INTRODUCTION

Wild cattle and similar species have been successfully managed for many years. This group includes all species of the genera *Bos* (true cattle), *Bubalus* (Asian water buffalo and related forms), and *Syncerus* (African or cape buffalo). Asian water buffalo, and American and European buffalo, *Bison sp.*, are already defined by the U.S. Department of Agriculture as domestic animals; husbandry techniques for other domestic relatives of wild species have also been established by the agricultural community. Regardless, managers should always remember that while wild cattle may demonstrate behavioral and husbandry needs similar to those of their domestic counterparts, they are still wild animals and should always be treated as being potentially dangerous. In general, the social system of most species of wild cattle is similar to that of domestic cattle, and they are best kept in a gregarious herd containing only one adult male. When housed in close quarters, additional facilities are needed to separate adult males. An exception to this rule is the anoa, *Bubalus depressicornis*, which does better when housed in pairs or in groups containing one male and two adult females. Social needs of the tamaraw, *B. mindorensis*, may be another exception or have needs similar to those of the anoa but little captive husbandry information about tamaraws has been documented.

HUSBANDRY

Minimum requirements for exhibit size and furnishings, diet, social groupings and husbandry techniques are generalized unless species specific statements are needed.

General:

Guidelines for captive management of most species are similar to those developed for domestic cattle, *Bos taurus* and *B. indicus*. Several species are found in tropical environments but adapt readily to temperate or near-arctic conditions.

Requirements unique to certain species are listed separately.
Temperature:

In general, cattle and related species do well in temperate and tropical environments. The genus Bos includes gaur, Bos gaurus; banteng, B. javanicus; and kouprey, B. sauveli, all species native to regions located between 30 degrees North and 15 degrees South latitude. Regardless, gaur in particular have shown amazing versatility in their ability to adjust to colder ranges of temperature. Although they occur naturally in tropical areas of India and Malaysia where the temperatures exceed 100 degrees F (38 C), in North America they display no adverse effects when maintained outdoors when temperatures are below 0 degrees F (-18 C). The yak, Bos grunniens, a native to China and Mongolia, is found at high altitudes and is extremely cold hardy. Banteng, and probably anoa, tend to be more sensitive to cold, wet conditions, and temperatures below 32 degrees F (0 degrees C). The same is true of water buffalo, Bubalus bubalis, a native of tropical latitudes. Water buffalo have a comfort range of between 50-75 degrees F (10-22 C) (Fahimudin, 1989), and they show physiological stress above 97 degrees F (38 C). Direct sunlight for an extended length of time is also stressful. It is recommended that shade structures be made available. African buffalo, Syncerus cafer, are more suited to dry climates than Asian buffalo but have similar temperature requirements.

Ventilation and Humidity:

The recommended ventilation for cold weather housing of domestic cattle (Phillips 1970 [1108]) is 4-6 complete air changes per hour. A barn with forced air heat is capable of maintaining 45 degrees F (7 C) and four air changes an hour. Recommendations for animals in a warm confinement building state (Phillips, 1970 (1107)) it is important for the ventilation system to:
1. Provide fresh air to meet respiration needs of the animals.
2. Control moisture build-up within the structure.
3. Move enough air to dilute airborne disease organisms produced within the housing unit.
4. Control or moderate temperature extremes.

Table I. Recommended ventilation rates for livestock in warm confinement buildings (Phillips, 1970).

<table>
<thead>
<tr>
<th>Desired Room Temperature in degrees F</th>
<th>Animal</th>
<th>Winter</th>
<th>Minimum Winter Nominal Summer</th>
<th>Ventilation Rate in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nominal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Listed Unit</td>
<td>Cubic Feet of Air per Minute</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy Cow 55 35 100 200</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy Calf 55 10 50 75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef-per 1000 lb 55 15 100 200</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For hot weather conditions, the recommendation increases to 16 -32 complete changes of air per hour. It is important to note that temperature ventilation and humidity are related to the ability of these species to adapt to captive environments.

**Lighting:**

Because of their size, wild cattle, are generally kept outside where natural light is available. When kept indoors for extended periods of time, skylights, florescent or incandescent lights are suitable until the animal(s) can be allowed out again.

**Water:**

All species of wild cattle and buffalo are water dependent. In a captive environment, water should be available 24 hours a day. A wallow or pool should be available for water buffalo to aid in thermoregulation.

**Sanitation:**

In captive environments, cattle and buffalo produce large quantities of manure and urine. Because enclosures may be under continuous use for many years and these species are naturally inclined to feed off the ground, all surfaces should be cleaned and disinfected daily to limit exposure to unclean or parasite-infested areas. Periodic steam or high pressure cleaning is recommended.

**Diet:**

In nature wild cattle are grazers or browsers, and have a digestive physiology that relies on a continued intake of material. Instead of offering an entire ration at a single feeding, diets should be broken into at least two, and preferably more, feedings. At the very least, pelleted rations and half the hay ration should be fed in the morning; the remaining hay ration should be fed in the after-noon. Rapid consumption of pelleted rations can lead to bloat, acidosis, and other metabolic dysfunctions. Continued access to hay may also reduce behavioral and social problems within a captive population. To protect against repeated parasite reinfection, feed
should be offered in sturdy tubs or other durable containers which can be easily cleaned and disinfected, and in hay mangers. Under most situations, wild cattle should be fed a pelleted ration supplemented by a hay that is available ad libum. Most legume and grass hays available throughout North America meet the basic needs of all species. Hay quality should be periodically checked, however, to ensure that overall dietary requirements remain in balance and meet the recommended needs of this group. Diets should be balanced between available protein, high fiber base and trace minerals. Fresh browse should be available whenever possible, checking locally obtained foliage prior to feeding to insure it is not contaminated, toxic, or otherwise detrimental to the animals.

**Housing:**

Indoor holding must be able to accommodate correct social groupings for each species. Basic stalls measuring 10 x 15 ft. (3.1 x 4.6 m) per animal are generally adequate. Mature bulls may require more space however and their stalls should measure at least 20 x 20 feet (6.1 x 6.1 m). One of the basic problems when housing wild cattle and buffalo indoors concerns floor substrate. These animals are all large-hoofed and can lose their footing on slick surfaces. To prevent slipping, it is strongly recommended that a broom-swept texture be added to concrete surfaces in order to give the flooring a rough texture. It is important to note which way the floor drains before applying a broom finish to ensure that grooves in the concrete follow the slant of the surface toward the floor drain. Keeping large species of cattle on concrete floors for extended periods of time can cause lameness. Therefore, efforts should be made to give them daily access to outside enclosures and more natural substrates. Wild cattle are strong and can be very destructive to buildings and enclosures. As a result, all facilities should be well constructed to prevent facility damage as well as to insure the safety of both the animal and keeper staff. When designing indoor facilities, particular care should be taken to avoid using swinging doors in animal stalls unless they are needed to form runways. Cattle are prone to playing with unsecured doors with their horns, damaging structures in the process. Barn doors should be sliding doors whenever possible. Indoor enclosures should contain a minimum of 25-45 sq. ft (2.33-4.2 m2) per animal, larger areas being required for larger species. Outdoor areas should measure at least 300-1000 sq. ft (28-93 m2) per animal but larger areas are much more desirable. Visual barriers are useful to allow subordinate animals safe areas to rest; shade structures should be present in all enclosures. Most barriers suitable for domestic cattle have proven successful in keeping wild cattle within displays.

**Social Biology and Behavior:**

Captive populations are housed in three basic social systems:
Cow/calf herds composed of several females and their calves may be housed together, occasionally with a breeding bull. At night, breeding bulls and male calves reaching sexual maturity should be housed in separate stalls to prevent aggressive or pre breeding behavior that may cause injury to cows due to close proximity and a lack of escape routes. Single breeding males need to be separated indoors to avoid over solicitous behavior toward the females and calves. Bachelor herds of young males not currently needed for breeding programs. In general, wild cattle are relatively docile but any member of this group can become extremely aggressive and dangerous when aroused.

VETERINARY NEEDS

Any facility interested in maintaining wild cattle should obtain the services of a large animal veterinarian. Wild cattle have similar medical needs to those of domestic breeds. When considering vaccinations regimes, managers should consult a veterinarian familiar with the needs of exotic cattle, and should remain informed of applicable state and federal regulations. Under zoo situations, wild cattle should not be vaccinated on a routine basis because some will not develop a titer while others will never lose one and be impossible to transfer interstate. When wild cattle are first obtained, they should be quarantined at least 30 days, and tested under a protocol that follows the guidelines set by the American Association of Zoo Veterinary quarantine procedure. A minimum of two fecal examinations are recommended per year and appropriate parasite therapy instituted as necessary.

LITERATURE CITED
Allen, D and M. Baer 1988.
EVALUATION OF HOOFSTOCK DIETS AT THE ST. LOUIS ZOO. Allen and Baer Associates, Inc.
Fahimuddin, M. 1989.
VENTILATION FOR WARM CONFINEMENT LIVESTOCK BUILDINGS. Guide 1107, University of Missouri - Columbia Extension Division.
VENTILATION FOR WARM CONFINEMENT LIVESTOCK BUILDINGS. Guide 1108, University of Missouri - Columbia Extension Division.