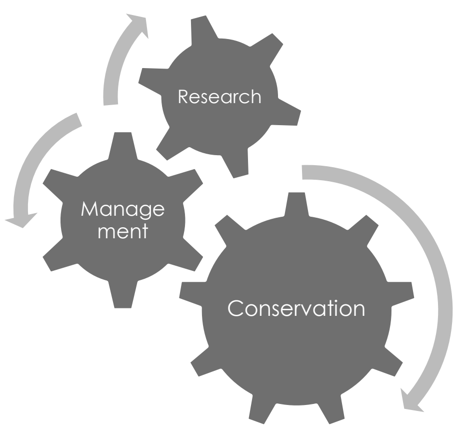
ECOLOGICAL PARAMETERS FROM 1 TO 4 TO BE STUDIED TO ADDRESS PROJECT'S AIM

GOALS AND OBJECTIVES

PROJECT AIM

This project aims at addressing major challenges for **improving black rhino conservation** through rigorous quantification of their ecological niche and habitat use, and ultimately, a better estimation of their habitat suitability.

Research is needed to improve knowledge on black rhino ecology where it is lacking in light of effective management leading to reinforced conservation .



A ranger monitoring in Ithala Game Reserve, ZA

TASKS

Ultimately the aim of this project is to develop an up-to-date carrying capacity model and optimize management of the species. To accomplish this aim, five tasks focusing on black rhino habitat use, in depth feeding ecology, population health, competition pressure and modeling will be performed.

1 Understand **habitat use** through animal spatial and temporal movements. Evaluate individuals' choice of microhabitat, focusing on topography, rainfall, surface water availability, geology, vegetation communities and how they utilize it. Test for seasonal movements and how black rhinos respond to extraordinary events such as fire. Determine individual home range size and habitat use.

2 Gather detailed **dietary information** of preferred and avoided species, the availability and quality of species and factors that drive forage selection. Assess the impact of alien invasive plant species, which are spreading thoughout South Africa, on black rhino diet.

3 Scrutinize population performance by **assessing population health**. Parasitic load will be quantified and used and as an indicator, as parasites are known to degrade body condition and general health leading to poor population performance. Habitat and diet may play an important role in controlling parasites, therefore aspects linked to toxicity of diet and the effect on population health will be explored.

4 Investigate potential **competition** pressure black rhinos may face from other browsers. Research whether competition for resources exists and if avoidance of large densities of others browsers such as elephant, impala, kudu or giraffe occurs.

5 Integrate all the previous, data generated from task 1 to 4, into a **habitat suitability map** and ultimately into a **carrying capacity model**. The study environment's habitats will be scored and the models tested.

How will this benefit black rhino conservation?

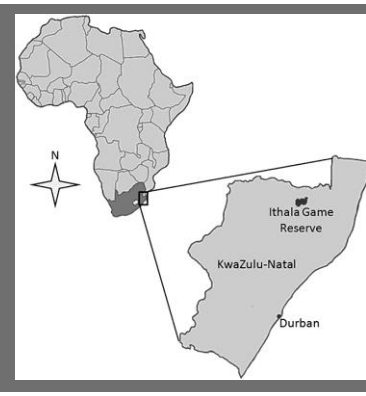
Effecient population management
Accurate estimation of habitat suitability will lead to effecient population management. New tools for black rhino monitoring will assist managers in taking management decisions in the aim of increasing the species' numbers.

Successful translocation
Translocation implies expanding black rhino range and creating new breeding populations in new potential areas. Resolving black rhino ecological requirements will lead to successful translocations. Outcome of this project will permit the selection of new optimal habitats and contribute to implementing their management strategies.

METHODOLOGY

STUDY SITE

This study will take place at **Ithala Game Reserve** (IGR), in Northern KwaZulu-Natal, South Africa. The reserve is 296 km2 of size with a diversity of habitats and variable topography. It hosts a wide variety of herbivores and the local black rhino population is estimated at 46 individuals (Van Der Westhuizen, 2016). Extensive monitoring is already in place and coarse georeferenced vegetation maps are available. The entire reserve will be utilized to cover all potential habitats available to the species.



METHODS

Ithala Game Reserve was chosen as study site as it hosts a well monitored black rhino population. At present black rhino productivity is set at 4.25% per annum and research on the species is a priority to ascertain whether management actions are having their desired effect in terms of reaching conservation targets (IGR: Integrated Management Plan: 2009-2013). Preliminary evidence was gathered there for the purpose of the proposed project and methods were adapted to the context.

BETTER ESTIMATION OF HABITAT SUITABILITY AND CARRYING CAPACITY

HABITAT USE

Spatial movements
Collared individuals
Observations
Topology & maps

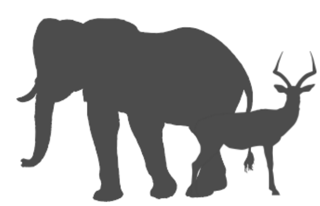
DIET

Preference
Avoidance
Food quality
Olfactory cues

POPULATION HEALTH

Parasitic load
Faecal analysis
Visual assessment
Blood samples

COMPETITION



Diet comparison
Elephants
Other browsers
Density avoidance

IGR HABITAT SUITABILITY MAP AND **CARRYING CAPACITY MODEL**

METHOD DETAILS

1 HABITAT USE

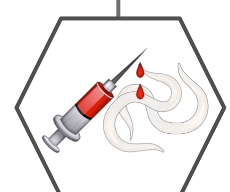
To address how black rhinos use their habitat, first we will use IGR's **rangers' continuous monitoring information** to build a precise **map** of all rhinos within the reserve. Second, because rangers' observations are only based on sightings, a selection of individuals will be **fitted with GPS- based transmitters** to record their accurate movements (n = 10). This will allow calculating precise average home range size and habitat choice during a full year. Fire regimes, surface water availability, geology and vegetation communities will also be mapped. Such information will be georeferenced and incorporated into topographic and climatic models **for building the first axes of the black rhinos' niche**.

2 DIET AND BROWSING PREFERENCE

To accurately establish black **rhino diet**, observed and identified animals will be followed along their feeding paths for 50m. All plant species encountered within a 2m strip on each side of the path will be recorded. Because black rhino browsing leaves behind characteristic sharp angled branches (Kotze, 1993), we can estimate food plant preference, and categorize each plant species as browsed and non- browsed. We will also quantify the number of bites on browsed plants to develop relative importance for each species and test the chemical ecology underlying food preferences A DNA library of local plants will be built for metabarcoding fragments of consumed plants found in dung samples, which will contribute to establishing foraged species (including forbes). Diet selection results will allow building a **host-plant preference index** to be implemented into the carrying capacity model.

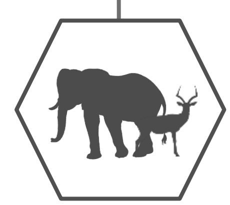
To address the mechanisms of browsing choice, we will measure **plant palatability** and **food quality** indicators through phytochemical analyses. Foliage from browsed and non-browsed plants will be collected, oven-dried and analyzed using liquid chromatography (secondary metabolites), elemental analysis (carbon to nitrogen ratio), and colorimetric methods (crude proteins and phosphorous). Finally, because black rhinos may forage through **olfactory cues**, we will also sample plant volatile organic compounds to better determine causes of **selective foraging**. Comparative analyses on plant primary and secondary metabolites will highlight the chemical composition driving plant choice, and allow building a **phytochemical landscape map** to identify host plant quality hotspots for black rhinos.

3 POPULATION HEALTH



Parasitic load will be quantified by **faecal egg counts** in fresh dung samples (Stringer et al., 2014). **Blood samples** will be taken opportunistically from darted individuals and will be examined for blood microfilariae (Solismaa et al., 2008). The effect of diet on parasites will be tested through bioassays with black rhinos' revealed most preferred plants' crude extracts on commercially available parasites.

4 COMPETITION WITH OTHER BROWSWERS



Once we establish black rhino diet composition, we can **compare resources** used in elephant diets from a study previously done in IGR (Shrader, 2012), and to other known browser diets to test for potential diet overlap at the landscape level. Additionally, black rhino locations will be compared to collared elephant herds' to test for **avoidance** of large densities of **other browsers**.

5 HABITAT CARRYING CAPACITY PREDICTION

Finally, a habitat suitability map will be generated using Geographic Information System (GIS), specifically the package Biomapper on ArcGIS. Habitat carrying capacity for IGR will then be calculated using all the accumulated evidence from tasks 1 to 4. According to the black rhino ecological requirements, all habitat elements will be reevaluated, scored and integrated into the model.

INNOVATIVE TECHNOLOGY

HEIG-VD PARTNERSHIP

The University of Neuchâtel has teamed up with the **School of Management and Engineering Vaud (HEIG-VD)** to develop an innovative technology not only for research but also to improve black rhino security.

The aim of this research component is to investigate the use of geolocalisation of black rhinos through LoRa and gather detailed habitat use information.

HAUTE ÉCOLE D'INGÉNIERIE ET DE GESTION DU CANTON DE VAUD

www.heig-vd.ch

For more information:

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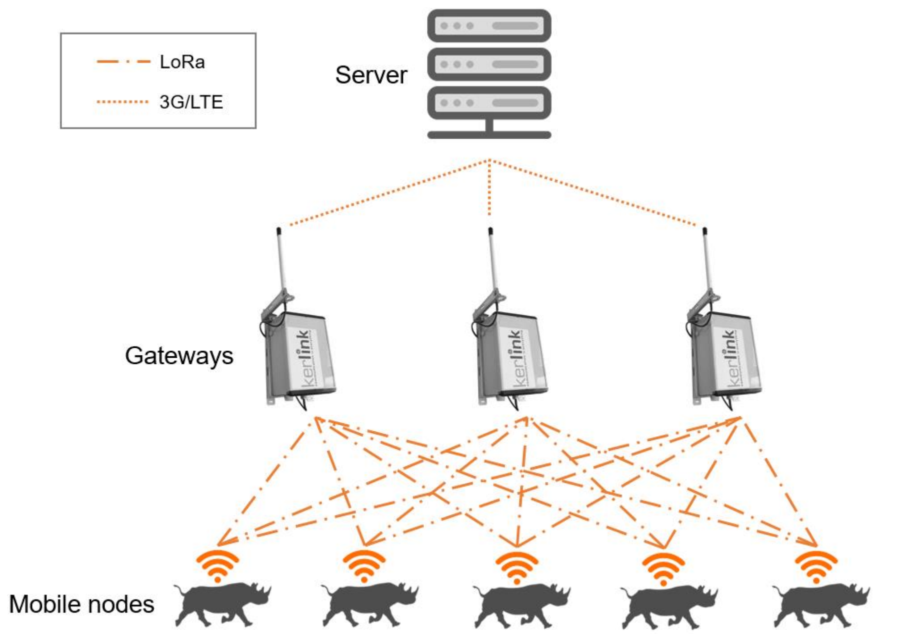
A ranger monitoring in Ithala Game Reserve, ZA

LORA

LoRa is a long-range, low-power, low-bitrate, wireless telecommunications system where mobile nodes communicate with gateways connected to the internet (Augustin et al., 2016).



Gateways will be positioned according to topography and in range of cellular network in various strategic locations in IGR. The protocol LoRaWAN will be employed for communication between gateways and mobile nodes. Mobile nodes will be adapted to rhino morphology and fitted on ankle collars or horn implants. Mobile nodes will be composed of a LoRa module, a specially designed antenna (868MHz), a GPS chip, an accelerometer and a battery.

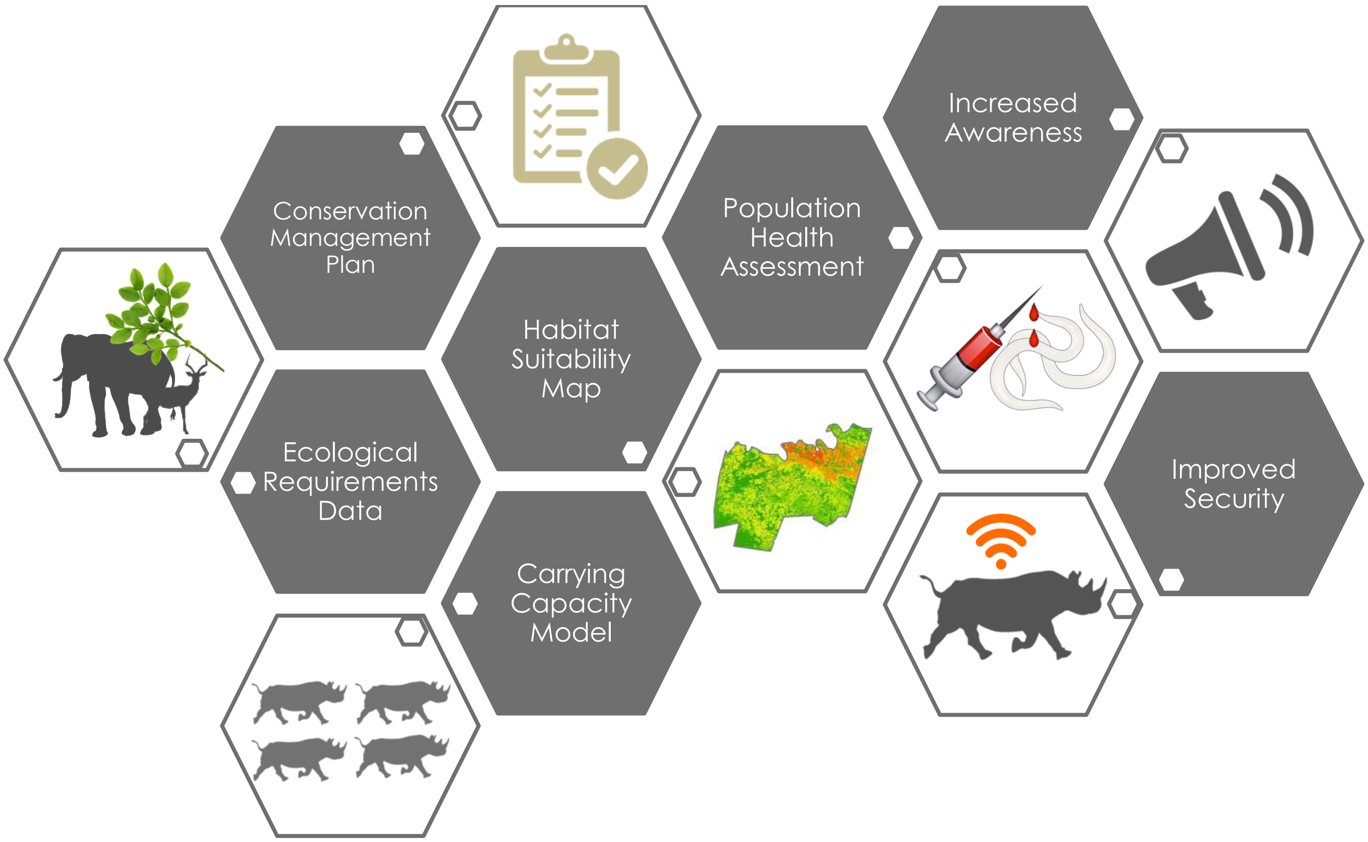
Equipped individuals will be monitored at a daily basis. Precise geolocalisation sent every 6 hours will contribute to determining habitat use and home ranges for each animal. Information collected from the accelerometer will be used to determine the animals' activity cycles and areas.

Yielded data will be accessible to investigators through a secured and authenticated web platform harboured by the HEIG-VD in Switzerland. Rhino locations will be projected on an interactive map for facilitated use in the field.

How will this protect them?

Reduced response time and increased monitoring
Not only will monitoring be increased through an interactive map, but a mortality alert will also be sent to management if an animal is inactive for too long, which will reduce response time and facilitate counter poaching.

EXPECTED OUTCOME



- Novel data on **black rhino ecological requirements** such as habitat and diet preference, food quality selectivity and quantification of competition with other browsers.
- **Habitat suitability map** of Ithala Game Reserve, which will assist the reserve's management plan for black rhino and other species and contribute to refining carrying capacity models.
- Updated **carrying capacity model**: gathering data on species ecology will allow building a new carrying capacity model which, in term, will lead to optimal selection of new translocation sites for range expansion. This will aid management of populations, optimize removals and contribute to reach the target of a 5% growth rate.
- **Conservation management plan**: using IGR's population as a study model, a more general conservation management plan applicable to other reserves will be put together in the hope of increasing overall population numbers.
- **Population health assessment** tool will enable a more accurate assessment of population health, complimentary to scoring by body condition. It will also benefit selection of individuals for removal and translocation and monitoring.
- **Improved protection** of black rhinos through remote sensing monitoring and surveillance.
- **Increased awareness** of black rhinos' conservation biology and status among locals, rangers and students will contribute to the species protection.

This project is expected to produce outputs useful to professionals in the field such as park managers, rangers and those implementing conservation strategies and monitoring population performance.

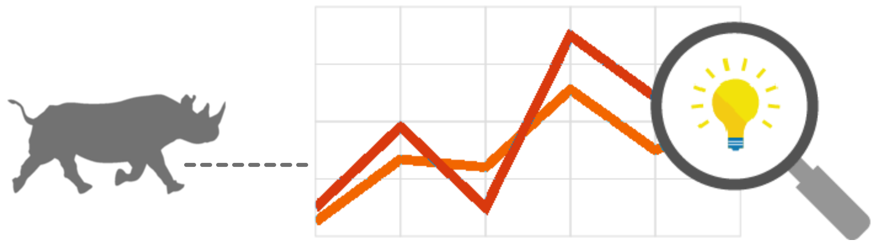
REPORTING

PRINCIPLE INVESTIGATOR

Vanessa Duthé
MSc Conservation Biology, 2018

As the principal investigator, this project will be the subject of my PhD thesis. Previous experience with black rhinos and novel results through my masters thesis ("Investigating black rhino (*Diceros bicornis*) feeding ecology in Ithala Game Reserve, South Africa." 2018) led me to pursuing research on this important topic. Moreover I am passionate about african ecology and measures leading to the protection of endangered species.

Searching for black rhinos in Ithala Game Reserve, ZA



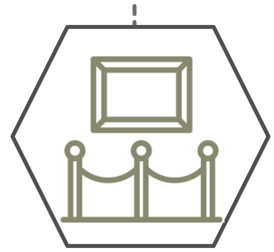
PhD thesis in conservation ecology with the University of Neuchâtel in Switzerland.

Publications in relevant peer-reviewed scientific journals.

Presentations of the project's progress. Posters, talks and attendance to conferences.

Publications and updates in international and local press, social media and on our website.

Exhibit at Ithala Game Reserve's main lodge, Ntshondwe, in the lobby and during regular workshops.



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