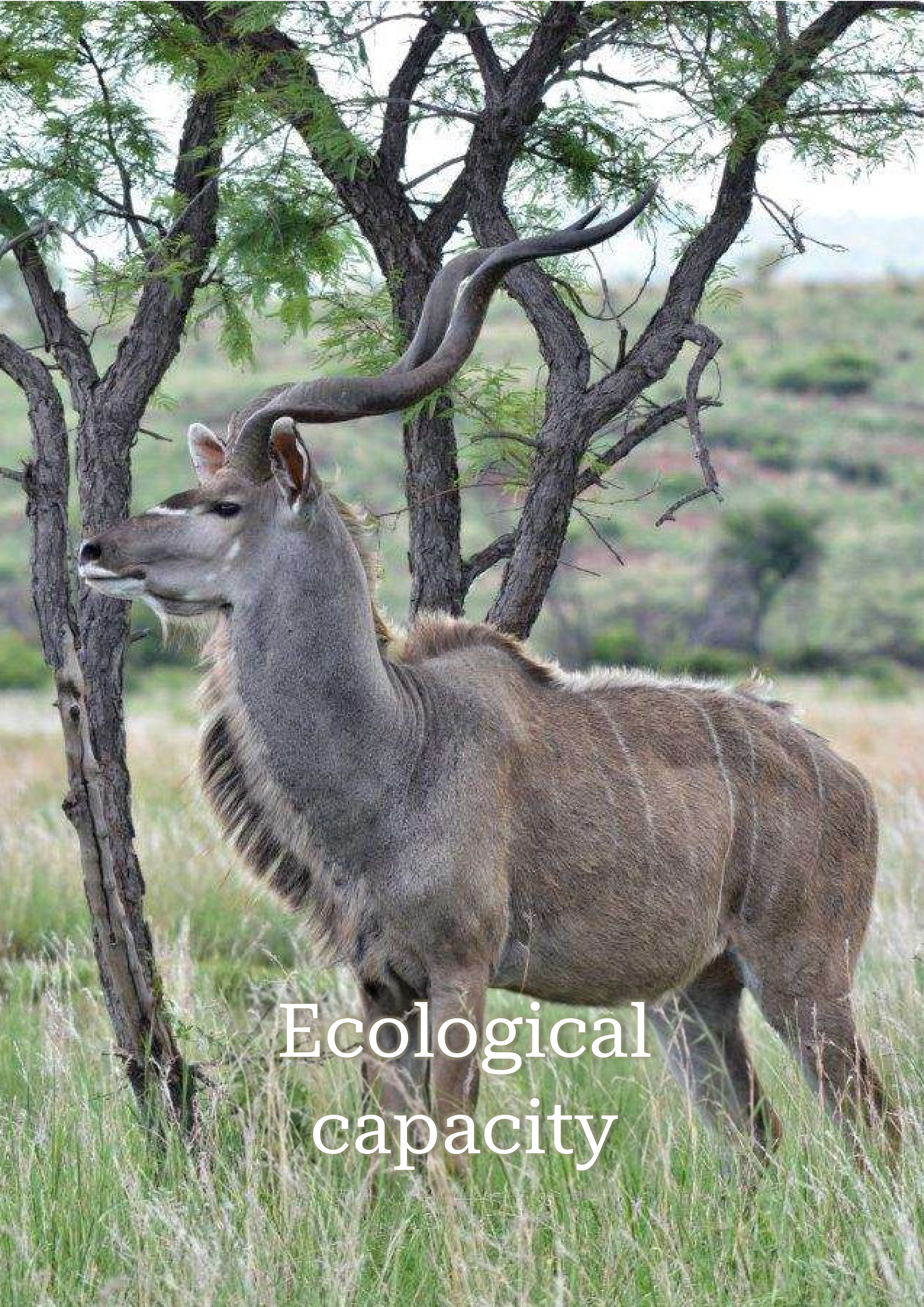


Ecological capacity

Module # 13-Component # 3

Ecological capacity

Objective

Understand the purpose and method for assessing ecological capacity.

Expected Outcome

- Understand the aim of determining ecological capacity.
- Calculate graze and browse replacement values for game species.
- Relate these values to the grazing and browsing capacity of an area.

Gemsbok: *Oryx gazelle*

Ecological capacity

The ecological capacity is defined as **the number of animals that can be sustained in a defined area without affecting the habitat quality** and implies a **natural balance between animals and plants**. The ecological capacity is thus dependent on both the **grazing and browsing components**.

The aim of determining the ecological capacity is to **determine the numbers and ratios of bulk feeders, mixed feeders and grazers** that can be sustained in an area.

In managing wildlife, there is a **diverse range of factors** that need to be considered when determining ecological carrying capacity.

These include:

- Habitat preference
- Food preference
- Territoriality
- Interspecies competition
- Habitat protection

The issue is also further complicated by the **management objectives** of the reserve manager and ecologist. Game reserves may be managed for **game viewing, trophy hunting, venison production or game farming**. Thus, various options in terms of the ecological carrying capacity are available.

These include:

- Economic carrying capacity
- Maximum harvest density
- Minimum impact density
- Maintenance density
- Tolerance density

Several techniques for **assessing ecological capacity** exist. The estimate method rests on **detailed observation of the veld condition** and the **number and state of game.**

Economic carrying capacity

Recognising that wildlife management is also an **economic activity**, it is often the wildlife manager's point of view that determines the basis on which carrying capacity may be defined.

Maximum harvest density

This is the number of **animals** (herbivores) that a **habitat can support while a maximum sustained utilisable surplus is produced**. This means that the maximum number of animals are kept, and the **surplus is constantly being taken off** in harvesting/culling/relocation programmes. This is done to satisfy the management objectives of either **venison production** or true **game farming** to resale live animals. At maximum harvest density, the **population quality, as well as the habitat condition, is very good**. A relatively **young age structure** and high turnover are typical of a population at maximum harvest density. Consequently, **very few trophy animals** become available. The **production of trophy animals** would require a population density that is higher than the maximum harvest density so that certain animals (**mostly males**) need to be kept for a few extra years to reach trophy size.

Various nature conservation programmes in South Africa are based on maximum harvest density. The **buffalo and elephant control programmes** in the Kruger National Park are a good example. Practising a maximum harvest density programme **requires an annual count on which the harvest can be based**. In this way, the population is prevented from exceeding the determined optimum.

Minimum impact density

In some management programmes, it is **necessary to keep the numbers of some populations low**. This is done to **limit the impact** of one **population** on another or to limit the impact of a specific population on the **available habitat**. The objective is to **place more importance on habitat or a competing population.** The species that is kept at its minimum density may be viewed as a pest species that must be controlled but not eliminated. Predator populations are frequently kept at minimum impact density.

Example: Sheep farmers in the arid Karoo region keep a resident population of hyrax (dassie) at this level. This encourages the caracal to predate this population instead of the lambs. **Population quality** under these conditions is usually either very **good or optimal, as is habitat.**

Maintenance density

This refers to herbivores and is the **population size that is determined by the availability of grazing**. It is the **extreme limit of ecological density**, and the **population quality and habitat condition** are usually **less than optimum,** and even a slight change in climatic factors such as a drought or even poor rains quickly leads to extreme habitat deterioration and the decline of the population due to starvation or predation as their condition declines further.

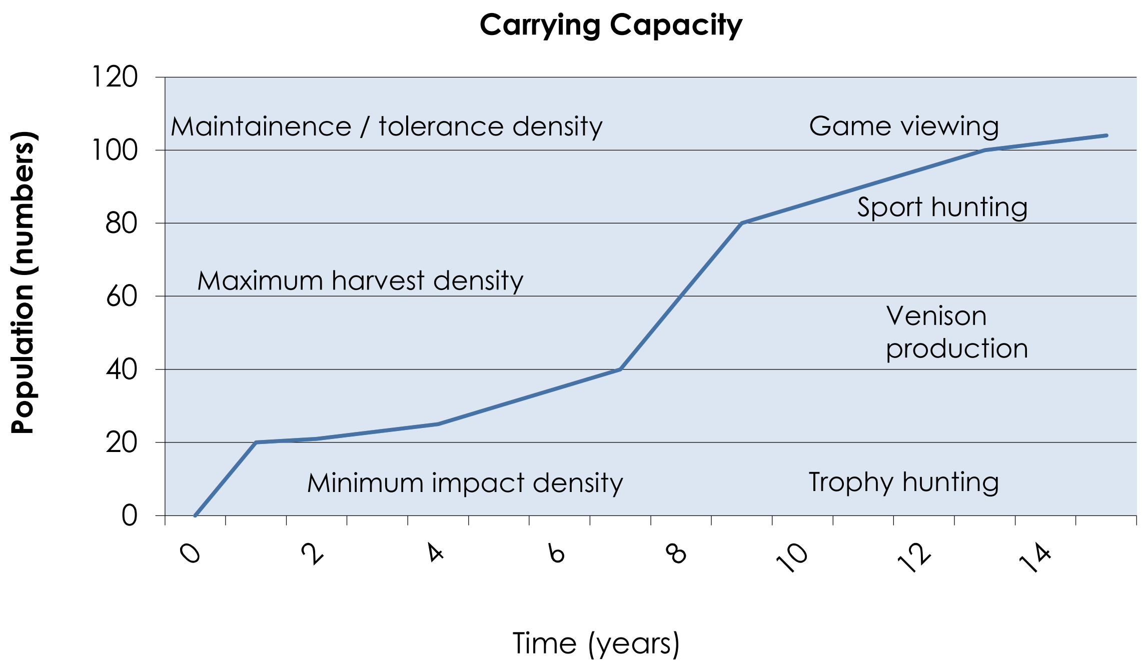
This type of population maintenance structure is usually the **result of either poor management or a management policy that allows nature to take its course**. However, in restricted habitats such as reserves, this policy **inevitably leads to population crashes** and environmental outcry, as seen with the **Tuli elephants** or the whole **Tsavo National Park** (Kenya) populations in the early 1970s where over several years, approximately 30 000 elephants starved to death along with ± 5000 black rhino and thousands of other species.

Roan antelope: *Hippotragus equinus*

Tolerance density

This is the **number of animals** that a habitat can carry when typical; **behaviour and/or physiological mechanisms are the main population controlling factors**.

It is also known as **Saturation Point Density or Toleration Density**. Tolerance density is especially important in territorial animals. In this scenario, space is the significant limiting factor. Territorial animals protect and defend the best areas within a specific habitat. Consequently, there is usually no degradation of this habitat as only a limited number of animals utilise the area.



Ecological Carrying Capacity

Determining carrying capacity

Large stock units

Game can also be **equated to large stock units** (L.S.U.'s). A large stock unit is defined as a bovine of 450 kg [992 lb] whose mass increases by 500 g [1.1 lb] per day with a digestive efficiency of 55%. This concept was originally developed for the cattle industry. However, most game animals have been analysed and **conversions to L.S.U.'s** made.

Habitat evaluation can also be calculated **in terms of L.S.U.** carrying capacity-this has been calculated for veld type instead of specific species and their volume. However, simply having the habitat data and then using the tables below will **not provide a very accurate measure of habitat carrying capacity**, as the conversion table does not consider the food preferences of the animals. The fact that 12 head of cattle can be sustained on 100 hectares of veld does not mean that the equivalent L.S.U. number of giraffe, zebra and bushbuck would be able to do the same.

The L.S.U. method also takes **no account of territoriality** and **does not really consider browsers** at all.

Veld type	Large Stock Units per 100 hectares
Mopani-veld	4-5
Terminalia **sandveld**	6-8
Kalahari sandveld	6-7
Combretum **veld**	8
Wild syringa veld	8-9
Mixed broad-leaved bushveld	9
Vachellia tortilis **veld**	12
Knobthorn-marula veld	10-12
Mixed thornveld	10 -12
Turf thornveld	12

Large Stock Units vs veld type (Grossman 1991)
(Note: there are 68 defined veld types for South Africa)

Species	Mass in kg	L.S.U.
Blesbok	61	0.22
Bontebok	55	0.21
Buffalo	495	1.07
Bushbuck	30	0.13
Duiker: common	19	0.09
Eland	500	1.08
Elephant	4500	10
Gemsbok	210	0.56
Giraffe	830	1.58
Hippopotamus	1340	2.24
Impala	50	0.19
Klipspringer	13	0.07
Kudu	200	0.54
Nyala	60	0.23
Rhino: Black	900	1.65
Rhino: White	1800	2.75
Roan antelope	250	0.64
Warthog	70	0.25
Waterbuck	180	0.50
Wildebeest: blue	180	0.50
Zebra	260	0.66

Large Stock Unit Conversions (Grossman 1991)

Energy method

The energy method is **based on the energy requirements** of a particular animal and employs the following equation: A = B x C / D

Where:

A = ecological capacity
B = the available feed (g/ha)
C = the amount of metabolisable energy in the feed (KJ/g)
D = the amount of metabolisable energy from the feed that an animal requires per day.

Since African **herbivores** have been classified as **grazers, browsers,** and **mixed feeders** according to their feeding habits. This is incorporated into the calculations of grazing/browsing capacity. Mixed feeder stocking rates can be calculated in terms of both grazer units and browser units by using the following equation for **Grazing Units** and **Browsing Units:**

GU = $(450)^{0.75}$ x (average body mass) $^{-0.75}$ x (% Graze)
BU = $(140)^{0.75}$ x (average body mass) $^{-0.75}$ x (% Browse)

The following case study uses these equations to calculate the **G.U.** and **B.U.** for the **Ecological Carrying capacity of the area** and their **resident species**.

Gemsbok: *Oryx gazelle*

Case study: Msasa Nature Reserve

The **derived grazing capacity was reduced by 30%** as the calculated value applied to livestock, which can easily be moved from overutilised to underutilised areas. Many **game species tend to be more selective** than livestock and are **less manageable** in terms of achieving effective **rotational grazing**. The adjusted values for grazing and browsing capacity were pooled to indicate the ecological capacity.

Graze and browse replacement values allocated to each game species were calculated with equations 1 and 2, respectively. The replacement values determine the total number of grazer and browser units be stocked.

Although the grazing capacity was markedly reduced in Community 2 to facilitate the **Terrain Inaccessibility Factor** (T.I.F.), the **browsing capacity was left intact** since numerous browsing animals such as eland, kudu and klipspringer were encountered in the hills throughout the year.

Species	GU/individual	B.U./individual
Mountain reedbuck	0.13	0.00
Warthog	0.13	0.00
Waterbuck	0.56	0.00
Zebra	0.58	0.00
Blesbok	0.22	0.00
Wildebeest	0.50	0.00
Red hartebeest	0.37	0.00
Bushbuck	0.00	0.35
Duiker	0.00	0.10
Giraffe	0.00	3.33
Klipspringer	0.00	0.35
Buffalo	0.97	0.26
Eland	0.20	1.96
Elephant	1.47	8.24
Gemsbok	0.40	0.40
Impala	0.08	0.20
Kudu	0.04	0.90
Springbok	0.07	0.22
Steenbok	0.02	0.10
Rhinoceros	2.19	1.32

Graze and browse replacement values allocated to game

Community	Grazing capacity in L.S.U. or G.U.	Browsing capacity in B.U.
1	62.75	16.00
2	339.30	287.10
3	52.51	10.23
4	11.90	2.72
5	26.65	5.64
6	73.61	0.00
Total	**539.63**	**321.69**

The ecological capacity of Msasa Nature Reserve

The **derived ecological capacity may be rather high.** However, the data provides an invaluable **starting point in making recommendations on stocking rates.**

Gemsbok: *Oryx gazelle*