



**IUCN SSC Asian Elephant Specialist Group**  
**Guidelines on management and care of**  
**captive Elephant bulls in Musth**



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# **IUCN SSC Asian Elephant Specialist Group Guidelines on management and care of captive Elephant bulls in Musth**

Janine Brown, Ravi Corea, Ashoka Dangolla, E.K. Easwaran, Susan Mikota, Zaw Min Oo,  
Kushal Sarma, Chatchote Thitaram

(Additional input: Dennis Schmitt, Christopher Stremme)

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## **Introduction**

*Musth* is a natural phenomenon in healthy male elephants. The word is derived from the Persian 'mast', which means 'intoxicated', and in elephants refers to behavioral and physiological changes associated with elevated testosterone that can last from weeks to months. Bulls in musth often are unpredictable and can become aggressive, so managing them presents significant challenges. There are legitimate concerns over poor welfare experienced by bulls in captivity throughout Asia. Restraint by short tethers, social isolation, and lack of access to fresh food and clean water exacerbate frustration and aggressive behaviors that can become fixed so that even nonmusth bulls continue to be dangerous to work with, resulting in continued freedom restrictions. Inability to approach aggressive bulls can result in poor hygiene of surrounding areas, leading to health problems, such as foot rot and parasite infestations. Repetitive behaviors, such as rocking and swaying, often develop in elephants under restricted containment (short chains, small or unenriched enclosures), and can be exacerbated during musth. These stereotypies often persist even after improvements in management are made, so it is important to manage young bulls with as few restrictions as safely possible, and to use more positive training techniques to build better elephant-mahout relationships.

Methods of captive bull management often are counter to life in the wild, where they have freedom to move, forage, socialize and breed. Contrary to long-standing perceptions, wild bulls are not always aggressive towards each other, nor are they always solitary. They often seek the company of other elephants, and not just for breeding. Young males are drawn to older bulls, who teach them important social skills. However, bulls in musth can be aggressive and cause extensive damage to property, as well as being a threat to other elephants and humans. In captivity, lack of space and social opportunities can exacerbate bull frustration resulting in acts of direct or displaced aggression, especially during musth. Of all the challenges facing captive elephant owners/managers today, none may be greater than those related to proper bull management, in or out of musth. As a result, clear guidelines are needed to outline humane methods to care for bulls in a way that meets welfare needs and protects people. There is no one-size-fits-all solution, however, because of differences in bull temperament and extrinsic life histories. This means that management must be targeted to each bull individually.

## Biology of Musth

Musth is the physical and behavioural manifestation of physiological changes that include temporal swelling, temporal gland secretion (TGS), urine dribbling (UD), and elevated androgens (e.g., testosterone, dihydrotestosterone, androstenedione), swelling of bulbourethral gland, visible from swelling of the perianal region. Some behavioral changes such as reduced responsiveness and obedience to mahout commands are often recognized by experienced handler visible sign described above occur. Some bulls may also exhibit heightened aggressive and sexual behavior. Musth is generally considered a sign of good health. Bull elephants advertise their musth status through a variety of chemicals present in TGS and urine. In young Asian bulls (<15 years of age), TGS has a sweet odor due to the presence of acetates, an alcohol (3-hexen-2-ol) that smells of leaves, and pleasant-smelling ketones (acetophenone and 2-heptanone). Known as honey or moda musth, it is of shorter duration and is associated with comparatively lower androgen levels and behaviors that are more erratic and unpredictable. In adult Asian bulls, TGS has a stronger odor due to the presence of carboxylic acids and frontalin, while musth urine contains higher levels of alkan-2-ones, alkan- 2-ols, and some aromatic compounds compared to that of females and non-musth males. Elephants have well-developed primary and secondary (vomeronasal) olfactory systems, and both males and females respond to these chemicals. Estrous females have been known to seek out musth bulls, while sub-adult and non-musth males generally avoid them. Ultimately, the state of musth can confer an advantage to adult bulls, elevating their dominance status so they gain more access to estrous females and experience a higher paternity success. Younger, more subordinate bulls may outcompete older, dominant bulls for breeding females when they are in musth. However, it is not obligate for a bull to be in musth to breed with a female.

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### Signs of Musth

- Swelling of the temporal gland
- Frequent protrusion and erection of the penis, including rubbing against the belly
- Perianal swelling (bulbourethral gland)
- Frequent urination
- Flehmen in response to checking the female vagina or perineal area
- Malevolent look, wild eyes

- Acting 'spacey', glassy-eyed
- Increased aggression to humans and other elephants
- Defiant behavior, lack of response to commands
- Unpredictable or erratic behavior
- Increased show of dominance towards other elephants
- Lack of interest in food

## Stages of Musth

Bull management is complicated by the fact that musth periods vary considerably among bulls in both duration and intensity. Some bulls are manageable during musth, while others are not. For this reason, it is important to recognize the signs of imminent musth, which do not happen suddenly, but rather can be broken down into definable stages:

- Pre musth: Some bulls noticeably gain weight prior to musth. The temporal glands begin to swell and some volatile compounds are secreted; the elephant will often touch this area with his trunk. There can be a swelling under the tail due to hypertrophied bulbourethral glands. Appetite is subsequently reduced, and the bull will display frequent penile erections and masturbation. Testosterone levels are slightly elevated, about 2- to 3-times baseline. Behavioural changes can include occasional defiance and higher command-compliance ratios to mahouts. Pre musth in young bulls can be more difficult to predict, so good records are essential to document all signs leading up to musth and used to recognize impending musth in future years. The most common behavioral change in a normally docile elephant is a noticeable air of arrogance that can border on defiance. They may exhibit a desire for female company and will sniff the urogenital area and display a flehmen response. A bull may similarly check the genitals of other bulls to exert dominance.
- Early musth: Characterized by more TGS, which becomes odorous as the period progresses. Behaviour becomes increasingly aggressive and erratic, and a bull may become unresponsive to commands.
- Full musth: Temporal glands secrete a thick tar-like fluid, and urine dribbling is continuous. Androgen concentrations increase significantly (10- to 20-times baseline) and many, though not all, males become more disobedient, unpredictable and highly aggressive. Some bulls can be safely handled during musth and will continue to obey commands, especially those with good mahout-elephant relationships. A bull in musth will exercise dominance over other adult males, and some may become overly aggressive with females, especially under captive conditions.

- **Post musth:** Presence and staining of dried TGS on the face and urine on the rear legs is still evident. The bull may be in poorer condition due to reduced feed intake during musth (human or self-induced). Physical and behavioural activity generally return to baseline; however, it should be noted that many killings by captive bulls occur during the post musth period, within 2 weeks after musth signs disappear and when testosterone is declining.

### Factors Associated with Musth

- **Age:** In the wild, musth occurs in sexually mature bulls, generally those over 25 years of age. However, in captivity, it can occur in much younger males (as young as 7 years).
- **Season:** Bulls generally exhibit musth annually, and often at the same time each year. Although not strictly seasonal, the incidence of musth in Asian range countries is higher between October and February, depending on the region. In the wild, dominant bulls experience musth for periods of about 30-45 days during which time they become preoccupied with seeking out and breeding females. Musth in captive bulls can last longer, averaging 2-3 months or more. Consistency in annual musth periods makes it possible to predict time of onset in many bulls. However, some exhibit musth more than once a year, while in others the onset of musth is highly variable and less predictable.
- **Diet and body condition:** One factor that enhances an elephant's chances of exhibiting musth is continued consumption of highly nutritious or caloric foods (e.g., grains, bananas, sugar cane) and maintaining a high body condition.
- **Activity:** Bulls are more prone to entering musth if they have a sedentary life style, are not engaged in daily physical activities, or are offered rest after a strenuous work period (e.g., logging season).
- **Social conditions:** Expression of musth can be moderated by social dominance status. Musth in younger bulls can be suppressed by the presence of older, more socially dominant bulls in an area, although in some cases, having a subordinate male in musth in close proximity to a more dominant bull can actually make the subordinate male's musth stronger and/or prolonged. Groups of bulls may show asynchronous musth periods, with dominant males coming into musth first during periods of optimum resources. Musth can also be affected by the presence of estrous females. Bulls in musth seek out receptive females, and in some cases estrous females can trigger musth in companion males.

## Guidelines for management and care

The management of musth bulls in Asia has remained largely unchanged for centuries. Traditional methods often involve tethering them to trees or posts with short ropes or chains, or hobbles, and often in areas with little shade or water. Restriction of water during musth is particularly dangerous because of increased fluid loss due to urine dribbling and TGS, which can result in kidney damage.

Managers of musth bulls must be willing to invest in resources and facilities to ensure the safety and welfare needs of both animals and humans, whether that be adequate forested areas for long chaining, or structural facilities of adequate size for containment.

Food intake is sometimes restricted based on the assumption that this will terminate musth sooner. These practices are inhumane, leading to wounding of the legs, development of stereotypic and destructive behaviors, and resulting in bulls becoming even more aggressive. Aggressive bulls may be difficult to approach, which can result in a lack of hygiene on its keeping ground, leading to health problems such as foot rot and high parasite infestation. Managers of musth bulls must be willing to

invest in resources and facilities to ensure the safety and welfare needs of both animals and humans, whether that be adequate forested areas for long chaining, or structural facilities of adequate size for containment. The following are recommended guidelines for proper musth bull management. However, it is important to note that individual differences in bull temperament and behavior mean that management strategies for some bulls may not be applicable to all. For that reason, bull individuality must be taken into consideration when developing musth management plans.

1. Identify all prospective musth candidates in a facility and keep a written record of all musth episodes. Make sure the camp manager or person in charge has instructions on how to score physical and behavioral musth signs (e.g., musth log, photos; see Appendix II). Episodes of musth experienced by a bull over past years should be charted and used to predict future musth periods. Musth records should include: age of first musth occurrence if known, dates of musth by musth phase, duration of musth periods, where the bull was when musth began (tethered or not, engaged in logging, procession, tourist activities, etc.), intensity of musth signs, severity of aggression, injuries to staff or other elephants, and if any mitigating actions were taken during each musth cycle (drugs, isolation, etc.). Ideally, musth records are computerized, and should be transferred when a bull changes ownership.
2. Ensure that elephant owners and/or mahouts entrusted to these bulls are knowledgeable, reliable, free from addictions, physically fit, and have adequate experience working with bull elephants.
3. Mahouts should receive adequate training in elephant handling. Training should include methods for positive elephant training/handling. For facilities with more than one elephant, a Chief Mahout should be appointed who can ensure that all mahouts at a facility follow

proper guidelines for elephant management (including training, proper use of ankus, health checks for mahouts and elephants, etc.).

4. At the first indication of musth (pre musth signs), bulls known to become dangerous should be removed from contact with people and other elephants. If a bull becomes too aggressive, there may be no alternative but to restrain it, either on chains or in a fortified enclosure. Other bulls can be safely handled during musth. For some bulls, being in close proximity to a larger, more dominant bull can lessen the intensity of musth. For others, placing a subordinate bull musth near a dominant bull can stimulate a more intensive musth. For these reasons, it is critical for mahouts to know the temperament of each elephant and plan accordingly. Special attention should be paid to young bulls that are just starting to experience musth, as they often are less predictable and more difficult to gauge behaviorally.
5. Facilities should have an isolated area where musth bulls can be safely maintained. Ideal options for musth bull containment are:
  - a. Long chain in a forested area with water, natural forage, and shade (recommended, 20-30 meter chains).
  - b. Electrified paddock (recommended 12 x 12 meters).
  - c. Steel enclosure with natural substrate (recommended 12 x 12 meters).
  - d. Large paddock with access to water and shade, with opportunities to socialize with other elephants if possible (see Appendix III).



***Fig: Tusker in musth in Mudumalai TR***



6. During restraint/containment, positive reinforcement interactions are critical to maintaining good mahout-elephant relationships.
7. During the daytime, the living area should have shade, either by forest canopy or a well-constructed roof.
8. Elephant resting areas (day and night) should be cleaned of feces and urine daily, which can be difficult for natural substrates that can become wet from rain or urine/feces, so selecting musth restraint areas that can be cleaned properly is important. Feces should be stored/disposed of away from the elephant (composting of feces is recommended).
9. As the bull enters musth, provisioning of concentrated rations and high calorie foods (e.g., grains, bananas, sugar cane, etc.) should be limited; instead they should be fed primarily fodder (e.g., napier grass, cornstalks, etc.), with access to drinking water. Bulls should not be over-conditioned, and fed to maintain a body condition score of 2.5-3 (1-5 scale) or 5 (1-11 scale). However, withholding food and water to lower body condition as a means of reducing musth symptoms should not be allowed.
10. Bulls should have an annual veterinary exam, and be checked by a knowledgeable person post musth to ensure he is in sufficient condition to return to work, and is safe to be around visitors. Facilities should either have a veterinarian on site, or have an agreement with local elephant veterinarians or an elephant hospital for medical or emergency services.
11. For facilities that engage the public, there must be signs in at least two languages (local + English) to warn staff and visitors about the musth-reserved area.
12. Facilities should have a written emergency/aggression management plan in place for uncontrollable musth bulls, following a protocol whereby the least amount of force is used to control an elephant, and the hook is used per the protocol. Elephant owners and/or mahouts should have knowledge of what is considered bad treatment of their elephant, and there should be consequences if bad treatment occurs. Emergency elephant capture teams should be prepared by conducting regular rehearsals. Facilities should maintain long distance syringe projectors (tranquilizing gun) with accessories and drugs to control bulls that become a threat to life and property. Veterinarians equipped to handle rampaging bulls should be on hand at festivals and other cultural events.

## **Mitigation strategies for musth bulls**

Drugs and other pharmaceuticals have been used to diminish musth symptoms and control aggressive behavior for variable lengths of time. These can affect neural function or act on the hypothalamo-pituitary-gonadal (HPG) axis to reduce androgen production and potentially ease a

bull out of musth, thus making it more manageable. Sedatives may calm bulls, while other drugs have been shown to suppress the HPG axis or block testosterone action (e.g., anti-androgens, GnRH analogs, GnRH vaccines). However, reduced testosterone concentration or function does not guarantee alleviation of aggressive behaviors, or that a bull is safe to work with.

It is important to note that musth is a natural phenomenon in adult bulls and chemically suppressing it is not normal. It also is vital that musth-suppressing treatments only be used when the welfare of the bull or human safety is in question, and not for routine control of aggression. **Chemical treatment should never replace good management.** Many of these drugs have not been fully tested in elephants, so caution is strongly advised. It also is not known what the long-term consequences of these treatments are. Some potentially serious side effects based on human use may include decreased muscle and bone mass, diarrhea, liver damage, lung disease, and sensitivity to light. Finally, because behavior can be unpredictable, precautions for handling musth bulls should be followed even if they are being treated and show reductions in testosterone.

### ***Short-term treatments to diminish musth symptoms***

A number of drugs have been used to mitigate musth symptoms for short periods of time through sedative actions or suppression of the HPG axis, but these should be used only in emergencies and not as a routine management strategy. These include:

- a. Sedatives
  - i. Xylazine (0.088-0.13 mg/kg BW) recommended for short-term use only as the body can adapt so it becomes less effective; note that effects can be unpredictable.
- b. Antipsychotics/anti-anxiety
  - i. Haloperidol (antipsychotic, may reduce agitation); e.g., 100-200 mg i.m. daily as needed
  - ii. Diazepam (benzodiazepine, anti-anxiety) 300-500 mg daily as needed
  - iii. Trilafon (dose and efficacy undetermined)
  - iv. Zuclopenthixol - dose and efficacy undetermined in elephants; in other ungulates, *Zuclopenthixol acetate* (Clopixol-Acuphase) begins to act after about 1 hour and lasts for 3 -4 days, while *Zuclopenthixol decanoate* acts for 10-20 days.
- c. Antiandrogens
  - i. Flutamide @ 5000-7500 mg daily for 3 days or as needed
  - ii. Cyproterone acetate @ 2.5 mg/kg/day as needed

d. GnRH analogs

- i. Detirelix (GnRH antagonist) 4-12 mg/day i.m. as needed
- ii. Degarelix acetate (GnRH antagonist, Gonax®) 240 µg/kg/day i.m. as needed
- iii. Leuprolide acetate (GnRH agonist, Lupron®) 22.5 - 45 mg (s.c. or i.m.) every 3 weeks. Effective long-term treatment involves repeated injections given every 2-6 months.

e. Steroids

- i. Synthetic progestagens [e.g., medroxyprogesterone acetate (i.e., Depo-Provera)], 750 - 1500 mg i.m. as needed

***Control of rampaging bulls (captive or wild)***

Tranquilizers have been used on bulls that escape confinement, become uncontrollable, or are an immediate threat to people, property or other elephants.

Example protocol:

1. Administer xylazine by dart at a dose of 80-120 mg per ton (0.088-0.13 mg/kg). Be aware that xylazine is slow acting and very unpredictable, and any disturbance can affect induction times. Addition of sedatives, like acepromazine (40-50 mg) or ketamine, can improve sedation outcomes. A side effect of some of these medications is photosensitization, so keep the animal in a shady area.
2. After darting, ear flapping and tail movements will diminish, and the penis will begin to relax (usually within 7-10 minutes).
3. Peak sedation occurs within 35-45 minutes (depending on degree of disturbance); animal will remain ambulatory.
4. Noose all four limbs. A bull can become particularly aggressive towards its mahout, so it may be more appropriate for other people to work the elephant.
5. If possible, move the bull to a shady place and tether the hind limb with a short chain or rope with enough length to lie down after recovering from sedation if needed.
6. Provide water (e.g., a strong trough, like concrete, that can withstand damage).
7. If a bull becomes recumbent, take steps to monitor and stabilize respiration and heart rate, providing reversal drugs if necessary.
8. Sedation can last 6 hours or more, with retraction of the penis being a sign it is wearing off.

The same applies to wild bulls or non musth bulls that threaten villages and people if other mitigating actions fail. If available, aggressive rampaging bulls also can be immobilized with etorphine or medetomidine with ketamine.

**\*\*Sedation should only be used in emergencies and under the supervision of an experienced veterinarian \*\***

### ***Long-term methods to prevent or suppress musth***

More recently, GnRH vaccines have shown promise in controlling reproductive and sex-related behaviours that are testosterone driven. In Asian bulls, pituitary LH responses to exogenous GnRH are greatest during the pre-musth period (about 1-2 month before musth onset), which is when serum LH and testosterone are increasing. Therefore, the assumption is that GnRH vaccination will be more effective when given prior to the predicted musth period to block the HPG axis and suppress testosterone. In Thailand and Sri Lanka, Asian bulls given 600 - 1000 µg of a GnRH vaccine (Improvac®) approximately 2 months prior to expected musth exhibited a postponement of musth for 2-6 months, a shortening of the musth period, or a complete prevention of musth symptoms for that year. Serum LH and testosterone concentrations were decreased when anti-GnRH antibodies were elevated, and no UD was observed in musth bulls after completion of the vaccination program. However, not all bulls respond to vaccination with a reduction in musth symptoms even when testosterone is reduced, as these may be learned behaviors.

***It is important to note that long-term treatment with GnRH vaccines may result in permanent immune-castration and sub- or infertility.*** A young Asian bull vaccinated over several years exhibited reduced sperm production and size of reproductive organs (i.e. ampullae, seminal vesicles, testes, and penis) long-term; thus, it should be used cautiously and only when absolutely necessary. If, however, some captive bulls are never intended for breeding (e.g., India temple elephants), and the welfare of those elephants is compromised by prolonged, debilitating or destructive musth periods, then GnRH vaccination is an option for long-term suppression of testosterone to improve welfare. Bulls may still be dangerous for a period of time after treatment, but as the testes and accessory sex glands regress, aggression should diminish.

## Conclusion

Balancing human and animal safety, and animal welfare needs is undeniably one of the greatest challenges facing handlers of elephant bulls, especially those that exhibit musth. Now is the time, however, for creative thinking to explore more humane and enriching ways to manage them. In particular, they should be allowed as much freedom as possible. Use of long chaining in the forest with access to food and water, or a secure paddock with enrichment (e.g., pool, mud, dust, scratching post) and shelter need to replace traditional methods involving short chains and hobbles (see Appendix I). Positive training methods should be part of the daily management. There are numerous examples throughout Asia and the western world of bulls being integrated into herds with females and calves, some even when they are in musth. This can only happen if a bull is handled properly and humanely, has a trusting relationship with its handler, lives in an enriched environment, and is given opportunities to express natural behaviors. It is also important to extend protocols to involve a lifelong commitment to use of proper training, management and care techniques for all bulls, not just when they are in musth. The AsESG cannot condone facilities that do not properly care for bulls. Members are willing and available to develop recommendations to improve musth management to assist facilities that want assistance or advise in improving conditions for bull elephants.

**IUCN/SSC Asian Elephant Specialist Group  
Management and Care of Captive Elephant Bulls in Musth**

**Appendix I**

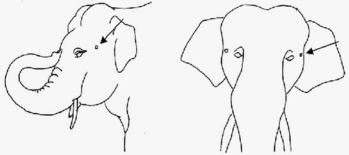
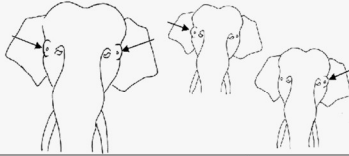
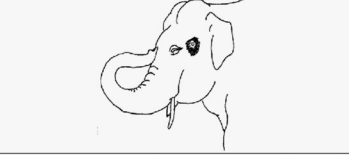
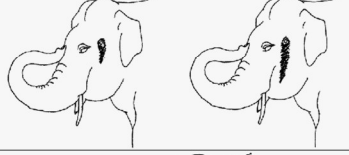
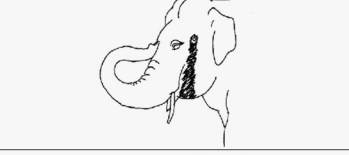
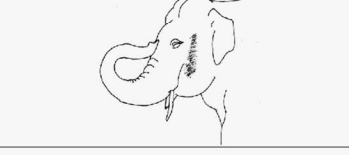
Inadequate management of musth bulls (lack of shade and/or short chains)  
(Photos courtesy of Sri Lanka Wildlife Conservation Society)



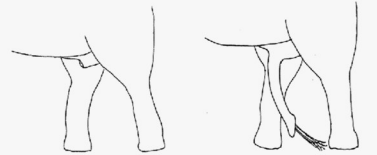
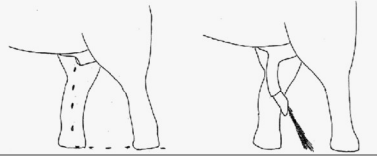
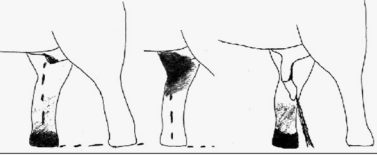
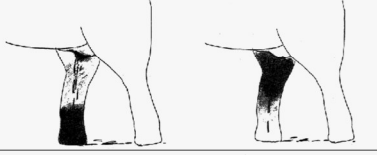
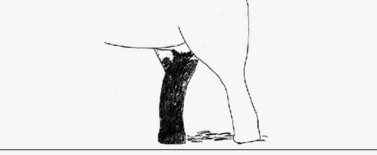
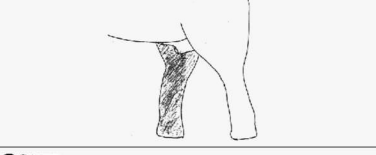
## Appendix II – Asian Musth Scale

### Courtesy of Sharon Glaeser, Oregon Zoo

#### Temporal Gland Secretion (TGS)

0	No visible TGS	
1	Swollen temporal gland area Opening may be enlarged May not be symmetrical	
2	Temporal gland area wet TGS less than 1/4 way to jawline	
3	TGS between 1/4 and 3/4 way to jawline	
4	TGS from 3/4 to all the way to jawline	
5	TGS staining is dried (lighter color than wet)	

#### Urine Dribbling (UD)

0	No visible UD Urination occurs normally (with penis fully extended)	
1	Occasional drops (without penis extended) Urination occurs with penis partially extended	
2	Regular drops and/or some steady streams (without penis extended) Urination occurs with penis less extended than #1 Legs (upper or lower) a little wet or stained with urine	
3	Steady streams from the opening and some dribbling from the skin of the sheath (without penis extended) Penis does not drop to urinate Legs (upper or lower) half wet or stained with urine Skin around sheath wet with urine	
4	Heavy steady streams falling from the opening and skin of the sheath so the stream looks wider than #3 (without penis extended) Penis does not drop to urinate Legs entirely wet with urine Skin around sheath wet with urine	
5	UD staining is dried (lighter color than wet)	

This musth scale was adapted from previous work by:  
 Jainudeen, M. R., C. B. Katongole and R. V. Short (1972). "Plasma testosterone levels in relation to musth and sexual activity in the male Asiatic elephant, *Elephas maximus*." *Journal of Reproduction and Fertility* 29: 99-103  
 Poole, J. H. (1987). "Rutting behavior in African elephants: the phenomenon of musth." *Behaviour* 102: 283-316  
 Scott, N. L. (2002). "Chemical communication and musth in captive male elephants", Portland, OR (USA): [Portland State University](http://PortlandStateUniversity)  
 Somgird, C., S. Sripaboon, S. Mahasawangkul, K. Boonprasert, J. L. Brown, T. A. Stout, B. Colebrand and C. Thitaram (2016). "Differential testosterone response to GnRH-induced LH release before and after musth in adult Asian elephant (*Elephas maximus*) bulls." *Theriogenology* 85(7): 1225-1232

Contacts:  
 Shawn Finnell ([shawn.finnell@oregonzoo.org](mailto:shawn.finnell@oregonzoo.org))  
 Sharon Glaeser ([sharon@pdxwildlife.com](mailto:sharon@pdxwildlife.com))



**Temporal Gland Secretion (TGS)**

0 = No TGS visible

1 = Swollen temporal gland area; opening may be enlarged; may not be symmetrical

2 = Temporal gland area wet; TGS less than 1/4 way to jawline (wet from gland to eye level)

3 = TGS between 1/4 and 3/4 way to jawline

4 = TGS from 3/4 to all the way to jawline

5 = TGS staining is dried (indicates post-musth)

**Urine Dribbling (UD)**

0 = No visible urine dribbling; urination occurs normally (with penis fully extended)

1 = Occasional drops (without penis extended); urination occurs with penis partially extended

2 = Regular drops with no breaks and/or some steady streams (without penis extended); urination occurs with penis less extended than UD1; feet and lower legs wet or stained with urine

3 = Many steady streams from the opening and some dribbling from the skin of the sheath (without penis extended); penis does not drop to urinate; legs wet or stained with urine; skin around sheath wet with urine

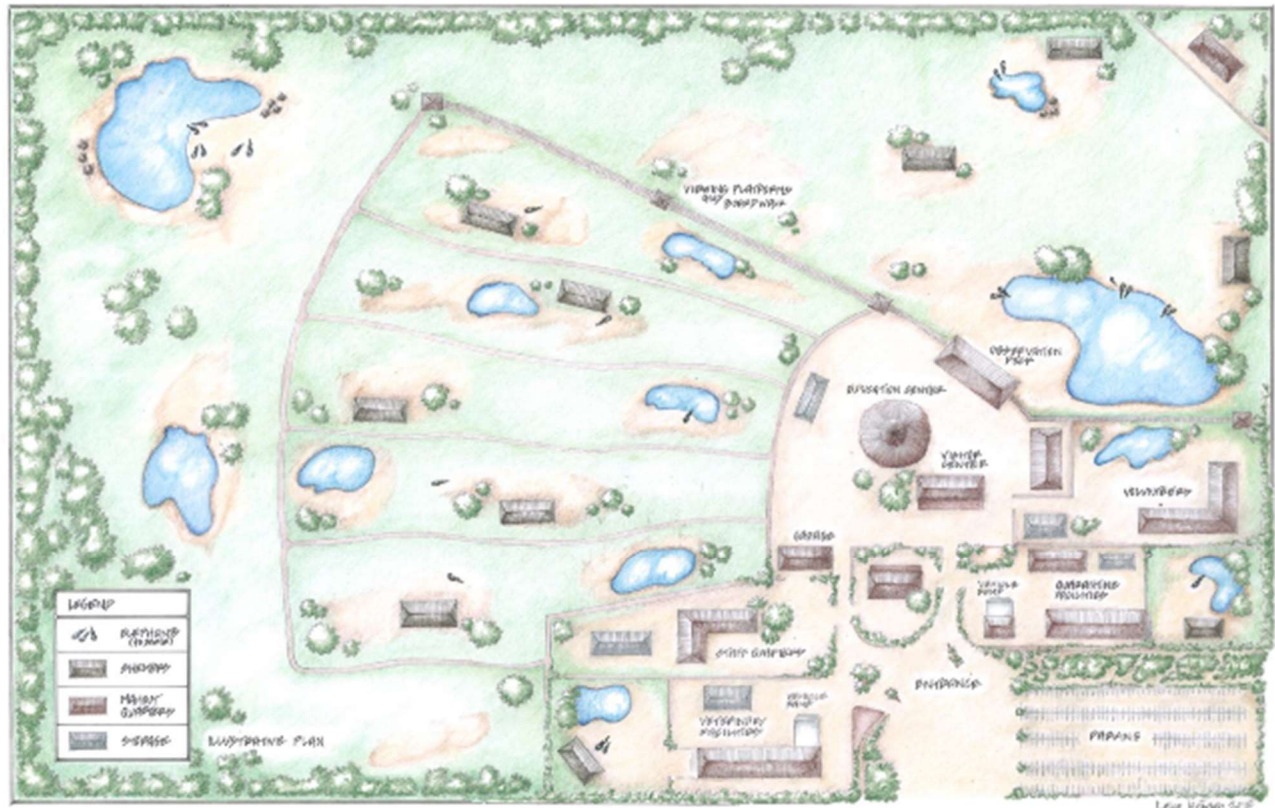
4 = Constant stream dribbling from the opening of the sheath (without penis extended) and wetness of skin; penis does not drop to urinate; legs wet with urine; skin around sheath wet with urine

5 = UD staining is dried (indicates post-musth)



### Appendix III – Concept design for bull enclosures

(Sri Lanka Wildlife Conservation Society, 2016)



A centralized facility where bulls can be brought during musth periods would serve the needs of local owners and raise the standards of care. Good welfare for musth bulls can be offered at a facility that has secure paddocks that provide access to a bathing pond, mud, dust, scratching post, shade, social opportunities (through a barrier or perhaps together) and water.