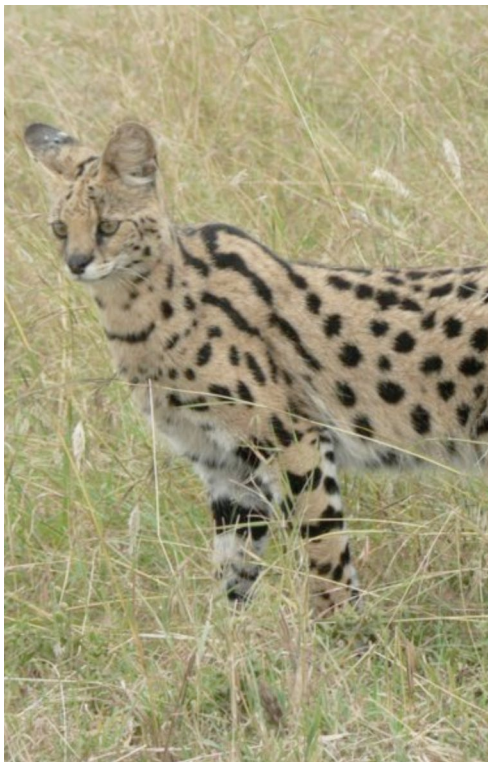
Department of **Agriculture and Fisheries**
Biosecurity Queensland

Invasive animal risk assessment

Serval

Leptailurus serval



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Front cover: *Leptailurus serval* in Serengeti, Tanzania. Note the large spot coat pattern.

Contents

Introduction

Name and taxonomy

Species: *Leptailurus serval* (Syn. *Felis serval*, *Caracal serval*)

Common names: serval, African serval

Family: Felidae

Subfamily: Felinae

Related species: *Profelis aurata* (African golden cat), *Caracal caracal* (caracal) (Johnson et al. 2006)

Description

The serval has a slender build and long legs. It has a distinct, elongated skull, with a small, slim head, set gracefully on a long neck. The ears are large and erect; black with distinctive central white bars. Servals have the largest ears and the longest legs, in relation to their body, in the entire cat family (Webber 2004). The tail is spotted, with six to seven black rings, a black tip, and a white or light tan underside. The coat is yellowish tan with black spots, bands and stripes, and each serval has a unique coat pattern. Background fur colours vary from buff red to a pale gold. Some servals have a large number of small spots, giving them a speckled appearance. Servals in dry habitats usually have larger and more pronounced black markings. Black servals, also referred to as 'melanistic', have been seen in mountainous regions of Africa. There are also white servals, but these are extremely rare (Webber 2004).

A serval weighs 13–19 kg. Its body length is 70–100 cm with an added tail length of 35–40 cm. The height at the shoulder is about 60 cm. Males are slightly larger than females. Except for the short tail and large ear size, a serval physically resembles the cheetah (Webber 2004).

Figure 1: Serval portrait taken in Sabi Sands in July 2007 by Lee R. Berger. Note the small spot coat pattern. (Image from Wikimedia Commons under a *Creative Commons Attribution Share-Alike 2.5 licence*).

Biology

Life history

Gestation period: 66–77 days

Young per birth: 1–5 (average 2–3)

Birth interval: Females can give birth twice a year with a minimum normal interval of 184 days

Weaning: 4–7 months

Sexual maturity: 18–24 months

Sexual activity: 10 years in the wild; longest recorded 14 years (captive serval in Basel Zoo) (Wackernagel 1968)

Life span: 12–20 years (Sunquist et al. 2002)

Servals are non-seasonal breeders, but births tend to peak during the wet season when high prey density coincides with new plant growth (Smithers 1978).

The female serval protects her kittens in a den or lair, surrounded by dense vegetation, or in an abandoned burrow; however, she will frequently move them to new hiding places after birth to protect them. Females may also use tree hollows to hide kittens (Kingdon 1984). Like the cheetah, female servals raise their kittens by themselves, and must leave them while hunting (Webber 2004).

Social organisation

Male and female servals maintain separate territories and lead solitary lives. Social interaction is restricted to mating. Servals are occasionally seen in pairs, or a female will be in a group with her kittens (Geertsema 1985).

Female servals hold exclusive territories from 2–9 km². Territories held by males are usually twice the size of a female's, and will overlap two or more female territories (Webber 2004).

Servals in the Ngorongoro Crater, Tanzania were found to have home ranges of 11.6 km² (males) and 9.5 km² (females). These home ranges were sometimes found to overlap to the extent that only 21% of the range was exclusively used by the individual. At times, up to four servals were observed to be within 200 m of each other (Geertsema 1985).

A female serval that was hand-raised and then released into a nature reserve in Natal established a home range of approximately 6.2 km² (range 3–9 km²) (Perrin 2002).

Boundaries are clearly defined with frequent scent and scrape marks. Servals continually spray with urine to mark their territories. This is a very effective warning to a serval from an overlapping territory to keep its distance. Male servals display ritualistic aggression by sitting and facing one another and one animal puts his front paw on the other's chest. The second serval then bobs his head and may bite the upraised paw. This exchange can escalate into a fight, but more often remains a protracted 'stare-off'.

Adult males have been observed to display some affectionate social behaviour by resting together during the day. When defending themselves the cats growl loudly and arch their backs. At various times, the serval can snarl, spit and purr. A high-pitched cry is used when calling to other servals (Webber 2004).

Diet and hunting behaviour

The serval is an opportunistic generalist predator whose prey includes small animals such as lizards, snakes, frogs, small birds (quails, quelea, teal), insects, fish, ground squirrels, hyraxes, mole rats, and domestic poultry. More than 90% of the serval's diet is composed of prey that weighs less than 200 g (Cat Survival Trust 2002). A study of serval diet in Natal shows that servals tend to prey on readily-available, slow-moving species. Scat analysis in this serval population revealed a diet of 60% vlei rats, 15% striped mice, 5.6% birds, and some insects and reptiles. Even though they mainly feed on small mammals, this study shows that servals are generalist predators and will readily adapt to new prey types (Bowland and Perrin 1993).

Servals are also capable of hunting larger animals such as small antelope, flamingoes, vlei rats, hares and duiker (Sunquist et al. 2002). A juvenile serval was observed hunting and killing a flamingo. Frogs can also make up a significant part of the diet (Geertsema 1985). Servals have been recorded killing animals as large as a female impala (45–50 kg) and adult duiker (up to 45 kg); however, prey of this size is normally hunted in pairs (Kingdon 1984; Animal Diversity Web 2000, 2006). Servals will also prey on turtle eggs, with approximately 52% of leatherback and olive ridley turtle nests in Angola experiencing predation from a number of predators, including servals (Weir et al. 2007).

Servals that have been either hand-raised or raised entirely in captivity have been shown to maintain themselves in a natural environment without any prior training in hunting (van Aarde and Skinner 1986; Perrin 2002). A female serval that was hand-raised, released into the wild, and tracked was found to prey on easily accessible chickens and geese from nearby human settlements. Even after hand-raising, the serval was observed to show innate hunting techniques. When hunting, the serval's ears would go forward to listen to prey. Once the prey was detected, the serval would slowly stalk its prey, keeping its body and head motionless. The serval would pounce when it was close enough to the prey, leaping up to 1.5 m high. The forelimbs were used to hit the prey, the impact of which usually killed it (Perrin 2002).

Servals have a basal metabolic rate that is 123% of the value expected from body mass. Domestic cats (*Felis catus*) have a basal rate of 127% of what is expected (McNab 2000). Servals have a broad thermoneutral zone, meaning that they can tolerate a wide range of temperatures and adjust their body temperate and oxygen intake depending on ambient temperatures and activity (such as hunting or resting) (Downs et al. 1991).

Servals have a bite force at the canine teeth of 172 Newtons, whereas feral domestic cats have a bite force of 56 Newtons (Christiansen 2007; Wroe et al. 2005). Because of this higher bite force, servals can subdue larger prey than can feral cats.

Because most of its prey is small in size, servals must hunt frequently. Generally, adult servals spend about six hours out of every 24 hours hunting and travelling (Cat Survival Trust 2002). It is not uncommon for a serval to kill 16 times or more in a single day. Servals have an extremely high ratio of success (49%) (Geertsema 1985) with their hunting attempts,

compared with lions (30%) and most other cat species (10%) (Cat Survival Trust 2002). Servals in the Ngorongoro Crater, Tanzania have been estimated to kill and eat 5700–6100 prey animals per year. This equates to approximately 3950 rodents, 260 snakes and 130 birds per serval (Geertsema 1985).

Servals are mostly nocturnal, although this depends on the seasonal activity of their prey items. For example, servals in the Ngorongoro are mainly crepuscular, with activity peaks at dawn and dusk. This is because prey such as vlei rats and frogs are active at this time (Geertsema 1985). The female serval that was radio-collared and tracked in Natal was mostly nocturnal, with most activity occurring about an hour after sunset. This was attributed to foraging or hunting, as the main prey in this area are rodents such as vlei rats and striped mice (Perrin 2002).

In the Serengeti servals tend to be more diurnal as the prey is Nile rats, which are active during the day (Cat Survival Trust 2002). When hunting, servals may travel up to 4 km in a night (Nowak and Walker 1999).

Servals use a variety of hunting techniques: stalking and pouncing, zigzag bounding, vertical leaping, hunting in water, digging for animals such as mole rats, looking in holes and crevices for animals, hunting in trees (Geertsema 1985).

Servals use their large, sensitive ears when hunting for prey such as rodents. They can be very patient and will wait for long periods to accurately detect the location of their prey. Once located, the prey is then stunned or killed instantly when the serval leaps with all four feet off the ground and hits its victim with its forefeet. If the initial attack is not successful, the serval can then make a series of quick stiff-legged jumps to kill its prey. Servals are renowned for their athletic ability and agility, and will leap high to attack prey; they can leap 1–4 m horizontally and 3.5 m vertically (Webber 2004).

Figure 2. Serval demonstrating a vertical jump of almost 2.5 metres. (Photo: Steve Jurvetson. Image from Wikimedia Commons under a *Creative Commons Attribution 2.0 Licence*).

Using their sensitive hearing, servals can detect prey underground. They have shown keen intelligence by digging holes in mole rat tunnels, then sitting back patiently to wait until the mole rat comes out to repair the damage to its home, at which time the serval then fishes it out. Servals also hunt in shallow water and will stalk and catch frogs, fish and wading birds. Another hunting technique effectively used by servals is to use their long legs to run and leap in a zigzag pattern through tall grass with high bounces to flush out prey. Servals can run quickly in short bursts (Webber 2004).

Preferred habitat

Servals are extremely adaptable but generally prefer tropical savannah habitats, usually where there is a readily available supply of water and cover in the form of tall grass, reed beds or other riparian vegetation. The margins of the serval's natural range extend into alpine grasslands and dense forests along the grassy banks of waterways. Servals have been found in high altitude, low temperature environments, such as the Aberdare Mountains in Kenya (altitude 3000 m) and in Kamberg Nature Reserve (Natal) where the elevation ranges from 1585 to 2244 m. Kamberg Nature Reserve has a mean minimum monthly temperature in July of 0.7 ˚C, heavy frost at least six months of the year, and occasional snowfall (Sunquist et al. 2002). Servals are not found in rainforests. In parts of south-west Africa, they will occasionally occupy arid areas (Big Cat Rescue 2006).

Servals are quite common in rural areas and are able to coexist with humans in agricultural environments (Cat Survival Trust 2002).

Major habitats, as listed by the IUCN Red List are:

- forest—subtropical/tropical dry
- savannah—dry, shrubland
- subtropical/tropical dry, grassland
- subtropical/tropical dry (Cat Specialist Group 2002).

Servals can be arboreal (Estes 2000).

Predators and diseases

Natural enemies include hyenas, African wild dogs and leopards. The serval suffers from poaching for its beautiful spotted coat (Webber 2004).

Diseases include:

- feline rhinotracheitis virus (herpes virus), calicivirus, and feline panleucopaenia virus and rabies (Ugandan Wildlife Education Centre 2008)
- auto immune hemolytic anemia (captive serval, Moonridge Animal Park, California) (Croxton 2007)
- Tyzzer's disease (captive serval) (Poonaacha 1997).

Distribution and abundance overseas

Wild servals exist in the following African countries:

Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of the Congo, Côte d'Ivoire, Djibouti, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Malawi, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Togo, Uganda, United Republic of Tanzania, Zambia, Zimbabwe.

They are believed to be extinct in Algeria, Morocco, and Tunisia (UNEP–WCMC 2008).

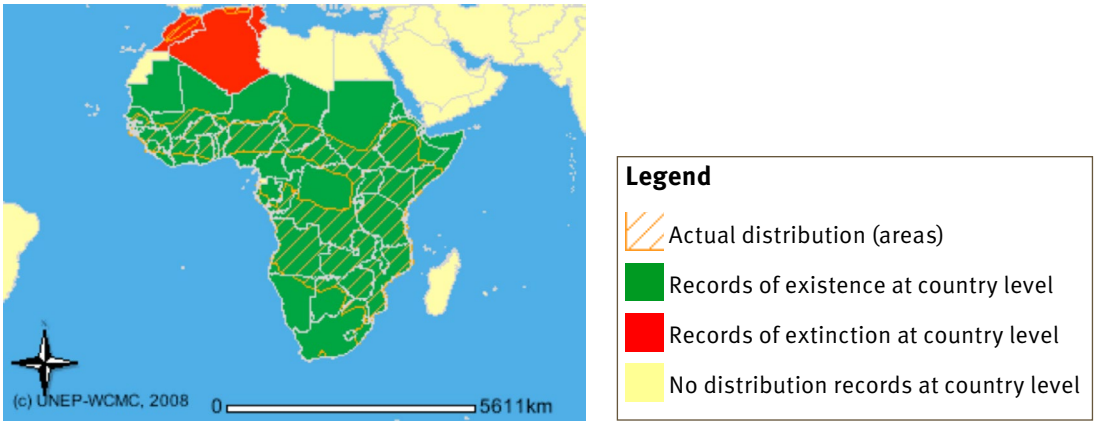

Figure 3: Distribution of *Leptailurus serval* in Africa (UNEP–WCMC 2008).

Based on estimates of density and geographic range, the serval's total wild population size is estimated at more than 50 000 mature breeding individuals, but with a declining trend due to poaching, persecution and degradation of its habitat (Cat Specialist Group 2002).

There are currently 365 captive servals in 135 zoos across the world (ISIS 2008). Almost all of the animals held in zoos are captive bred (Sunquist et al. 2002).

An unknown but large number of servals are kept and breed as pets in the USA, where there are frequent reports of escapes and strays.

Species' conservation status

CITES Appendix 2—not necessarily threatened with extinction but may become so unless trade is controlled (UNEP–WCMC 2008).

IUCN Red List—*Leptailurus serval* listed as species of 'Least Concern' in 2002.

North African serval (*Leptailurus serval* ssp. *constantinus*) listed as 'Endangered' in 1996 (Cat Specialist Group 2002).

Major threats to servals include loss of wetlands, habitat degradation due to over-grazing and burning of grasslands, trade of serval pelts for ceremonial and medicinal purposes, and loss of native prey species due to changes in habitat (Cat Specialist Group 2002).

Threat to human safety

Servals kept as pets have attacked unprovoked, causing serious injuries that require hospitalisation.

For example, in June 2000 in New York, a 4-year-old boy underwent plastic surgery for a bite to the neck and two puncture wounds to the face when he was attacked by a 40-pound African serval being taken for a walk. The man walking the cat received several stitches for bite wounds to his hand. In December 2001, a 7-year-old boy in Florida was taken to hospital after being attacked and bitten on the neck by a 40-pound declawed African serval at a picnic. The child was walking when the unattended serval leaped on him and knocked him to the ground. In the United States, several incidents of servals escaping from their owners have been reported in regional newspapers (Big Cat Rescue 2006).

History as a pest

The serval has not naturalised outside its native range. The serval has been successfully reintroduced into a number of South African game reserves within its former range (Van Aarde and Skinner 1986; Anderson 1992).

Quantitative assessment

Introduction

A numerical risk assessment system is used to rank species according to their likely impacts and level of risk as pests (Bomford 2003; Bomford 2006). This approach allows ranking and prioritisation of large numbers of pest species. First, a species' potential distribution is predicted using a climate-modelling computer program. The remaining steps involve allocating scores for each of a number of attributes relevant to a species' pest status. Attributes are wide-ranging, including aspects of the species' biology, costs to the economy, the environment and society, and management efficacy.

Potential distribution

One of the factors that determine the potential range of a pest species is climate. The climate-modelling software (PC CLIMATE Version 2) was used to predict the area of Australia where climate is suitable for servals (*Leptailurus serval*). The model was created using PC CLIMATE (Bureau of Rural Sciences 2004) using all 16 climatic parameters for matching locations of the 'worlddata_all.txt' dataset and the Closest Standard match algorithm for the analysis. Seven hundred and five metrological data points within the current known range of serval (Nowell and Jackson 1996) were used in the analysis. Summation of the scores for five highest match classes gives a Climate Match Score of 1578, which indicates a high climate match to Australia (Bomford 2006).

Figure 4. Metrological data points used in PC CLIMATE analysis (black points only were used, grey points available but not used).

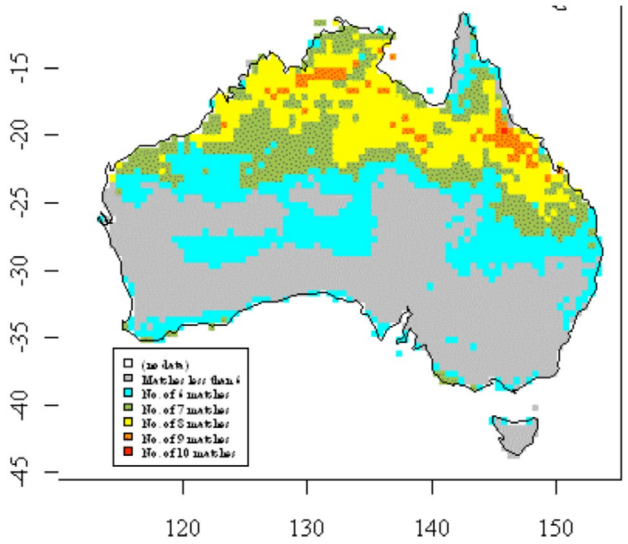

Figure 5. Potential distribution in Australia of the serval *Leptailurus serval* based on climate match to native range (red areas indicate highest climatic match, declining through orange, yellow, green, blue and then grey, which has the lowest match).

Table 1. Climate Match Score of the serval *Leptailurus serval* for Australia.

Match level class	Colour on map (Figure 5)	Number of grid squares on map
10 match	Red	1
9 match	Orange	66
8 match	Yellow	409
7 match	Green	461
6 match	Sky blue	641
Climate Match Score		**1578 (of possible 2795)**

Based purely on an assessment of climatic parameters, most of Queensland would be considered suitable, especially north-eastern Queensland. However, it is important to note that other habitat requirements, such as the availability of food, water and shelter, will determine the species' regional range and local abundance.

Using the Bomford (2006) system, servals were assessed as an 'extreme' threat species under the VPC Threat Categories (see Appendix).

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Appendix

The Bomford risk assessment for vertebrates (Bomford 2003, Bomford 2006) estimates the likelihood of a particular species establishing in the wild and the probable consequences. The Bomford system generates a score that can be compared with scores for other taxa. Higher scores indicate a greater chance of establishment in the wild.

The Bomford assessment involves scoring 11 attributes on scales ranging from 0 to 5.

Attributes cover three categories: risk to public safety, establishment risk and risk the taxon would become a pest. These include biological factors, climatic preferences and potential impact. Scores in the three categories are then combined to place the taxon in one of four Vertebrate Pests Committee (VPC) categories. These categories are used to determine restrictions for the import, movement and keeping of exotic vertebrates (Natural Resource Management Standing Committee 2004).

Bomford risk assessment

Species:	*Leptailurus serval* (serval)
Date of assessment:	10.08.2008
Literature search type and date:	See references

Stage A. Risk posed by captive or released individuals		
Factor	**Score**	**Comments**
A1. Risk to people from individual escapees (0–2)	1	Servals that are kept as pets have attacked unprovoked, causing serious injuries that require hospitalisation
A2. Risk to public safety from individual captive animals (0–2)	0	Apart from someone entering an enclosure or otherwise being in reach of a captive animal, there is nil or low risk to public safety
Stage A. Public safety risk score = Sum of A 1 to A2. (0–4)	**1**	

Stage B. Risk of establishing a wild population		
Factor	**Score**	**Comments**
B1. Degree of climate match between species overseas range and Australia (1–6)	5	High climate match in Australia Climate Match Score = 1578
B2. Exotic population established overseas (0–4)	0	Servals only exist in wild populations in Africa, and are kept as pets in the United States and Europe. There is no record of servals establishing outside of Africa.
B3. Taxonomic class (0–1)	1	Mammal
B4. Non-migratory behaviour (0–1)	1	Non-migratory in its native range
B5. Diet (0–1)	1	Generalist diet includes a variety of prey species: lizards, snakes, frogs, small birds (quails, quelea, teal), insects, fish, ground squirrels, hyraxes, mole rats, domestic poultry, small antelopes, flamingos, vlei rats, hares and duiker.
B6. Lives in disturbed habitat (0–1)	1	Servals adapt very well to human agricultural environments
B7. Overseas range size score (0–2)	1	12.5 million square kilometres (based on distribution in Nowell and Jackson 1996)
Stage B. Establishment Risk Score = Sum of B1 to B7 (1–16)	**10**	

Stage C. Risk of becoming a pest following establishment		
Factor	**Score**	**Comments**
C1. Taxonomic group (0–4)	2	Order carnivora
C2. Overseas range size including current and past 1000 years, natural and introduced range (0–2)	1	12.5 million square kilometres (based on distribution in Nowell and Jackson 1996)
C3. Diet and feeding (0–3)	3	Strict carnivore
C4. Competition with native fauna for tree hollows (0–2)	2	Can use hollow trees for shelter of young

Stage C. Risk of becoming a pest following establishment (cont.)		
Factor	**Score**	**Comments**
C5. Overseas environmental pest status (0–3)	0	Not an environmental pest in any country or region
C6. Climate match to areas with susceptible native species or communities (0–5)	5	The species has more than 20 × 10% climate match (closest match) grid squares, and/or more than 100 grid squares within a 30% climate match, that overlap the distribution of any susceptible native species or communities. See Appendix 3 for list of susceptible native animals.
C7. Overseas primary production pest status (0–3)	1	Minor pest of primary production in any country or region—will take domestic poultry
C8. Climate match to susceptible primary production (0–5)	3	Commodity damage score = 52
C9. Spread disease (1–2)	2	All birds and mammals (likely or unknown effect on native species and on livestock and other domestic animals)
C10. Harm to property (0–3)	0	$0
C11. Harm to people (0–5)	3	Injuries or harm moderate but unlikely to be fatal and few people at risk (see A1)
Stage C. Pest risk score = sum of C1 to C11 (1–37).	**22**	
Summary		
Stage A. Risk to public safety posed by captive or released individuals		Moderately dangerous
Stage B. Risk of establishing a wild population	10	Moderate establishment risk
Stage C. Risk of becoming a pest following establishment	22	Extreme pest risk
Pest Risk Score < 9—low pest risk; 9–14—moderate pest risk; 15–19—high pest risk; > 19—extreme pest risk		
VPC threat category	**Extreme**	