

Searching for the Last Kouprey

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INTRODUCTION

Kouprey (*Bos sauveli*) are currently listed as Critically Endangered on the IUCN Red List of Threatened Species (Timmins et al. 2008) and will certainly go extinct in the near future unless effective action is taken immediately. The primary threat to Kouprey is hunting for both local consumption and the wildlife trade. Any extant populations are most likely to be greatly reduced and fragmented and therefore at risk from the demographic and genetic problems associated with small populations (e.g., inbreeding, susceptibility to stochastic events). *Ex situ* conservation is not currently a possibility as no Kouprey are currently held in captivity. Despite a growing concern that Kouprey may already be extinct, the 2008 Southeast Asian Wild Cattle Conservation Strategy Workshop determined this conclusion to be premature because species-specific survey efforts across the Kouprey's range had not yet occurred (IUCN/SSC in review). They recommended that, prior to undertaking any additional surveys, all recent survey results be analyzed to identify regions within the Kouprey's historical range with the highest probability of Kouprey persistence, based both on habitat type and survey effort to date. The overall goal of this project is to produce recommendations (including maps) of areas where follow-up surveys aimed specifically at detecting Kouprey persistence can be carried out.

PROJECT OBJECTIVES

The project has three main objectives, which were carried out by the Asian Wild Cattle Specialist Group (AWCSG) led by R. J. Timmins:

- (1) To review all recent survey efforts, primarily camera trap photos but also survey and patrol records from the Kouprey's historical range to determine whether any Kouprey records had been overlooked. This review work concentrated in Cambodia, where any remaining Kouprey populations are most likely to be found;
- (2) To assess areas of potentially suitable Kouprey habitat using remote sensing data, survey reports, and other available data; and
- (3) To conduct a gap analysis, based on the results from objectives (1) and (2), and identify regions with the highest likelihood of Kouprey persistence which would form a set of high-priority sites for follow-up surveys.

Additionally, the AWCSG gathered data on other wild cattle species, particularly Banteng (*Bos javanicus*) and Wild Water Buffalo (*Bubalus arnee*) but also Gaur (*Bos gaurus*). The review of previous survey efforts incidentally included data on the occurrence of these species, which can provide information on hunting pressure as well as a proxy for assessing Kouprey habitat suitability given the broad general overlap in regional wild cattle habitat requirements (see below).

RESULTS

I. Review of Recent Survey Efforts

In-country gathering of recent survey data within the Kouprey's historical range occurred between July 24 and September 17, 2010. Before travelling, inquiries were sent to all organizations believed to hold relevant data; however the vast majority of data were gathered while in the region. The primary researcher, R. J. Timmins, visited organizations in Thailand, Laos, and primarily Cambodia. Vietnam was not visited because prior inquiries revealed that there were no relevant camera-trapping data available that could not be obtained by other means.

To date approximately 74,000 images have been examined, representing an estimated 90% of relevant images from the region (Table 1). Although Banteng, Wild Water Buffalo, and Gaur were all recorded from the region, there were no camera trap images of Kouprey. However, not all the relevant data were examined: the majority of images from a minimum of seven projects known to have captured wild cattle were not reviewed, including two sets from potentially important areas of eastern Cambodia (see below).

Data limitations

There were some limitations in the availability of survey data, primarily camera trap records. This resulted in a greater amount of time than predicted spent reviewing the data and placed limits on the mapping and gap analysis. These issues are listed here to aid in future efforts to document survey data:

- The film development of only a subset of images from some camera trap surveys. This may result in the exclusion of captures which, while perhaps only rarely of the target species, may be a source of significant data 'loss' for other species;
- The disassociation of camera trap images from the same survey from each other, from the original negatives, and/or from the metadata. Also, there is a frequent lack of information on the duration of camera trap surveys; and
- Limitations on the ability to cross-reference between databases, both within a given methodology (camera-trapping) and between data from different methods (e.g., surveys, patrols).

II. Identification of Suitable Kouprey Habitat

Because only a subset of the data was formatted for spatial analysis, the mapping of suitable Kouprey habitat and subsequent gap analysis is somewhat imprecise. A significant number of the various features required for the mapping and analysis do not yet exist in a GIS-compatible format, including oral records of survey sites and results and the location of patrol efforts. In lieu of this, results are based on expert interpretation of the available data. The future inclusion of this unformatted data will highlight additional subtleties of potential Kouprey range and gaps in survey effort. A more accurate mapping exercise, necessary for a thorough gap analysis, would also greatly benefit from expert feedback from individuals familiar with local factors, especially current human land use and the general status of the area's wildlife. However, neither of these additional efforts is likely to change the basic conclusions of this report.

Historical Kouprey Range

Historical wildlife records are relatively poor within the four potential Kouprey range countries. Even though historical records of Kouprey come from a relatively small area centered in northern Cambodia, it cannot be concluded that that Kouprey did not formerly occur throughout the deciduous forests of Cambodia, Vietnam south of the Central Annamites, Central and Southern Laos, and eastern Thailand to

at least the Chao Parya. The lack of historical Kouprey reports outside of this area may be due to a variety of different factors, including limited surveys for wild cattle and the use of a wide variety of local names for *Bos sauveli*, particularly in areas infrequently visited by people likely to document the presence of wildlife.

If the historical Kouprey records dating from the 1900's accurately reflect its historical distribution, this geographic range probably reflects the species' sensitivity to hunting as opposed to its Holocene range. The Kouprey's likely early eradication from significant portions of its original Holocene range is supported by its historically recent rapid decline in Cambodia. As discussed in more detail below, the Kouprey appears to be more sensitive to hunting and other human activities than other wild cattle species with which it co-occurs. This would not be the first species to have experienced significant range loss either before historical documentation or during the early years of natural history exploration - e.g. Wild Water Buffalo, Greater Flamingo (*Phoenicopterus roseus*), Great Cormorant (*Phalacrocorax carbo*), Giant Ibis (*Thaumatibis gigantea*), and the three Asian Rhinoceros species.

Historical Kouprey Habitat

Little data exist on the Kouprey's preferred habitat. The majority of historical records come from relatively open plains of Deciduous Dipterocarp Forest (DDF). Within this broad habitat type, Kouprey records appear to be associated in particular with areas supporting numerous pools, mineral licks, and grassland 'glades' (*thong* in Lao and *viel* in Khmer). Such habitat is widespread in the region's DDF-dominated lowlands and is often associated with major stream valleys. However, this habitat is not ubiquitous and there are extensive areas of 'denser' DDF types throughout the region.

It is possible that the historical association of Kouprey with these more open DDF formations is biased by the circumstance under which the records were generated. Most records come from well-known colonial era large mammal hunting areas, particularly Lomphat, other parts of the Srepok plains, and the plains of Chhep. It is logical that popular sites for hunting Kouprey would reflect areas of relatively high abundance and would indicate something about the species' habitat preferences. However, these sites may not reflect the Kouprey's overall ecological niche. Big game hunting areas generally host multiple game species and are biased towards easily accessible areas with good visibility, which are factors that single out the Chhep and Srepok plains with their multitude of glades and pools. Conversely, denser tree formations with fewer and only small glades lack these features and may have been avoided by hunters, regardless of the potential presence of Kouprey.

Kouprey could have used other DDF habitat types extensively, or at least have had self-sustaining populations within denser DDF habitat types. A high proportion of DDF-associated bird and mammal species have been documented in a range of structurally similar habitats, including pine savannahs in hill and mountain areas and coastal *Melaleuca* (paperbark) woodlands. For instance, Eld's Deer (*Rucervus eldii*) which is currently considered a DDF specialist preferring habitat similar to the Kouprey's, was historically known to have occurred in pine savannahs in at least two separate areas of Indochina from which it has now been extirpated. Giant Ibis, a species with perhaps the greatest similarity in range and habitat preference to that documented for the Kouprey, may have historically occurred in wider range of habitats, as shown by historical records from the northern areas of peninsular Thailand. However, the Kouprey's more rapid decline compared to the region's other wild cattle is consistent with a preference for relatively open habitats. Open country species are generally more threatened than those associated with dense forest formations, e.g., Jungle Cat (*Felis chaus*) and Eld's Deer, both of which favor open DDF formations with a high number of glades and pools.

Threats to Kouprey

The preeminent threat to Kouprey remains hunting, even within the most well-managed protected areas. The Kouprey remains iconic and well known in at least the collective bestiary of the Cambodian populace, both for its rarity and associated value. Its horns still remain a treasured and sought after status symbol for wealthy Southeast and East Asians, and bounties for Kouprey trophies are believed to still circulate (J. Murray pers. comm. 2010). In addition, wild cattle of all species remain targets for food for both subsistence and trade as well as for national and international wildlife trade in body parts for use in traditional medicines.

Overlaid on the primary threat of hunting is continued habitat loss, and the development of new roads, tracks and settlement that allow increased accessibility to remaining forested areas. The current accessibility of most forest areas within the Kouprey's historical range is due to a number of contributory factors, including: the significant reduction in civil unrest; major infrastructural upgrades to roads and other transportation routes; regional economic growth with increased access to markets, which has promoted greater demand for wildlife products, valuable timbers and land, and provided resources for emigration to new lands; and, in particular, the recent division of land into concessions and other forms of land holding that promote access and movement to new lands. Thus, while Kouprey habitat *per se* is disappearing steadily, but rather slowly, available habitat for Kouprey where hunting pressure is low enough for persistence is now very scarce.

Determination of Suitable Kouprey Habitat

The first priority in assessing potential Kouprey habitat was the identification of areas of DDF with a high number of pools and glades that are within its historical range. We also considered the possible presence of Kouprey outside of this apparently preferred habitat. Although it is unlikely that viable Kouprey populations could be found in marginal habitats, under exceptional circumstances such habitat may host individuals or small groups that have persisted due to low hunting pressure. Given the extremely threatened status of Kouprey any possibility of occurrence seems worth consideration. Marginal habitat is likely to include denser DDF formations, areas of Semi-evergreen Forest (SEF) with sporadic glades and deciduous patches, and hill grasslands and savannas.

In establishing a predictive map of remaining potential Kouprey habitat, three considerations were taken into account:

A) *Suitability of habitat type*: Four categories of habitat type were identified:

Tier 1: Lowland DDF with extensive pools and glades;

Tier 2: Generally denser DDF with a high percentage of canopy cover and lower pool and glade densities;

Tier 3: Dense closed canopy DDF and Mixed Deciduous Forest (MDF) mosaic; and

Tier 4: Hill areas with extensive grasslands that are almost certainly suboptimal Kouprey habitat and may never have supported the species, but for completeness have been mapped if they also qualified due to other factors.

B) *Size of forest patch*: It was not considered possible for Kouprey to persist in areas smaller than 100 km² or less than 7 km in width. It is unlikely that Kouprey exist in these smaller or narrower forest fragments due to accessibility and the likelihood of high surrounding human population densities, both of which increase the probability that Kouprey have already been extirpated. Additionally, it is less likely that Kouprey have avoided previous detection in these smaller forest fragments. This conclusion is supported by the evidence of extirpation of wild cattle populations from such areas (e.g. Xe Bang Nouan NPA and Phou Theung PPA in Laos) and the observation that regionally no areas of small isolated unprotected habitat are known to have documented wild cattle populations. Wild cattle can persist in small areas if protected, as appears to be the case in some of the Dongrak Mountain protected areas in

Thailand, but a long period of incidental observation by park staff strongly suggests Kouprey are not present in such areas.

C) *Survey coverage*: As survey work to date has generally been insufficient to rule out Kouprey presence (see below), survey effort was a weak consideration in mapping potential Kouprey habitat.

III. Gap Analysis of Potential Areas of Kouprey Persistence

Areas of suitable Kouprey Habitat

The extent of suitable habitat *per se* does not appear to be a factor limiting Kouprey presence. The largest remaining areas of Kouprey habitat are in Cambodia and are largely covered by existing protected areas. Despite the widespread regional loss of lowland forests, several large areas persist and would most likely support Kouprey in the absence of hunting.

Very little Tier 1 habitat persists in either Laos or Vietnam in areas of possible Kouprey presence. What does exist in these countries is general close to extensive rural population centers. However, there are several hill landscapes supporting extensive grasslands or deciduous forests where there may be a very slight possibility of Kouprey presence.

No Tier 1 or 2 habitat persists in Thailand within the Kouprey's historic range. What remains of potential Kouprey habitat is in the form of secondary deciduous formations within an SEF matrix or dense DDF formations associated with rocky hill savannas. The latter appears to be the most extensive of any potential Kouprey habitats in Thailand and is restricted to a narrow band along the Thai–Cambodian border.

Efficacy of previous camera trapping efforts

It is difficult to determine the efficiency of camera traps in documenting regional wild cattle populations and assess the adequacy of previous surveys in locating any remaining Kouprey. However, a number of factors suggest that their ability to detect these species may be lower than expected and given its lower overall abundance, Kouprey will be much more difficult to detect than Banteng, Wild Water Buffalo, and Gaur.

Wild Cattle generally occur in small groups or herds. Camera traps may fail to detect individuals within the herds if they are blocked by other herd members or if they pass by the camera during its programmed delay between photographs, or simply move too quickly to be detected. Depending on detection settings, large-bodied species such as cattle may be only partially photographed or may be beyond the flash range of the camera. Individual Kouprey or those associating with other wild cattle species might well be missed. Additionally, area that a camera trap monitors is actually quite small, a few tens of meters square at most, decreasing the probability of a given camera capturing any individual wild cattle.

In addition, many of the camera trap images reviewed for the presence of wild cattle came from studies designed to detect other species groups. A relatively high number of cameras appear to have been positioned along trails, possibly to increase the likelihood of detecting Tiger (*Panthera tigris*). However, the likelihood of wild cattle being detected by such a set-up would appear to be relatively low as they don't generally appear to follow trails in Indochina's lowland DDF formations. The probability of capturing wild cattle can be increased by sighting camera-traps at microhabitat features where wild cattle are concentrated, such as pools. But in Tier 1 habitat, features that concentrate wild cattle are often numerous, potentially diluting the concentration effect of such habitat features would have if they were scarcer.

Although wildlife surveys and other field activities could potentially have detected Kouprey, the probability of this seems low due to four main factors, many of which are specific to the Kouprey's range:

- In general, wild cattle are not easily seen even in areas where they occur on a regular basis;
- When sightings do occur animals are usually distant, often partially obscured, and rarely stay in view for a long period, resulting in low rates of species identification;
- Most observers are not familiar enough with Kouprey to be able to confidently identify all but the most obvious of sightings; and
- Most field activities have an overall low probability of sighting wild cattle for inherent reasons, e.g. large group size, noise, different observational focus.

Seima Protection Forest and Biodiversity Area (SPFBA) presents an example of the above phenomenon. SPFBA has a conservative estimate of at least one hundred individuals each of Banteng and Gaur and there are indications of reduced flight reactions among wild cattle since the initiation of survey activities in the early 2000's. This is the most intensively studied of all forest landscapes within potential Kouprey range, with the possible exception of areas in Thailand. However, from the beginning of 2006 until mid-July 2010 there were only 68 reported observations of wild cattle by patrol and monitoring teams with the mean number of animals seen per sighting being 2.5. Given the results from camera-trapping efforts on the area this suggests that most animals in a group were not seen.

Despite the large number of camera traps deployed throughout the Kouprey's potential range, given the above factors it is likely that nowhere has coverage of suitable Kouprey habitat been particularly good. In addition, two DDF lowland landscapes potentially harboring Kouprey have essentially never been camera-trapped at all while even within the best surveyed areas multiple habitat blocks of over 100km² have never been surveyed with cameras.

The recent advent of digital cameras has led to a dramatic increase in the number of images recorded per camera trapping session. This is due to a variety of possible factors, including: the greater capacity of memory cards compared to film; greater reliability; better detection function; and reduced concern about running out of memory (as opposed to limited film rolls), resulting in more liberal detection settings and reduced intervals between shots. Regardless of the explanations, it is highly likely that film cameras detected the presence of far fewer animals than the current digital models per unit of survey effort.

Likelihood of Kouprey persistence and the numbers of Kouprey remaining

A list of areas and associated probability of Kouprey persistence produced by the gap analysis can be found in Appendix I; they are mapped in Figure 1. The probability of persistence is ranked as unlikely, highly unlikely, and improbable.

Despite the relatively poor (and often not yet mapped) survey coverage of potential Kouprey habitat, a number of factors suggest that the probability of Kouprey persistence appears to be very low and several factors indicate that it is unlikely that any area retains a viable Kouprey population. However, the limited survey coverage in suitable habitat to date and low probability that current methodologies (sign survey, camera trapping, direct observation) can detect Kouprey at extremely low abundances support a conclusion that the persistence of Kouprey cannot be ruled out.

Given a reasonable population size, wild cattle are readily detectable by camera-trapping, sign surveys, and direct observation. Sign surveys are probably the most effective method of detecting wild cattle while direct observation is the least effective with camera trapping intermediate. However, sign surveys are likely the least effective at documenting Kouprey presence because of the difficulties in identifying

cattle tracks to the individual species level. As abundance falls, the likelihood of detection by each of these methods becomes less likely; at what point does it become improbable? As a point of comparison, camera trapping results from a study of elephants in Sumatran rainforest suggest that there is a threshold density of 14-66 elephants/100 km² below which camera-trapping may not be a useful survey method for this species (Hedges & Tyson, 2002). Indeed, below this threshold camera-traps may be unable even to reliably confirm the presence of elephants, at least with a typical camera density and placement. Karanth (1999) suggests a similar phenomenon exists for tigers, with a threshold tiger density of between 1 and 4 tigers/100 km² below which camera-trapping may not be practical.

If ecologically intact populations of Kouprey have survived, albeit at greatly reduced densities, they would by now have been detected. Although camera traps might have missed individual Kouprey or occasionally groups of 2-3, it seems clear that they have not missed larger populations retaining dispersed small herds. Results from 10 years of successful efforts to camera-trap Banteng in habitats also suitable for Kouprey support this conclusion (e.g., c. 650 photos of Banteng from c. 55 camera sessions in SPFBA; c. 200 photos from c. 42 cameras in Phnom Prich Wildlife Sanctuary, 25 from 10 camera-trapping sessions in Preah Vihear Protection Forest, 15 from 4 camera-trapping sessions in Kulen Promtep Wildlife Sanctuary). This conclusion is corroborated by local reports, that while in some areas where Banteng are still seen routinely, Kouprey have not been seen in recent years.

However, it is clear that camera traps have not been deployed in all suitable Kouprey habitat and, in those areas where they have been, coverage has been insufficient to rule out Kouprey presence (see the case study: Eastern Plains of Cambodia). Additionally, lack of detection by camera traps may be the result of a threshold effect. In some areas outside the Kouprey range where other wild cattle species are known to occur at low density, relatively extensive camera-trapping has failed to detect them (e.g., Nakai-Nam Theun NPA in Laos). Anecdotal evidence also suggests cameras may miss many animals in a population. Preliminary analysis of wild cattle photos for this study suggests that identifiable individuals (usually mature bulls with distinctive horn configurations or body scars) are rarely recaptured by cameras.

Additionally, the lack of recent reports of Kouprey by local forest users should be interpreted cautiously. Given the recent period of extremely low Kouprey abundance (if they persist), it is likely that local knowledge of the species has also been greatly reduced, decreasing the likelihood that forest users can effectively distinguish Kouprey from other wild cattle species. Thus, though human presence has increased throughout the Kouprey's potential range, this may not correlate directly with an increase in the likelihood of detection.

If Kouprey persist it is most likely to be as a dwindling population with limited reproductive output. The average Kouprey lifespan, based on data from congeners is probably less than 20 years; therefore it is unlikely that individuals alive in the early 1990s would still be alive today. Yet even in the early 1990s Kouprey were considered on the brink of extinction. The most reasonable scenario for Kouprey persistence into the second decade of the 21st century would be the presence of a small herd in the early 1990s in a remote, rarely visited area of Cambodia. If undetected Kouprey are extant they are most likely present in large remote forested areas adjacent to rural regions with low human population densities and thus low levels of human activity. To have avoided detection to date, Kouprey would likely have persisted as lone animals or in very small groups probably associated with Banteng herds, as a reasonable sized herd of Kouprey would likely have been seen multiple times and reported. There is no *a priori* reason why Kouprey would be more likely to persist in unsurveyed and/or unprotected areas in numbers substantially higher than areas that have been surveyed and protected. If reasonable numbers of Kouprey had persisted in such regions it is likely that they would by now have become known to both

the local and conservation communities. Furthermore, the best surveyed sites, the eastern plains, are most likely to hold Kouprey, i.e. they have large forested, difficult to access areas, relatively low rural human population density, extensive Tier 1 Kouprey habitat in remote areas, and relatively high populations of the other three wild cattle species.

DISCUSSION AND CONCLUSIONS

The two most likely scenarios are that the Kouprey is already extinct or that they persist as dispersed single animals or small groups (2-3) in remote areas of Tier 1 habitat. At this time the eventual extinction of the species is the most likely outcome. Saving the Kouprey requires the fortuitous persistence of a viable number of breeding animals and the immediate application of intensive protection efforts, possibly including *ex situ* conservation.

Individual Kouprey may have survived anywhere where wild oxen still persist, but undetected persistence would most likely have occurred in the largest and remotest forest blocks. So although there might be a tendency to search for Kouprey in relatively unsurveyed areas, as the discussion above suggests, no landscapes have been sufficiently surveyed to rule out Kouprey presence, and in all likelihood the best surveyed landscapes may well have the highest probability of Kouprey persistence.

At present, further surveys specifically targeting Kouprey are not recommended. This is due to the difficulty of detecting their presence at very low abundances using camera traps, the inability to distinguish among wild cattle signs, and the extremely low likelihood of direct observation combined with the large areas of potential Kouprey habitat which would need to be surveyed. Generally speaking, the detection of individual Kouprey would require a survey methodology capable of detecting almost all individual wild cattle present in the area. To achieve such levels of detection in a large area (including the ability to identify individual animals) would require monumental resources better put into protection efforts. However, it is suggested that the AWGSC review different methodologies and strategies for detecting any remnant Kouprey.

Protection efforts should be bolstered in those areas with the highest probability of harboring Kouprey independent of Kouprey detection; these are also high priority sites for other wildlife species. All new camera-trap images from throughout the Kouprey's potential range should be reviewed by the AWCSG for possible Kouprey occurrence along with images previously captured and not yet reviewed. Analysis of all wild cattle data should continue as well, both to refine the results of the gap analysis and to aid in the conservation of other regional wild cattle species.

What to do if Kouprey were to be found?

What would happen if Kouprey were confirmed extant at a location? It is absolutely imperative that the presence of Kouprey should not be disclosed beyond conservation workers needed for the project. Wide knowledge of on-going Kouprey presence is the greatest threat to the species' survival. Three main options exist for potential effective conservation of any Kouprey that might be found: *in situ* conservation within a protected area using greatly increased protection efforts and possibly new strategies; *in situ* conservation in a well protected, fenced off section of the habitat of its current range; and *ex situ* conservation either locally or internationally.

Current precedents suggest that it would prove impossible to adequately protect any surviving Kouprey either *in situ* or *ex situ*. Factors that negatively affect prospects for Kouprey include:

- Lack of effective enforcement models, particularly where valuable natural resources are concerned. In part, this is funding-limited, but the lack of precedents argues against the ability to rapidly achieve effective protection even if resources were immediately available;
- Insufficient donor interest in supporting long-term protection actions;
- Few national resources available for protection activities. No protected areas within areas where Kouprey are most likely to have persisted (e.g., Cambodia) have either sufficient national funding support or in-country expertise for adequate wildlife protection;
- The strong likelihood that there remains a demand for Kouprey trophies in the wildlife trade; and
- A lack of precedent for successful *ex situ* conservation of species with similar conservation status and ecological characteristics within Kouprey range countries.

These conclusions suggest that perhaps one of the best conservation outcomes for Kouprey is that any remnant populations remain undetected in well-protected landscapes, such as the eastern plains of Cambodia where protection efforts could be increased, both in extent and intensity. The alternative scenario, in which Kouprey were detected in these same areas and subsequently targeted by hunters, would likely result in their extirpation due to inadequate protection within the timescale necessary to protect them. In light of the above it is perhaps best at least in the short-term if any Kouprey that are present in any well-protected landscapes remain undetected. This does not mean that Kouprey should not be conserved, but in the current situation, detecting Kouprey may be more likely than not to result in their accelerated extinction. However, there is precedent for detection and conservation of species without public knowledge, which would allow conservation groups to mobilize protection efforts without bringing in potential trophy hunting interests.

There are perhaps exceptions to these conclusions. If Kouprey were present and in immediate threat of extirpation, then there may be a chance of conserving the Kouprey in the form of capture and *ex situ* protection. Sufficient funding to support *ex situ* conservation of Kouprey is likely available but a successful outcome would depend on having the project set-up prior to the detection of Kouprey. Alternatively, if Kouprey are found in an area (protected or not) where protection is possible via fencing and intensive patrolling then *ex situ* conservation is a possibility. Under both scenarios it is critical to secure long-term funding support.

Recommendations on camera trap archiving

Given the growing number of images that are being produced by camera-trapping it would be of great benefit to develop an archive of both images and negatives as well as a standardized format for recording the metadata associated with such surveys. Without such an archive it is inevitable that data loss will occur. The most intuitive venue for such an archive would be an existing natural history museum, accustomed to the long-term archiving of biological specimens and associated data in a manner very similar to that needed for a photographic archive. An independent archive would be ideal as no regional wildlife conservation organization currently has as a core organizational goal the long-term archiving of data accrued during fieldwork. A recognition amongst organizations of the value of data archiving and a subsequent discussion of strategies and standards would be useful as a first step to minimizing data loss.

A Case Study: The Eastern Plains of Cambodia

The eastern plains landscape of Cambodia and a small slice of adjacent Vietnam is by far the largest remaining landscape containing potentially suitable Kouprey habitat, including one of the largest extents of Tier 1 Kouprey habitat, and is the best protected of all potential Kouprey landscapes. As a whole it

also has had the greatest amount of survey effort, although per unit area several other smaller, less suitable areas of habitat may be comparable. Despite this, it is the landscape with the greatest probability of Kouprey remaining (see above comments on Kouprey survey methodologies).

The accompanying four figures (Figures 3-6) illustrate four key survey regions for Kouprey within this landscape. The scale of the overlying grid is 1 x 1 km squares. Camera-trapping locations are indicated by small black points, each point represents a camera-placement at some point over the years from c. 2000 to 2010. Most such points represent at most a few months of 'effort' over this period, and camera-deployment was rarely simultaneous over even relatively small areas. Potential areas of Kouprey presence is represented in blue and Tier 1 habitats in beige. All remaining habitat within the areas of potential Kouprey presence is Tier 2 or Tier 3. Confirmed Banteng records are represented by green dots and locations where Gaur alone have been confirmed by pink dots; these are derived from both camera trap surveys and transect observations. Areas where general evidence of wild cattle has been detected (tracks and other signs) are marked by red dots. Pools are marked by blue dots; these have been derived from US Military 1:50,000 topographic maps and represent a subset of the actual pools present. Survey and patrol effort in addition to camera trap deployment is represented by grey dots; these converge in many places into grey lines. Villages and other areas of significant, human presence are marked by asterisks. Protected area boundaries are represented by yellow hashed lines. Although the data remain incomplete (e.g., post-2007 patrol data from the MPF is not included), these maps provide a reasonable representation of the spatial coverage of survey work over the past decade or so.

The Maps

Figure 2: Southwestern section of the eastern plains

This map mainly depicts the western 'buffer' zone of the Seima Protection Forest and Biodiversity Area (SPFBA) with a small portion of Lomphat Wildlife Sanctuary (LWS) in the extreme south and Phnom Prich Wildlife Sanctuary (PPWS) to the northeast. The attributes of this region that suggest the possibility of Kouprey persistence and a low level of survey effort include:

- The low overall camera-trapping effort throughout much of the area, except for a concentrated section in the southeastern section of the map.
- This area of low effort includes two patches of Tier 1 Kouprey habitat where camera-traps have failed to detect wild cattle, despite other evidence suggesting they are present. Although wetlands are not mapped for the large southern patch, there are in fact a sufficient number of pools present to justify the mapping as Tier 1 habitat. Wild cattle are probably present at low density in this patch due to the proximity of villages and relatively high local human populations likely underlie the relatively low survey effort over a significant portion of the area. However, the documentation of wild cattle either within or close to this patch strongly suggests that camera-trapping effort has been insufficient to document wild cattle presence there to date.

Figure 3: Central and eastern section of the eastern plains

This map depicts the northern two-thirds of PPWS along with areas of western MPF on the eastern section of the map and the extreme southern portion of LWS in the northern section. The attributes of this region that suggest a possibility of Kouprey persistence and a low level of survey effort include:

- Large areas of potential Kouprey habitat that have not yet been surveyed.
- A large number of camera traps have not detected wild cattle despite their clear presence within the mapped area. Of the camera traps that did record wild cattle, a significant number recorded only Gaur, thus failing to detect Banteng despite their widespread presence in the area. When the detection rates of these two species are compared it is clear that Banteng is the more numerous of the two species in most of the mapped area. The non-detection of Banteng

by a large proportion of the camera traps indicates the relatively low efficiency of camera-traps for detection of the species here.

- A large number of pools where wild cattle are more likely to be detected have not yet been surveyed by camera traps.
- Although this region has had camera traps deployed in it for the past nine years, the majority of 1 km² grid squares have had no camera locations within them, and for those that have, use of only a single camera location has been the most common pattern within them.

Figure 4: northeastern, eastern plains

This map depicts the core area of the MPF with a small contiguous section of PPWS in the southwest section of the map. The eastern border of MPF follows the international border with Vietnam, with Yok Don NP lying on the Vietnamese side. Information on survey effort in this region is currently incomplete. Data on survey effort and wild cattle records from Yok Don are not available. The camera-trapping efforts in MPF prior to 2008 have not yet been mapped, although they likely follow a similar spatial pattern to the post-2008 efforts that are shown, and additionally survey and patrols performed after 2007 have not been mapped. The attributes of this region that suggest the possibility of Kouprey persistence and a low level of survey effort include:

- Despite some small areas where camera-trapping effort has been high, large tracts of Tier 1 habitat have been poorly surveyed.
- Few of the 1 km² grid squares have ever had camera deployment within them and, of those that have, a single camera trap location has been common. Furthermore a large number of cameras failed to record known wild cattle presence.
- As with the previous area, a majority of pools have yet to be surveyed by camera-trapping.
- Camera-trapping in MPF since January 2008 has not yet detected Wild Water Buffalo, despite their known presence in the area.

Figure 5: Seima Protection Forest and Biodiversity Area, eastern plains

This map depicts the core area of the SPFBA. While the area is largely unsuitable for Kouprey, survey effort to date supports the conclusion that wild cattle detection requires intensive camera-trapping efforts. The capture rate of cameras in the eastern and southern areas has been poor, with less than half of the camera locations detecting wild cattle and only two locations detecting Banteng. Whatever the reason for this poor capture rate (either itinerant animals or poor detection rates), it suggests that high camera-trapping effort is required to confirm presence of wild cattle, even when the numbers of animals present is relatively high. The number of Gaur and Banteng present in SPFBA are conservatively estimated at over one hundred individuals each, concentrated primarily within the area covered by the map (WCS, unpublished). Survey results from here also nicely illustrate the ecological separation of Banteng and Gaur, with a paucity of Banteng records in the southern and eastern areas which host extensive SEF.

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Table 1: Camera-trapping projects conducted within historical Kouprey range and the availability of images to date.

Landscape	Organisation / project [^]	Time period(s)	# of camera sessions / locations	Paired cameras	Multiple years at location †	# of photos	# of wild oxen photos	Species	Proportion of images seen
Eastern plains south of the Srepok; PPWS	WWF	Dec 01-Dec 05	c. 127	?	Some	?*	c. 340?	B, G	Most (possibly a few lost)
Eastern plains (PPWS?) and/ or Prey Long	WWF	2006	28+	?	?	?*	?	B, G	Uncertain
Eastern plains (PPWS?) and/ or Prey Long	WWF	2007	?	?	?	?*	?	?	Uncertain
Eastern plains south of the Srepok; PPWS	WWF	Dec 08-ongoing	c. 65	None?	No	c. 19,300	unknown	B, G	All
Eastern plains south? of the Srepok; MPF	WCS	May 01?	7	No?	No?	?	30?	B,G,W	All?
Eastern plains south? of the Srepok; MPF	WWF	Feb 05- Dec 2006?	Uncertain (26?+)	?	?	? [500 +]*	?	B,G,W	Most (some likely missing)
Eastern plains south of the Srepok; MPF	Graduate student working with WWF and FA	Jan-March 2007	19	Some	No	30	5	G	All?
Eastern plains south of the Srepok; MPF	WWF	Jan 08-July 09	c. 65	Most	No	c. 14,000	unknown	B, G	All
Eastern plains south of the Srepok; MPF	WWF	Feb 10-ongoing	15?	?	No	c. 1070	unknown	B, G	All
Eastern plains south of the Srepok; Srepok / Lomphat	FA (WCS)	April-June 01	14?	?	No?	?	28?	B, G	All?
Eastern plains south of the Srepok; Srepok (west of Lomphat)	WWF	Mar 03-Mar 04?	c. 13	?	?	?*	3??	B, G	Most (possibly a few lost)
Eastern plains south of the Srepok; Lomphat WS	Freeland Foundation (formerly WildAid)	Nov 04-June 05?	?	?	?	?	c.40	B, G	Most?
Eastern plains south of the Srepok; Lomphat WS	BirdLife	Nov-Dec 2009	2	No?	-	?	0	-	None
Eastern plains south of the Srepok; SBCA	WCS	April 00-June 08	c. 214	Some	Some	?	c. 950	B, G	Most
Eastern plains south of the Srepok; SBCA	UEA / WCS	Jan-Feb 06	c. 26?	One?	-	?	0	-	All?
Eastern plains south of the	CI otter project /	2010	5?	?	-	?	0	-	All?

Srepok; SBCA	WCS								
Eastern plains north of the Srepok; Yok Don NP	BirdLife/ PARC Project	Mar 03	4	No	No	7?	0	-	3/7?
Eastern plains north of the Srepok; Yok Don NP	BirdLife/ PARC Project	Apr-Jun 04	16?	No	No	7?	5	B, G	All?
Eastern plains north of the Srepok; MPF	FA	Mar-Aug 06	Max 7 cameras, moved monthly	?	-	?	? [8+]	B, G	Uncertain; 8 seen (reproduced in government study report)
Prey Long	WWF	April 02, Nov 04, Jan-Mar 05, Jan 06	c.26	?	?	?*	c. 28?	B, G	Most (possibly a few lost)
Prey Long	CI	Mar, Jun & Sep 05	5-12?	1	-	c. 103	3?	B	1
¹ Kratie, Sambo dist. (Hog Deer area)	WWF	Jan-Feb 06	c. 5	No	No	?*	0?	-	Most (possibly a few lost)
¹ Kratie, Chhlong dist.	WWF	Dec 03-Mar 04, Nov 04, Jan 05	c. 16	?	?	?*	4??	G	Most (possibly a few lost)
Western Siem Pang District	WWF	Dec 02-Mar 03, Aug 03	c. 9	?	?	?*	0?	-	Most (possibly a few lost)
¹ Xe Pian NPA, Laos	FORMACOP Project	Late 1990s?	?	?	?	?	?	?	None
¹ Xe Pian NPA, Laos	FORMACOP Project	April 00-Mar 01	10?	No	No	101?	2?	G	7/101?
¹ Xe Pian NPA, Laos	WWF	Aug 05-Feb 06	10-19? [Max of 10 cameras]	?	?	778?	0?	-	Uncertain; 39 seen (reproduced in NGO study report)
Virachey mountains; Virachey NP	WWF	May-July 99, Dec 99-Mar 00, Jan-June 01	c. 78	No	No	?*	4??	G	All
¹ Virachey mountains; Veunsai	CI Veunsai project	Dec 09-May 10	14?	No	No	c. 9,600	?	G	All
Northern plains of Cambodia and adjacent plains of Laos; PVPF	WCS	Dec 00-April 08	c. 226	Some	Yes	?	c. 21+	B, G	All?
Northern plains of Cambodia and adjacent plains of Laos; PVPF?	WCS	Feb-Mar 07?	14?	No	-	?	9	G, (B)	All?
Northern plains of Cambodia and adjacent plains of Laos; PVPF?	WCS	2008-09	c. 31?	?	-	?	25	B, G	All?
Northern plains of Cambodia and adjacent plains of Laos; PVPF	WCS	July 10-Aug 10	10?	?	-	c. 1,450	?	B, G	All?

Kulen Promtep; KPWS	WCS	Dec 00-Feb 05 [many breaks]	c. 40	Some	No?	?	c. 22+	B, G	All?
Kulen Promtep; KPWS	WCS	April 10	?	?	?	?	?	?	Not seen?
Kulen Promtep; KPWS	WCS	Jun 10-Aug 10	14?	?	-	c. 13,000	?	B, G	All?
Cardamom Mountains; ¹ Kirirom NP	WCS	Feb-Apr 00	c.14?	?	No	?	0	-	All?
Cardamom Mountains; ¹ Bokor NP	WCS	Jan-Mar 00	33	No	No	350+	0	-	None (photos and negatives stolen)
Cardamom Mountains; ¹ Bokor NP	Freeland Foundation (formerly WildAid)	Dec 01 –June 06?	?	?	?	?	7?	G	Most?
Cardamom Mountains	FFI	?	?	?	?	?	None?	?	None
Cardamom Mountains; ¹ Phnom Samkos WS	FFI elephant project	April 2010-ongoing	?	Some	-	?	Single animal on two films	G	All Gaur photos, a few of the other photos
Cardamom Mountains	CI	March 01- Aug 05	c. 90+?	Some	?	1450+	3?	G	Only 2 of 1450+ seen
Cardamom Mountains	CI	Jan-Jun 2006	29	No?	?	c. 485?	4?	B	Only 4 of c. 485 seen
¹ Samlot MUA	Freeland Foundation (formerly WildAid)	Mar-Apr 04	10	No	No	c. 118	0	-	None?
¹ Khao Ang Runai WS, Thailand	Graduate student (Kate Jenks) study of Dholes	2008-ongoing?	?	?	?	?	?	[B, G]	None [future access to pictures has been promised]
¹ Various Thai protected areas	WCS / RFD Tiger assessment	1998-2002?	?	?	?	?	?	[G]	None [future access to pictures has been promised]
¹ Thap Lan NP, Thailand	Freeland Foundation; camera-trapping studies focused on Tigers and Gaur	2009-ongoing	?	?	?	?	?	G	A few [future access to pictures has been promised]
¹ Dongyai WS, Ta Phraya NP (others?), Thailand	Thai RFD	?	?	?	?	?	?	[G]	None
¹ Cat Tien NP, Vietnam	WWF / Cat Tien NP; general survey and Gaur studies	?	?	?	?	?	?	G	A small minority

^Note: precise attribution of projects to organisations has not been verified in all cases and information in this column reflects the sources of data used during the current project. The data in this table should not be reproduced without first seeking the guidance of the data owners.

† These sites are not considered to have any current potential to harbor Kouprey; the remaining landscapes are discussed in Appendix I.

*combined total # of films from these landscapes and time periods = c. 400 films

†camera location(s) used over multiple years

G=Gaur

B=Banteng

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Appendix I. Results of the Gap Analysis

I. Unlikely landscapes for Kouprey presence

Eastern plains of Cambodia south of the Srepok River

There are three core areas of Tier 1 potential Kouprey habitat in this region: the western Srepok plains west of the Khon Nhek village cluster; the eastern Srepok plains; and the O Te plains. These are connected by terrain with lower densities of pools and glades. The south- and central-east regions are hilly terrain with a higher component of Semi-evergreen Forest (SEF) and Deciduous Dipterocarp Forest (DDF) transitional with secondary and deciduous hill forest formations also interspersed with hill grasslands.

Habitat suitability: Extensive Tier 1 DDF covers substantial areas in three relatively discrete blocks, the rest of the area being a mosaic of Tier 2 DDF and Tier 3 DDF and Mixed Deciduous Forest (MDF) mosaic with dispersed patches of SEF.

Protected area coverage: Mondulkiri Protected Forest (MPF), Seima Protection Forest and Biodiversity Area (SPFBA), Lomphat Wildlife Sanctuary (LWS), and Phnom Prich Wildlife Sanctuary (PPWS).

Protection level: Protection level is above average in some areas but these efforts coincide only partially with the three core areas of Tier 1 DDF.

Survey coverage: Since the mid-1990s several surveys dedicated to detecting Kouprey have been conducted. There have been multiple additional surveys and camera-trapping has been more extensive here than any other landscape (Table 1). However, significant portions of the three core areas have received little to no survey effort, including camera-trapping (see the case study: Eastern Plains of Cambodia).

Wild cattle status: Wild cattle are present over a large proportion of the landscape and encounter frequencies suggest densities are significantly higher than in any other landscape.

Eastern plains north of the Srepok River

This is treated as a separate landscape of the eastern plains, divided from the southern section by the Srepok River. However, Kouprey would almost certainly be capable of crossing the river, particularly during the dry season, although current river-based human activities might prevent this.

Habitat suitability: Tier 1 lowlands with high pool and glade density over most of the area; dominated by DDF in mosaic with MDF and limited SEF.

Protected area coverage: MPF, LWS, and O Yadav Protected Forest (OYPF).

Protection level: Protection is present but below average in MPF; no current protection activities in the other two protected areas lying within the site.

Survey coverage: A limited number of sporadic and localized surveys have been conducted by WWF, including some camera-trapping. There was apparently a camera-trapping project conducted as part of a larger survey effort of the OYPF by the Cambodian Forestry Administration (FA) in 2006 but only a small number of pictures have been reviewed to date. The area was partially covered by at least two other ground surveys conducted almost a decade ago.

Wild cattle status: Uncertain. Cambodia FA findings, based largely apparently on track records, suggest wild cattle numbers are above average and similar to those south of the Srepok; however, these track records may contain significant duplications and the reliability of identification may be questionable in a significant number of cases.

Northern plains of Cambodia and adjacent plains of Laos

Habitat suitability: Tier 1 DDF throughout much of the area.

Protected area coverage: This area is largely protected by the Preah Vichar Protected Forest (PVPF). There is also a current proposal for a national or provincial level protected area in Laos that lies within

this region. In addition, the Chendar Plywood concession is being managed for wildlife by the Wildlife Conservation Society (WCS) and Cambodia FA.

Protection level: Above average compared with the region as a whole, although protection is likely to be not focused on Tier 1 Kouprey habitat.

Survey coverage: Reasonable coverage using several methods although this work (in particular camera-trapping) has not focused on optimal Kouprey habitat.

Wild cattle status: Both Banteng and Gaur are present but are likely to be localized. Encounter frequencies suggest significantly lower densities than in the Eastern Plains.

Kulen Promtep

Habitat suitability: There is relatively little Tier 1 habitat, much of which is close to areas of human settlement. The rest of the area is mainly Tier 2 DDF and Tier 3 mosaic of SEF, MDF and dense DDF.

Protected area coverage: This area lies almost entirely within the Kulen Promtep Wildlife Sanctuary (KPWS).

Protection level: Protection activities present, and above average for the region, but currently not covering all of the area.

Survey coverage: Both camera-trapping and ground surveys have been ongoing since the 1990s; however coverage of the best potential Kouprey areas has generally been low.

Wild cattle status: Banteng and Gaur are present but in low numbers.

II. Highly unlikely landscapes for Kouprey presence

Sesan District of Stung Treng Province between the San and Srepok Rivers

Habitat suitability: Largely Tier 1 DDF with an extensive block of SEF within the northern part of the area.

Protected area coverage: None.

Protection level: None. However this region is relatively remote, human population density is low, and there is no major road access as of yet.

Survey coverage: Little surveying and no known camera-trapping.

Wild cattle status: Uncertain; based on factors effecting wild cattle persistence in other landscapes, predictably small numbers of wild cattle would be expected to persist.

Eastern and northern Prey Long

Habitat suitability: Small areas of largely Tier 2 DDF; remaining area largely covered with SEF interspersed with mixed patches of DDF and MDF.

Protected area coverage: None.

Protection level: None. However, this area is relatively remote with low human population density. The extensive block of SEF that adjoins this area of potential presence might perhaps help to conceal Kouprey, dependent on the species use (if any) of SEF.

Survey coverage: Very little survey effort. Minimal and localized camera-trapping in 2004-2005 none of which occurred in the areas most likely to support Kouprey.

Wild cattle status: Banteng and Gaur are likely to be present in small numbers; Banteng were captured by camera-traps in 2004 and 2005.

Nam Gong and Virachey mountains

Habitat suitability: This region contains only a small area of habitat that might perhaps be suitable for Kouprey. The areas of potential presence form two somewhat discrete blocks of habitat separated by dense SEF. There is Tier 1 and 2 DDF in peripheral areas; however, due to high hunting pressure, it is very unlikely that Kouprey are present there. Interior areas of this mountainous region are dominated

by dense SEF, but significant areas of patchy hill grasslands and extensive areas of open canopy deciduous hill forest, neither DDF nor MDF, and probably a considerable amount of bamboo are present. The northwestern section of potential presence within this interior is covered with largely continuous deciduous forest cover. The southeastern section is dominated by sporadic open patches within an SEF matrix. These habitat types present may well preclude Kouprey presence, both historically and now.

Protected area coverage: Virachey NP and a provincial protected area in Laos (formal national recognition of such areas is apparently underway).

Protection level: There are no currently protection activities in either country although in the past there have been NGO-supported activities that included patrolling. However, this landscape is among the most inaccessible within the Kouprey's potential range. This inaccessibility combined with its large size low human population density suggests that hunting pressure may be significantly lower than most other areas.

Survey coverage: Very low within the area of potential Kouprey presence. There was limited camera-trapping in Virachey in the 1990s and a small number of foot surveys have been conducted over the years, although these have focused primarily on edge areas or the extensive interior SEF tracts. A camera-trap survey was also conducted at Veun Sai in 2010. The most suitable Kouprey habitats have never been surveyed.

Wild cattle status: Surveys conducted during the 1990s suggested widespread but low numbers of Gaur. A survey in Laos in 2009-2010 indicated the presence of wild cattle and the 2010 Veun Sai survey confirmed the presence of Gaur.

III. Improbable landscapes for Kouprey presence

Southeastern Bolaven Plateau

Habitat suitability: Suboptimal to marginal, dominated by extensive hill grasslands and pine savanna interspersed with SEF.

Protected area coverage: None.

Protection level: None.

Survey coverage: There has been very limited survey effort to date. Some parts of the area were covered by an environmental impact assessment conducted in the 1990s for the Xe Nam Noy Hydropower Project.

Wild cattle status: Uncertain. Wild cattle are likely present at very low densities if they have not been extirpated.

Western Siem Pang district of Stung Treng province and adjacent fringe of Laos

Habitat suitability: This region is dominated by Tier 2 DDF with relatively few pools and glades. It is adjacent to extensive SEF interspersed with deciduous forests and glades.

Protected area coverage: Partial coverage of mainly SEF components in the Xe Pian National Protected Area (XPNPA).

Protection level: Limited community organized patrols facilitated by BirdLife Indochina cover a part of the area.

Survey coverage: Minimal within areas of potential Kouprey presence, consisting of sporadic fieldwork (including little camera-trapping) most of which was conducted over a decade ago. Survey effort was concentrated in the regions peripheral areas.

Wild cattle status: Uncertain. Gaur likely present but at very low numbers; Banteng likely close to being extirpated.

Eastern Phnom Samkos hills and lowlands

Habitat suitability: Dominated by Tier 2 and Tier 3 DDF with deciduous hill forest in mosaic with SEF.

Protected area coverage: This region lies largely within Phnom Samkos Wildlife Sanctuary (PSWS)

Protection level: There is some protection activities in parts of the region.

Survey coverage: Minimal with no camera-trapping within potential Kouprey range. There are ongoing survey efforts by Fauna and Flora International and the Cambodian Ministry of Environment in subsections of the area.

Wild cattle status: Uncertain. Banteng are reportedly present, likely in low numbers. Gaur are probably itinerant and largely restricted to areas of SEF in PSWS.

Eastern Cardamom Mountains

This region of potential occurrence is composed of two largely discrete sections which share a majority of relevant characteristics; it will be addressed as a single unity below.

Habitat suitability: Suboptimal to marginal, composed of Tier 3 lowland DDF mosaic and hill grasslands and hill DDF within large blocks of SEF.

Protected area coverage: The majority of the northern block is covered by Phnom Aural Wildlife Sanctuary (PAWS) and peripheral sections are included in the Central Cardamoms Protected Forest (CCPF). The southern block is marginally included in both PAWS and CCPF.

Protection level: Minimal. PAWS is now a largely defunct enterprise. Conservation International (CI) patrols CCPF and the Wildlife Alliance (WA) carries out enforcement efforts in the general Cardamom region.

Survey coverage: It is difficult to assess survey effort for both areas but it appears to be minimal with very limited camera-trapping.

Wild cattle status: Uncertain. Gaur are likely to persist in small numbers and but probably only a few remnant groups of Banteng remain (they were recorded by camera trap in 2006).

Central Cardamoms

Habitat suitability: Suboptimal to marginal, dominated by hill grasslands within extensive closed canopy hill and upland forests.

Protected area coverage: Most of this region lies within the CCPF.

Protection level: Protection efforts within this region range from minimal to non-existent. However, the region's remoteness suggests that hunting pressure may be very low although there is no substantial evidence that large mammal populations are abundant.

Survey coverage: Difficult to assess but there has been little to no survey effort throughout most of the area.

Wild cattle status: Uncertain. Existing data for the Cardamoms region overall suggests wild cattle numbers are in general suppressed.

Xe Kong in Laos

Habitat suitability: Mainly Tier 2 and Tier 3 DDF in the western portion. The surrounding hills of the somewhat discrete eastern portion have isolated grasslands and probably pine savanna.

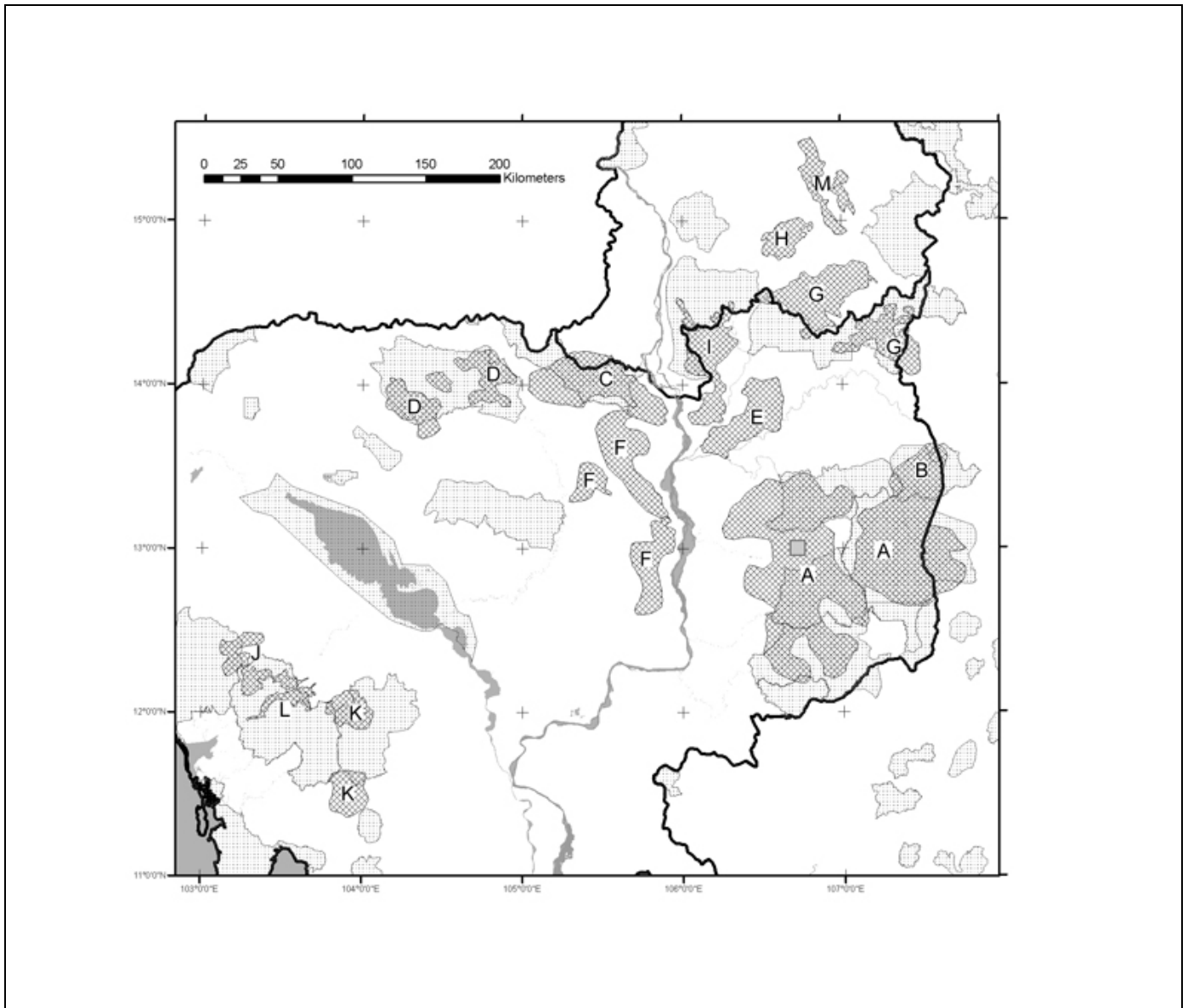
Protected area coverage: None currently though the region may soon be covered by a system of national and provincial level forest reserves.

Protection level: None

Survey coverage: None

Wild cattle status: Uncertain, possibly residual Banteng.

Figure 1: Areas and Potential Kouprey Persistence



Landscapes with potential Kouprey presence are crosshatched. Protected areas in Cambodia, Laos and Vietnam are outlined and stippled; none are shown for Thailand. Major rivers are shown in grey. The pale grey square in Area A, which is 10 km in length per side, is shown to help appreciate the enormity of several of the landscapes. For a description of each area, please see Appendix I.

Area A: Eastern plains of Cambodia south of the Srepok River; Area B: Eastern plains north of the Srepok River; Area C: Northern plains of Cambodia and adjacent plains of Laos; Area D: Kulen Promtep; Area E: Sesan District of Stung Treng Province between the San and Srepok Rivers; Area F: Eastern and northern Prey Long; Area G: Nam Gong and Virachey mountains; Area H: Southeastern Bolaven Plateau; Area I: Western Siem Pang district of Stung Treng Province and adjacent fringe of Laos; Area J: Eastern Phnom Samkos hills and lowlands; Area K: Eastern Cardamom Mountains; Area L: Central Cardamoms; Area M: Xe Kong in Laos.

Figure 2: Southwestern Section of the Eastern Plains (please see case study for detailed legend).

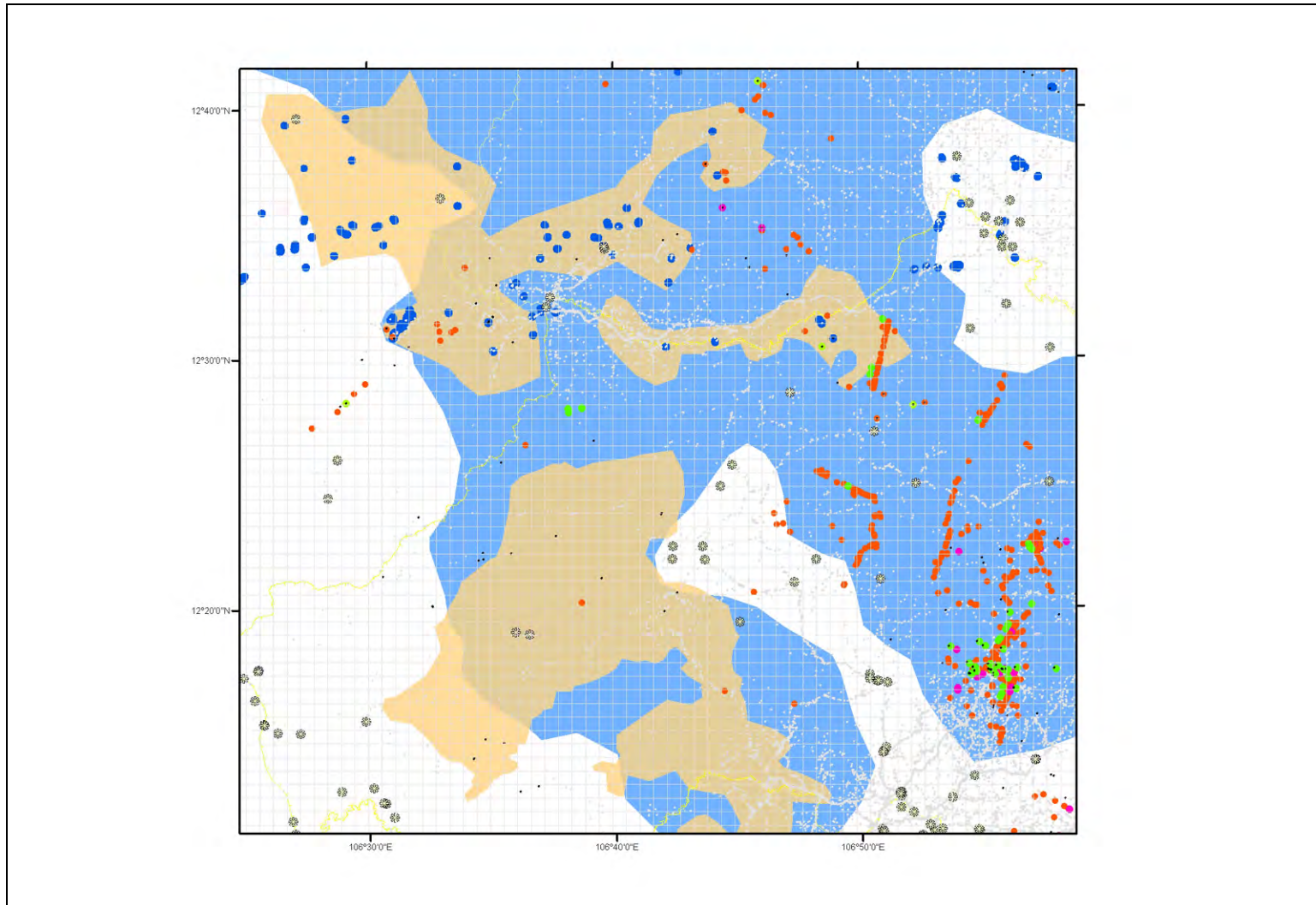


Figure 3: Central and Eastern Section of the Eastern Plains (please see case study for detailed legend).

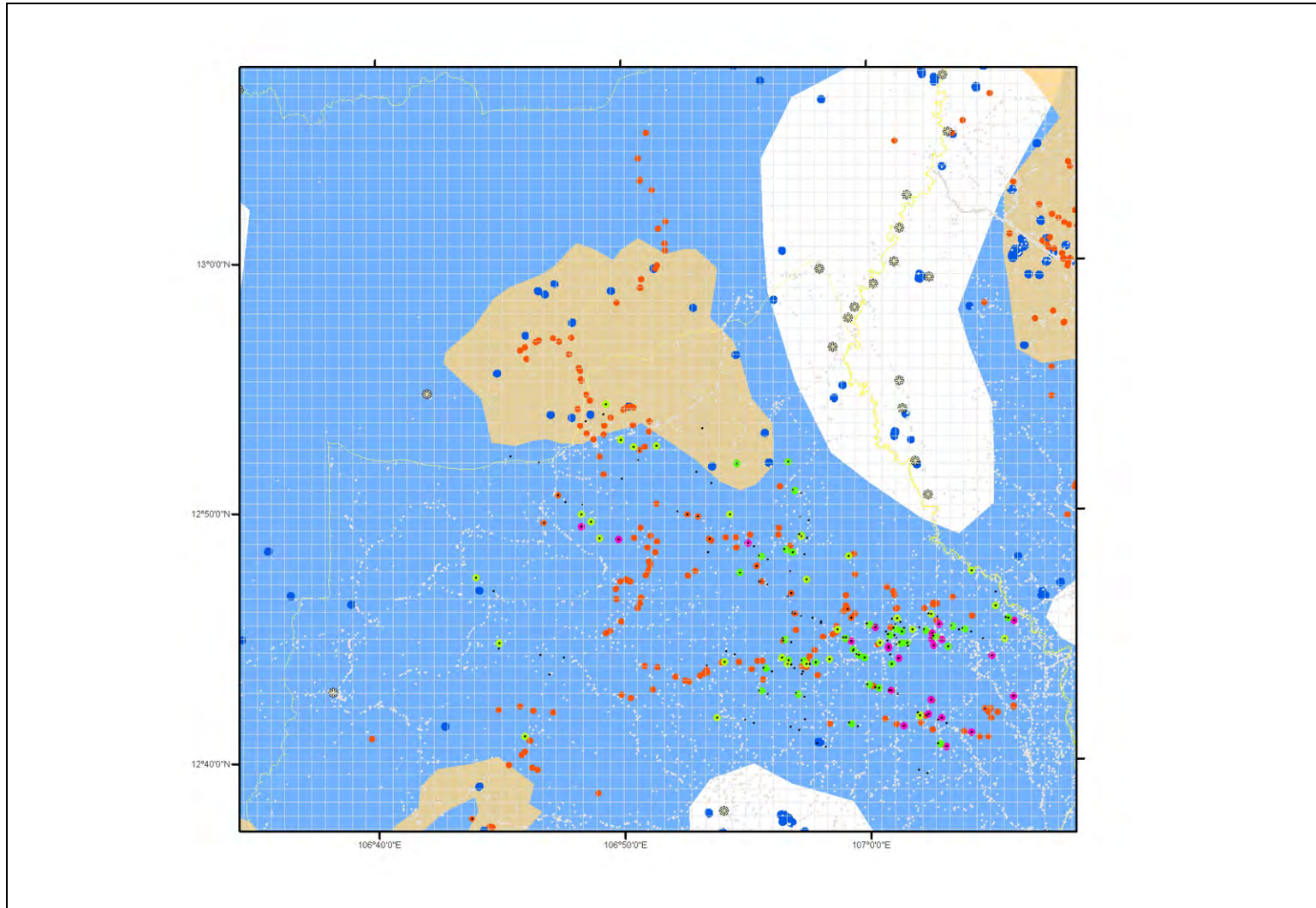


Figure 4: Northeastern, Eastern Plains (please see case study for detailed legend).

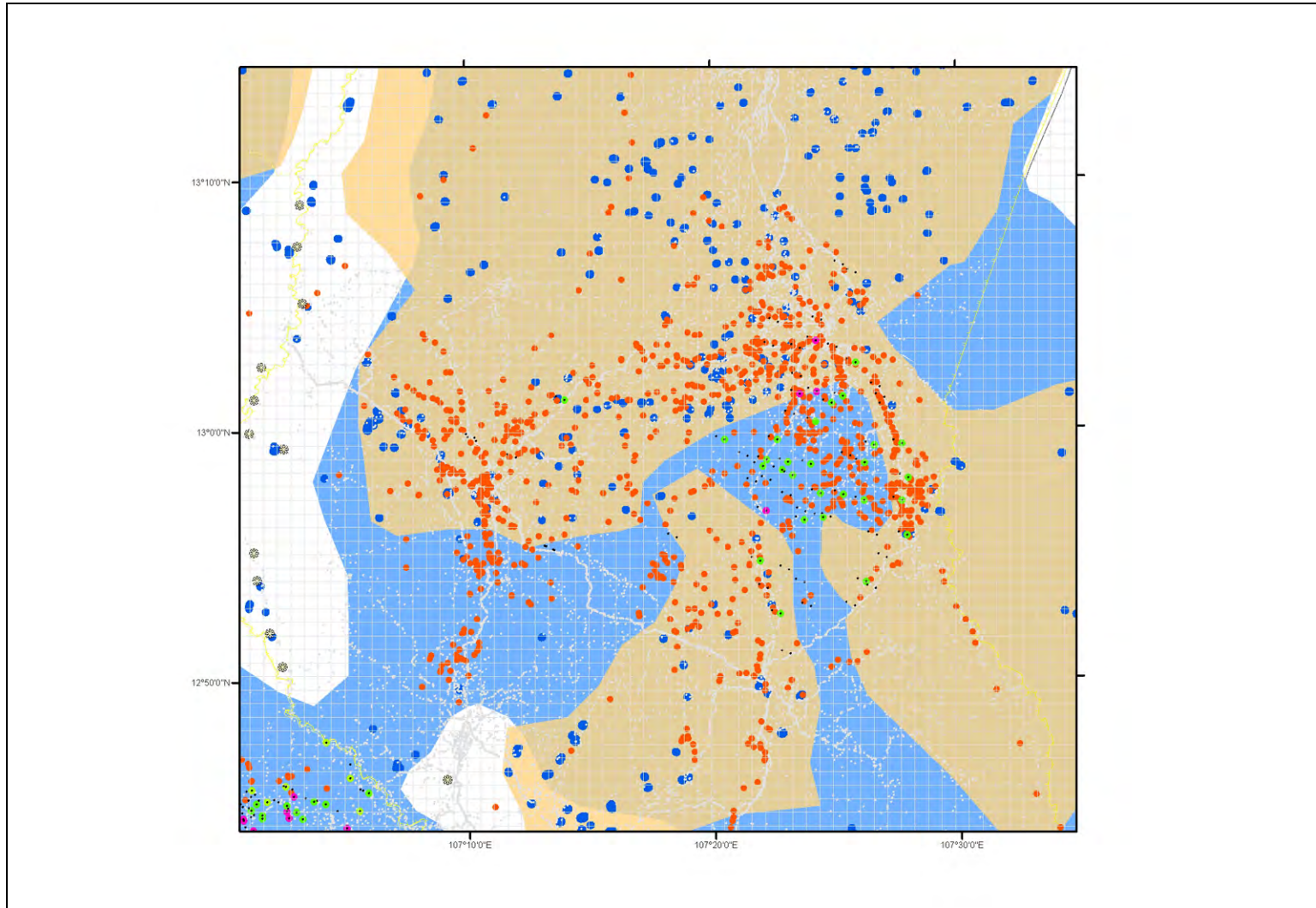


Figure 5: Seima Protection Forest and Biodiversity Area, Eastern Plains (please see case study for detailed legend).

