

A Survey of Eastern Areas of Xe Sap National Protected Area, Lao PDR for Saola and Other Large Ungulates



Conducted May to June 2014

**Final Report to report to Global Wildlife Conservation and the Saola
Working Group, by the World Wildlife Fund Greater Mekong Program**

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with contributions from R. J. Timmins

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Executive summary

General information

From 17.05.14 to 07.06.14 surveys were conducted in the eastern section of Xe Sap NPA and surrounding areas to the south. The primary objectives of the surveys were to assess the likelihood of Saola (*Pseudoryx nghetinhensis*) presence and the importance of the area for its conservation. A secondary objective was to assess the status of other select large mammal species. Inside the protected area, field surveys were conducted to assess the status of the general ungulate community. We also set 28 camera traps to gather information on the ungulate community. Leeches were collected in effort to obtain direct evidence of Saola presence. Outside the protected area, interviews were conducted with villagers to obtain information on Saola and other species.

Findings

The eastern section of Xe Sap appears to support moderate to high ungulate densities relative to adjacent areas I have surveyed in central Vietnam—though populations are certainly depressed from historic levels due to ongoing illegal hunting. Although definitive evidence of Saola occurrence in Xe Sap NPA has not been established, the easternmost corner of the protected area should, based on indirect information, be provisionally considered a high priority for Saola conservation. Field sign and interviews indicate that some large mammals recorded by earlier surveys to the region are present while populations of other species have severely declined or been extirpated from the area. Poaching levels were lower to moderately higher than areas I have surveyed in Vietnam. Limited information suggests that the majority of poachers are coming across the border from Vietnam.

Recommendations

Anti-poaching efforts are urgently needed in Xe Sap NPA. Hunting must be curtailed if priority conservation species (which potentially include Saola) are to persist. Efforts should be made to reduce snaring, apprehend poachers, and stop wildlife products moving from the protected area into Vietnam. A permanent station should be set up in the Kalo region so that the area can be routinely patrolled. The Xe Sap region is a high priority for future Saola surveys. Additional surveys should be conducted in the eastern sections of Xe Sap NPA. However, surveys are also needed outside of the protected area, where Saola may be present. Future work should focus on definitively establishing the presence of Saola in the region through sustained and intensive surveys. The Lao PDR government should consider a southern extension to the protected area.

Introduction

Study Area

Xe Sap National Protected Area (XS, approximately centered on 16°12' N, 107°02'E, Fig. 1) is located in southeastern Lao PDR along the Annamite Mountain Range. Its eastern boundary borders Vietnam. XS covers approximately 1335 km², and has a tropical monsoon climate. A general east-to-west moisture gradient exists across the protected area (WWF 2012). The eastern region, in Xekong province, is comparatively wet, with a climate similar to the Hue and Quang Nam Saola Nature Reserves (SNRs) in neighboring Vietnam. The western region, in Salavan Province, is much drier. XS supports diverse habitats, including evergreen, semi-evergreen, and high-altitude montane forest. A complex history of anthropogenic disturbances, including shifting cultivation and logging, has degraded much of the habitat (WWF 2012). Despite the threat posed by habitat degradation, the primary threat to the long-term viability of conservation priority species in XS is illegal hunting. Until recently, XS supported a diverse large mammal assemblage that included charismatic megafauna such as Asian Elephant (*Elephas maximus*) and Tiger (*Panthera tigris*) (Davidson 1998, Steinmetz 1999). More recent survey work indicates that large mammal populations are clearly depressed, and that several species once present in XS are likely extirpated from the protected area (Timmins 2012). Among the large mammal species present in the central Annamite Mountain Range the most important from a conservation perspective is the Saola (*Pseudoryx nghetinhensis*). The objectives of the present survey were to assess (i) the likelihood of Saola presence in eastern XS, and (ii) the relative importance of eastern XS to Saola conservation.

Saola in Xe Sap

Although biologists have never verified the presence of Saola in XS with hard evidence (e.g. dung verified by DNA analysis, camera trap photo), parts of the protected area are certainly within the historic range of the species (Timmins 2012). Previous surveys in XS, which have relied mostly on interviews with local villagers, have yielded equivocal results: Neither Timmins and Vongkhamheng (1996) or Showler et al (1998) obtained information on Saola despite extensive questioning. (Steinmetz, surveying XS in 1999, likewise obtained no information on Saola, though he focused on the western part of the protected area, where the species would not be expected to occur based on our current understanding of Saola habitat preferences). However, Schaller (1995) gathered one report of a Saola killed near Dakchung. The best evidence indicating that Saola occur in XS comes from neighboring Vietnam, specifically the adjacent Hue and Quang Nam SNRs. In the Quang Nam district, Saola trophy skulls are regularly found in the houses of the Katu people, a

local ethnic minority group living in central Vietnam. Furthermore, at least one Saola, recorded by a camera trap in September 2013, was present in the area opposite XS. Ecologically, there is no obvious reason why eastern XS would not have Saola. Although parts of the protected area, particularly in the western section, have dry forest that is probably not suitable for the species, the eastern region contains what biologists believe to be ideal Saola habitat: wet evergreen forest with little or no dry season. There is little doubt among regional biologists that XS had Saola. The relevant question from a conservation perspective is: Do any remain? Given the high level of poaching in the region, it is possible that Saola, like other large mammals once present in the region, have been extirpated. This becomes more likely given the fact that wet evergreen forest is restricted to the eastern parts of the protected area near Vietnam, where poaching levels are likely to be highest. (Note: The limited commercial value of the species [c.f. Asian elephant, large cats] means targeted hunting for Saola is unlikely. Most Saola are probably caught as “bycatch” in indiscriminant snares.) If Saola persist in XS, their numbers are undoubtedly low (as they are everywhere the species might survive). Confirmation of the continued existence of Saola in XS would be of global significance and their protection would be the highest conservation priority for the protected area.

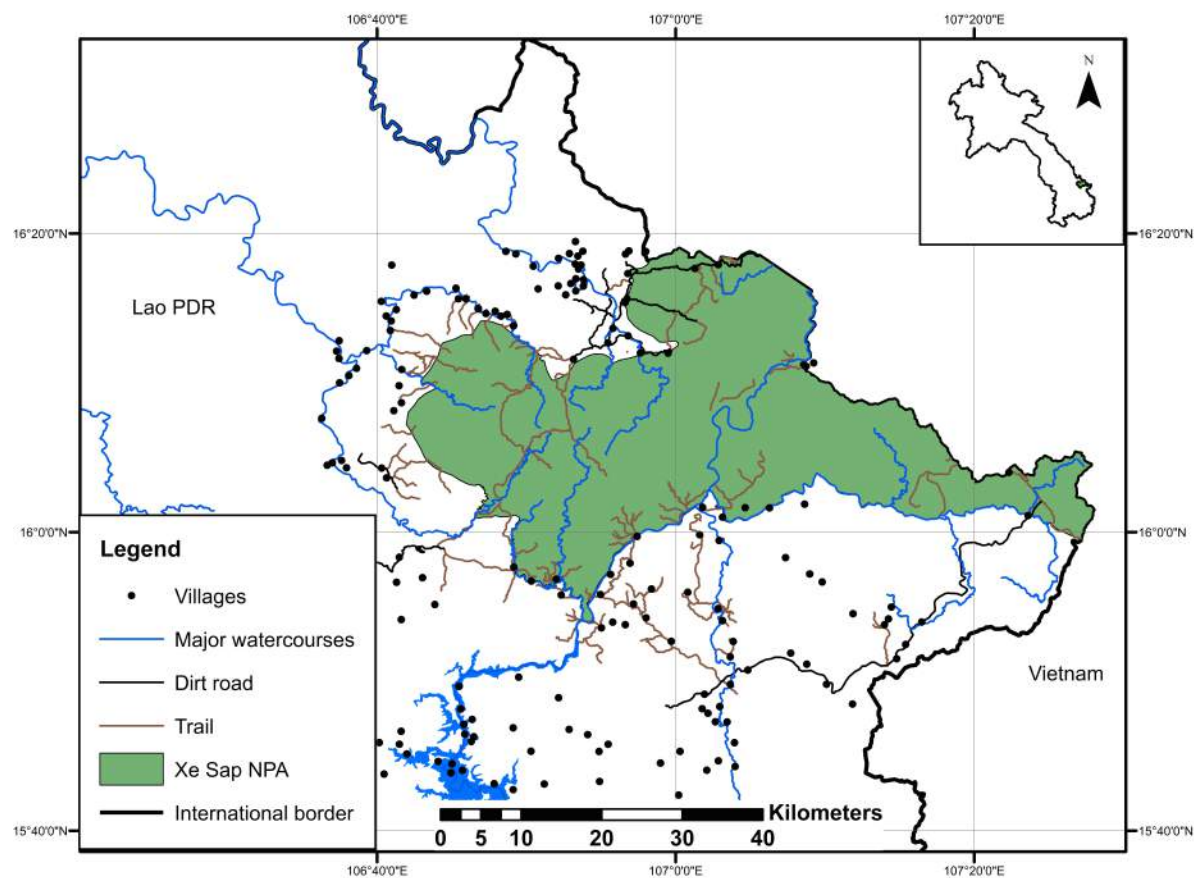


Figure 1: Xe Sap NPA

Selection of survey areas

Survey sites were selected based on: (i) my previous experience in adjacent areas in Vietnam, and (ii) satellite imagery analysis by Robert Timmins (RJT).

Since 2012, I have worked extensively in the Hue and Quang Nam SNRs and the Bach Ma NP extension (Fig 2). My experience in this region includes a four-month consultancy with WWF during the fall of 2013 during which I spent most of my time in the field. The Hue and Quang Nam SNRs are contiguous with XS. Among the areas I have surveyed, forest compartment number 352 (Fig. 3), located immediately adjacent to the easternmost section of XS, appears to be particularly good for large ungulates. The habitat is wet evergreen forest, and poaching levels appear to be lower here than in other areas of the SNRs. The lighter hunting pressure in this area is reflected by the presence of other rare and threatened taxa—including Sambar (*Rusa unicolor*), Asiatic Black Bear (*Ursus thibetanus*), and pangolin (*Manis spp.*), all of which were camera-trapped in 2013 (WWF unpublished data). Ungulate sign indicates that densities of muntjacs (*Muntiacus spp.*) and Chinese Serow (*Capricornis milneedwardsii*) are higher in this forest compartment than in other areas of the SNRs. Finally, sightings made in the past two years by Vietnamese Army staff and re-

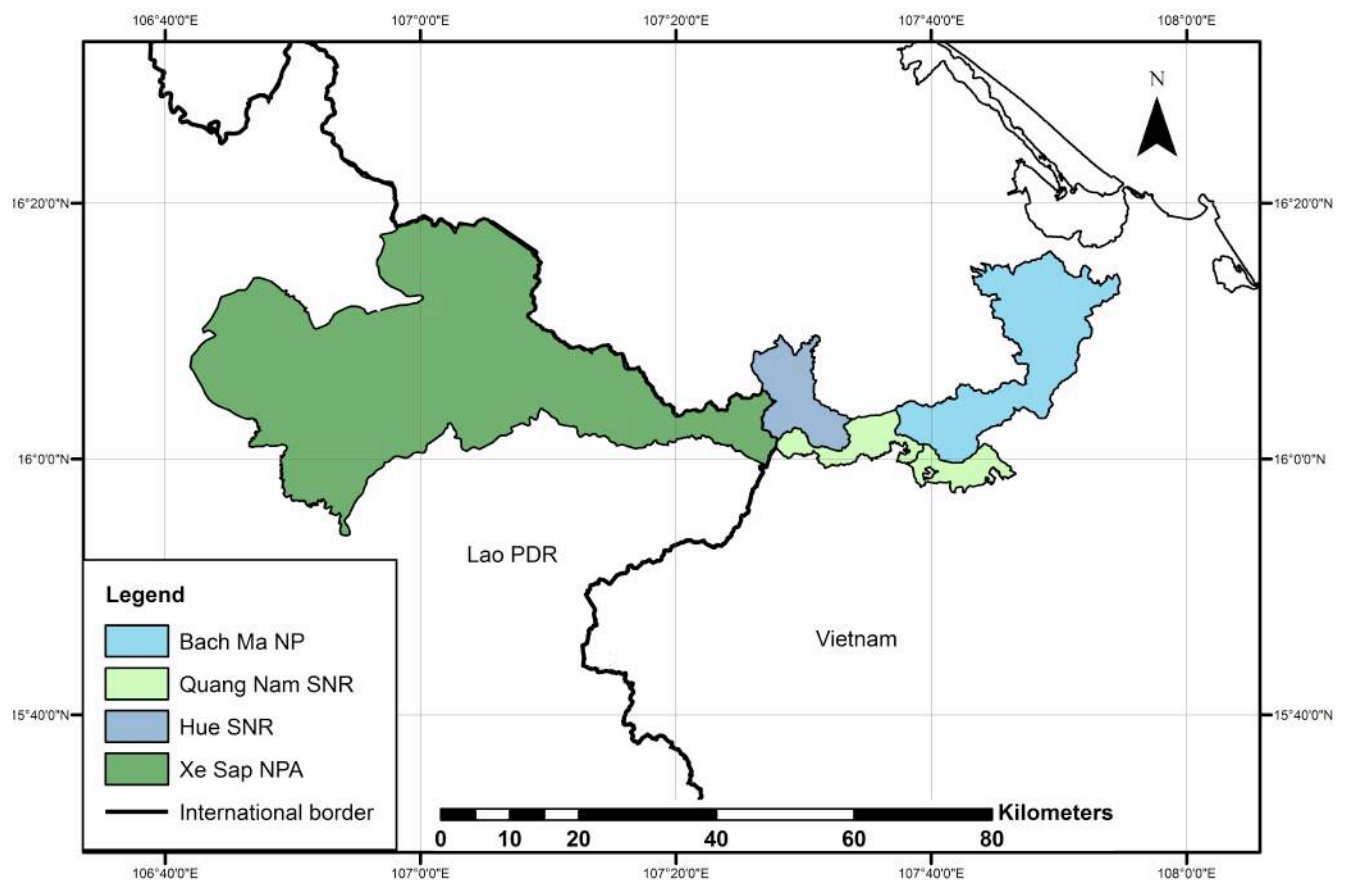


Figure 2: Xe Sap NPA relative to adjacent protected areas in Vietnam

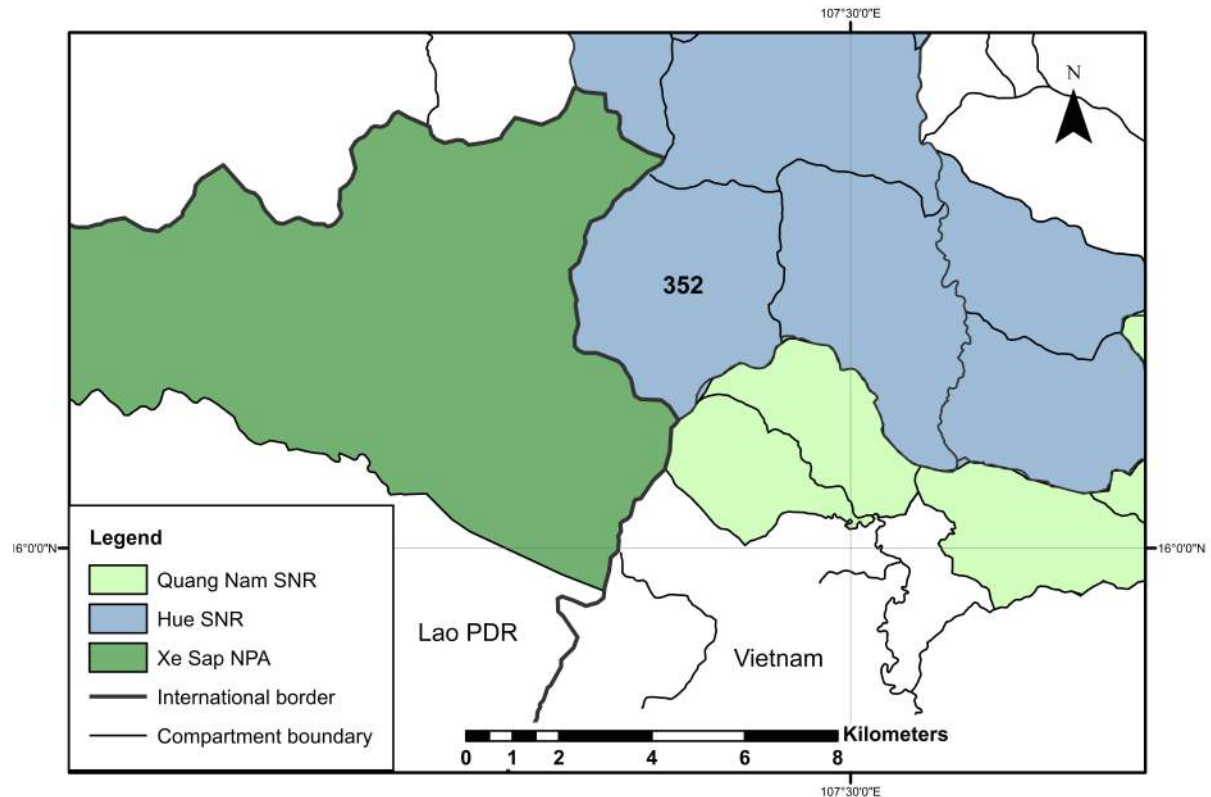


Figure 3: Hue Saola Nature Reserve compartment 352 relative to eastern Xe Sap NPA

ported to me in 2013 during extended fieldwork in forest compartment 352 are a promising sign that Saola may be in the area. (Though see issues associated with interview information noted later in the text). Ideal habitat, comparatively low levels of poaching, presence of other threatened mammal species, and recent sightings indicate that this region could be one of the best areas in the SNRs for Saola. It follows that nearby areas in XS should be considered high priorities for surveys as well. From this information, the area in XS immediately adjacent to forest compartment 352 was identified as a high priority for this survey.

RJT analyzed Landsat satellite imagery to identify priority survey locations. Locations were chosen based on habitat classification (e.g. forest type) and presumed anthropogenic influences (e.g. level of hunting based on distance from villages or roads). First, Landsat bandwidth values were altered to highlight areas of wet evergreen forest. Because all available information suggests Saola are largely restricted to this habitat type, this was the first criterion for choosing potential survey sites. Next, areas of optimal habitat were ranked according to accessibility. Less accessible areas are expected to experience less poaching pressure and therefore have a higher probability of Saola presence. From these criteria two survey areas were chosen (no. 1 and 2, Fig. 4). From the satellite imagery area no. 1 appears to have the best habitat (i.e. larger proportion of true wet evergreen forest). It is also adjacent to the Hue SNR forest compartment 352. However, its close proximity to

Vietnam means that it probably experiences higher hunting levels than areas further from the border. The habitat in area no. 2 appears to be less optimal for Saola (i.e. slightly drier forest) but is located farther from the Vietnam border, and thus may be insulated from Vietnamese poaching pressure. Although both areas were targeted for the survey, due to logistical issues, it was only possible to visit area no. 1. Area no. 2 remains a high priority for future Saola surveys. See “The potential priority sectors for Saola in Xe Sap NPA and adjacent areas” in the appendix for further discussion of survey areas as identified by RJT.



Figure 4: Priority survey areas identified by RJT

Timeframe / area surveyed

The remoteness of XS has been well documented by previous biologists (Steinmetz 1999, Timmins 2012). Surveying the easternmost section of the protected area was, not surprisingly, difficult and time intensive. From Pakse, the team travelled 3 days by car, then walked for an additional 3 days to reach the village of Ban Kalo, located near the eastern XS border (Fig. 5) In the dry season it may be possible to drive all the way to Ban Kalo with a 4WD vehicle. However, during the rainy season, the road from Ban Pannon to Ban Kalo is impassable except on foot. Our team arrived in Ban Kalo on 20.5.14. We spent the evening of 20.5.14 checking field supplies, buying food, and preparing for the survey. On 21.05.14 we hiked into the first survey location and set up camp (Fig. 5, see SI for camp coordinates). From 22.05.14 to 27.05.14 we surveyed from camp 1. Every attempt was made to survey a different section of forest each day. Most survey effort was concentrated towards the border with Vietnam, away from the road that bisects eastern XS. On 28.05.14 we moved south to a second campsite located within the first survey area identified by

RJT (refer to Fig. 4). Because it would have taken several days to travel to and then set up camp in survey area no. 2, I decided, after extensive discussions with the team members, that it would be a better use of our limited time to continue surveying area no. 1. An abundance of sign in the first survey area led me to believe that the area was promising for large ungulates, and therefore, could be promising for Saola. Also, given the large number of leeches probably needed to detect Saola if the species is present, I made the decision to survey one area intensively, rather than survey two areas less intensively. However, it should be noted that the second area (no. 2, refer to Fig. 4) identified by RJT remains a high priority for future Saola surveys, and should be explored as soon as possible. (See Discussion section for more information on future survey priorities). From 29.05.14 to 05.06.14 we surveyed out of camp 2. Survey efforts out of the second camp were focused to the southeast, along the border with Vietnam. On 06.06.14 we left the field site and returned to Ban Kalo. On 07.06.14 we left Ban Kalo. From 07.08.14 to 09.08.14 we hiked from Ban Kalo to Ban Pannon. The WWF car met our team outside of Ban Pannon. The team members, their affiliations, and roles are listed in Table 1.

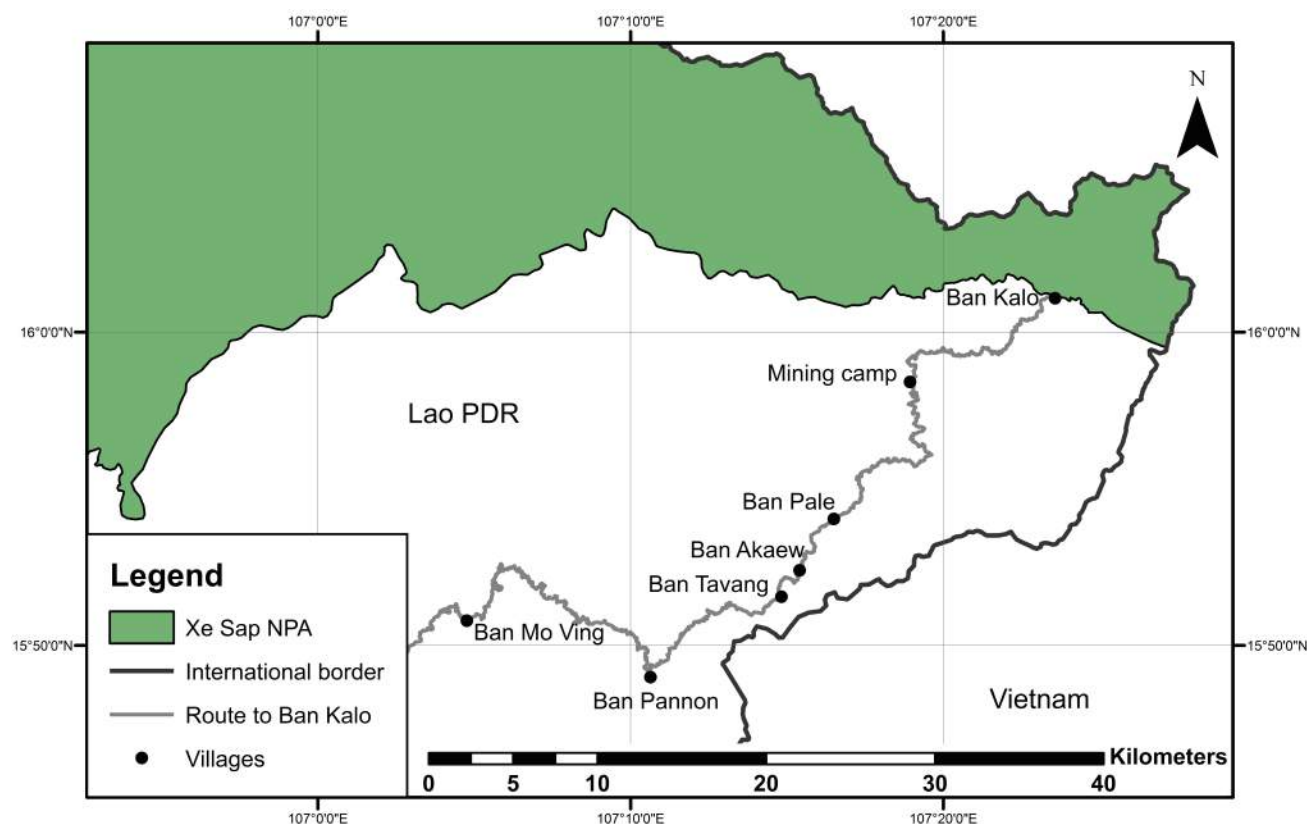


Figure 5: Travel route to eastern Xe Sap NPA

Team member	Affiliation / role
Andrew Tilker	Independent consultant / PI and first team leader
Khamhou	WWF—Laos / second team leader
Sonxay	Lao PDR border army / security personnel
Phoutsavanh	Cluster village (local police) / security personnel
Kai	PonRe / guide
Photthasone	DonRe / guide
Kaikeo	Local villager / porter
Yer	Local villager / porter
Teim	Local villager / porter
Pon	Local villager / guide
Kone	Local villager / guide
Khin	Local villager / guide
Nuy	Local villager / guide

Table 1: Survey participants

Methods

Saola presence: proximal

To assess the likelihood of Saola presence in eastern XS, and the importance of XS to Saola conservation in the Annamites, two qualitative indices were used: level of hunting pressure and relative abundance of other large ungulate species. All inferences derived from qualitative indices are made within the context of my findings from previous surveys in other protected areas in the Annamites (Hue and Quang Nam SNRs, Bach Ma NP, and Pu Mat NP). Hunting pressure was assessed by the number of snares, hunting camps, and manmade trails encountered during the survey. Snare type (foothold snare targeting large mammals, or neck / body snare targeting smaller mammals and ground-dwelling birds) was recorded. Relative abundance of other large ungulates was assessed from their signs. Hoofprints were identified to species when possible or, for ungulates that cannot be identified to species using tracks alone, to species group (i.e. muntjacs). Given suitable habitat, relative abundance of other large ungulate species is probably the most important indication that a particular area has high potential for Saola. Because poaching in the central Annamites is predominantly accomplished by the setting of nonselective wire snares, a healthy ungulate community, located within wet evergreen forest, is a good indication that the area is promising for Saola. For further indication of the relative abundance of large ungulates, we set 28

camera trap units. All cameras were set in areas showing recent ungulate tracks or feeding sign, mostly along small mountain streams. Camera trapping was not a concerted effort to photograph Saola: such a survey would likely require dozens or hundreds of cameras operational for an extended time period. The goal of the camera trapping was to assess the general status of the ungulate community in eastern XS. Results will be available in coming months (scheduled for early 2015.) These qualitative indices were supplemented by interviewing local villagers. In addition to providing information on Saola occurrence in XS, interviews made in villages en route to the study area provided insight into the potential distribution of Saola in the region and helped identify other areas that should be targeted in future surveys.

Saola presence: direct

A major goal of the survey was to definitively document Saola presence in XS by collecting terrestrial haematophagous leeches and analyzing these leeches for Saola DNA. Vertebrate DNA found in invertebrates (iDNA) is a promising tool for surveying rare and elusive tropical forest mammals (and possibly also ground-dwelling birds and reptiles). Initial studies showed that leeches feed on a range of mammal species, including Chinese Serow (*Capricornis milneedwardsii*) and Annamite Dark Muntjac (*Muntiacus rooseveltorum* / *truongsonensis* complex, number of species unclear due to unresolved taxonomy) (Schnell et al 2012), two large ungulates sympatric to Saola. Subsequent leech surveys in the Bach Ma NP extension and Pu Mat NP have used leeches to record other large ungulates, including Red Muntjac (*Muntiacus muntjac*) and Sambar (*Rusa unicolor*) (Tilker unpublished data). Sambar are rare in both protected areas and its presence in pilot studies that were limited in spatial and temporal scope is a promising sign that the method can effectively detect ungulates occurring at low densities. Leeches were collected opportunistically during hikes through wet evergreen forest. Leech abundance is often highest near moist vegetative areas adjacent to small streams. Extra time was spent searching these mesic microhabitats. Leeches were stored in RNAlater[®] buffer solution. At least two forms of leeches exist in the Annamites: brown leeches, which are usually found on the forest floor and are most common on mountain trails, and green or tiger leeches, which are usually found on understory vegetation and are most common near streams (SI, photo 1). It is not known if these leeches exhibit host-feeding preferences. Given the different microhabitats they are found in, and different areas of the understory in which they occur, species-specific feeding preferences are at least plausible. Understanding feeding preferences (i.e., if tiger leeches feed more often on large ungulates than brown leeches) would help direct future survey efforts. Leeches were therefore separated by type (brown or tiger) during collection. Leeches were collected in sets of 50. This was done for three reasons: (i) to avoid a low

leech to buffer ratio, which has been shown to cause degradation of the host DNA, (ii) to allow estimates of detectability (p) to be made, and (iii) to give spatial precision to the results (previous leech analyses in central Vietnam have been done at the forest compartment level). Each set of 50 leeches was stored as a separate GPS tracklog.

Results

Habitat

The habitat in the survey area was similar to other areas I have worked in the Hue / QN SNRs: wet evergreen broadleaf forest with a closed canopy. There was less secondary growth in this area than the region immediately across the border in Hue SNR forest compartment 352. This is expected, given the fact that there was a Katu village in Hue SNR forest compartment 352 until relatively recently (Nicholas Wilkinson pers. comm.), and the area has been logged, leaving large expanses of secondary growth. It is not known if degree of forest degradation influences *Saola* occurrence. The terrain was similar to other areas in the central Annamites: steep-sloped and marked by chasms. However, in general the terrain in the XS survey area was gentler than adjacent areas in Vietnam. At no point did we have difficulty reaching a given area. The same cannot be said of the remote areas of the central Vietnam protected areas, in particular the border areas between the Hue and Quang Nam SNRs.

Ungulate abundance

Sign was used to assess ungulate relative abundance. Hoofprints were the most common signs encountered, and were the primary evidence used to assess the ungulate community. Feeding sign was also taken into account, though with the caveat that this type of animal sign is almost impossible to identify to species with confidence. Ungulate dung was not found during the survey. In my experience, ungulate dung is found most often on slopes, and it is possible that the disproportionate amount of time we spent surveying along small streams limited our ability to find ungulate dung. Evidence of wild pigs (*Sus spp.*), Chinese Serow, muntjacs (*Muntiacus spp.*), and Sambar was found in both areas. Wild pig sign was the most common ungulate sign encountered. Prints were found at all elevations and in all microhabitats. Most pig sign indicated small groups (5—15 individuals), although tracks of solitary individuals, probably lone boars, were encountered in both areas. More than half of the sign was estimated to be less than one week old. Numerous pig nests (approx. 10 from both areas), many of them new (< 6 months old), were found along mountain ridges. Rooting was found along mountain ridges and in flat low-lying areas. Although

wild pig numbers have almost certainly been depressed from historic levels due to hunting, all available evidence indicates that eastern XS supports a healthy wild pig population. Serow prints, distinguished from other ungulate prints by shape and splay distance between the tips of the hoofs, were the next most frequently encountered ungulate sign. Serow prints were found at all elevations, though were more common at higher elevations (> 900 m), especially in difficult to reach areas near the border with Vietnam. Serow prints were encountered almost as often as wild pig prints, indicating that this area supports relatively high densities. Most serow prints were found along streams, though this is likely an artifact of survey effort, rather than a microhabitat preference. Muntjac sign was not as common as either wild pig or serow sign but was still found every two to three days in both survey areas. As noted above, muntjac prints cannot be identified to species with confidence. Therefore, even though at least three sympatric muntjac species probably exist in XS (*Muntiacus muntjac*, *M. vuquangensis*, and *M. truongsongensis* / *rooseveltorum*) (Timmins and Vongkhamheng 1996, Showler et al 1998, Timmins 2012), all muntjac prints encountered in the survey were recorded as *Muntiacus spp.* Muntjac prints were found most often in wet sand or mud alongside small streams (SI, photo 2). Our local Katu guides claimed that muntjacs visit streamside areas to feed on small ferns that grow in mesic microhabitats. This information, with the abundance of tracks, might lead one to assume a microhabitat preference. However, it is equally likely that more tracks were recorded in these areas simply because the substrate is better at preserving footprints from these light-bodied animals: muntjac camera trap photos in other areas (i.e. mountain ridges and slopes) indicate a substrate effect rather than habitat selection. Sambar prints were recorded eight times: three times in the first survey area, and five times in the second survey area (around camp 2). All were found at mid-range elevations (700—900 meters) in dense forest. All tracks were from individual animals. Given the low sample size, it is not possible to infer that Sambar were more common in the second survey area.

Ungulate feeding sign was more abundant than in any other area I have surveyed in the Annamites. Clipped leaves were a common sight along the banks of mountain streams (SI, photo 3). A high ungulate density could explain the high levels of feeding sign we encountered. However, one must be careful reading too much into feeding sign since a single animal feeding routinely along a stream could give the impression that many animals are in the area. This problem is heightened by the fact that it is more difficult to age feeding sign than it is to age tracks (although some local villagers claim that they can age feeding sign by the degree of browning the bitten section of the leaf).

Overall, ungulate abundance, based on tracks, appeared high relative to areas I have surveyed in Vietnam. Among sites in the SNRs, there are only two areas in which I have found similar levels of

ungulate sign from this diversity of species: forest compartment 352 in the Hue SNR, located immediately adjacent to the area surveyed in eastern XS, and forest compartment 20 in the Quang Nam SNR. Together, these areas, along with the easternmost section of XS, seem to be the best places I have visited for large ungulates in the Central Annamites landscape. They should provisionally be considered priority locations for Saola—at the very least for additional intensive surveys. Ungulate sign was encountered more frequently in eastern XS than the best areas I have surveyed in the Bach Ma NP extension, and considerably higher than the areas I have surveyed in Pu Mat NP.

Poaching

Snares and poaching camps were encountered in areas surveyed around both camps. All snares were removed and camps destroyed. Most of the snares we encountered were “noose-style” body snares set for smaller mammals (rats, squirrels, civets) and ground-dwelling birds (pheasants, partridges). The noose was made from wire. However, this is probably a result of our survey routes, rather than selective targeting of small mammals by hunters in the area; because leeches were most abundance in mesic microhabitats, we spent a disproportionate amount of time surveying alongside small streams, where hunters set traps for small mammals on fallen logs that act as natural bridges over waterways. Snares set for larger mammals were found less frequently than snares set for smaller game. However, it must be noted again that this is probably due to the small amount of time spent on ridges and slopes, where this type of snare is usually set. Snares were less common at lower elevations, a fact that can probably be attributed to the work of a nearby anti-poaching patrol team sponsored by WWF. Snares were encountered more frequently at higher elevations near the Vietnam border. It is particularly disturbing that snares were found in some of the most remote and inaccessible areas that we surveyed. (Though “remote” is a relative term for eastern XS. See Discussion for details). A moderate percentage of the snares (approx. 20%) were set weeks or even days before. Poaching camps were also more common near the border. Most camps appeared to be several months old, although one camp showed signs of recent use (SI, photo 4). Although it was not possible to definitively conclude the nationality of the poachers, our guides unanimously affirmed that the camps were from Vietnamese poachers coming over the border. The camps were identical in make and style to the camps I have seen immediately across the border in Vietnam. Number of snares and poaching camps were slightly higher in the first survey area than in the second. The most logical reason for this is that the northern areas of eastern XS are more accessible to Vietnam hunters coming from A’Luoï and the surrounding towns. The Katu people living in Ban Kalo affirm that hunting pressure increases as one moves

from south to north and attribute this gradient to increasing incursion by Vietnamese poachers entering the protected area from the north. In comparison with other areas I have surveyed in Vietnam, snaring levels in eastern XS are moderate. Snaring levels were much lower, for example, than heavily hunted areas of Pu Mat NP or the Bach Ma NP extension, where it is possible to find dozens or even hundreds in a single day, but slightly higher than most areas I have surveyed in the Hue and Quang Nam SNR. The lower snaring levels in the Hue and Quang Nam SNR are almost certainly due to the extensive efforts of the World Wildlife Fund (WWF) Forest Guards working in the region. It should be noted that even this moderate level of snaring in eastern XS poses a serious threat to any remaining Saola.

Leech surveys / camera trapping

A total of 2386 leeches were collected. In the first survey area, 1006 leeches were collected, and 1380 leeches in the second survey area. The total includes 1157 tiger leeches, 717 brown leeches, and 512 tiger and brown leeches that were combined in the initial stages of collection while protocols were still being developed. Leeches were collected opportunistically during hikes through wet evergreen forest. Survey and collection routes are shown in Fig. 7. More than 90% of the leeches collected were found in wet vegetation along small streams. Less than 10% of leeches were collected along slopes and ridges, though more than 30% of total survey effort was directed to non-stream areas. The vast majority of these leeches were tiger leeches. As a general rule, tiger leeches were found along small streams and brown leeches were found on mountain slopes and ridges. At no time were tiger leeches found more than five meters from running water. Also, at no time were brown leeches found immediately (< one meter) alongside streams. Tiger leeches were usually found hanging on vegetation at a height of approx. 30—90 cm, while brown leeches were found exclusively on the ground. These patterns correspond to what I have observed in the Hue and QN SNRs, Bach Ma NP, and Pu Mat NP. At an average of 170 leeches collected per day, total leech numbers were lower than expected. The scarcity of leeches can be attributed to the fact that although our fieldwork began at the start of the rainy season, rainfall was intermittent, and the forest was still relatively dry. All leeches were sent to the Kunming Institute of Zoology where they will be analyzed for host meal DNA.

Twenty-eight camera traps were set along likely animal trails and near recent ungulate feeding sign (SI, photo 5). Twenty-three Bushnell cameras belonging to WWF were set on 3-burst photo mode, and five Moultrie cameras belonging to Global Wildlife Conservation (GWC) were set to video (see SI for coordinates). Both models use a passive sensor and an infrared flash. Cameras were set opportunistically. We did not follow a systematic survey design, though every attempt was made to

space the cameras well so that survey effort was spread across the landscape, with the assumption that doing so would allow us to survey as many potential ungulate home ranges as possible. Even with these efforts, some clustering took place, especially in the second survey area, where we found abundant and fresh ungulate feeding sign near the border with Vietnam.

Saola interviews

I used every opportunity to ask villagers about wildlife in the region, particularly Saola. It is important here to include a cautionary note: although interviews with local villagers are potentially a valuable source of information, considerable care must be taken drawing conclusions from interviews, especially those that occur through relatively brief encounters (as was the case during the current survey). Robichaud et al (2010) provides a classic example: during surveys in Nam Kan, Laos, vastly different conclusions could be drawn about the presence of gibbons (*Nomascus spp.*) and Tigers based on which individuals were interviewed, how many people were interviewed, and the ability to follow up the interviews for further clarification. Add to this the potential for mistranslations, and it becomes clear that information gleaned from interviews must be treated carefully.

Interviews were conducted opportunistically; no attempt was made to use a structured approach. All interviews were conducted through a translator, sometimes from Lao to English, at other times from Katu English, and at still other times from Katu to Lao to English. I spoke with locals in Ban Pannon, Ban Pale, the mining camp south of XS, and Ban Kalo (refer to Fig. 5). First, through the village headman, I tried to make contact with the men in the village who went into the forest on a regular basis. Often these individuals were hunters. I then asked them to describe the large mammals in the forest. If Saola was mentioned, I followed up with additional questions. If Saola was not mentioned, I showed a picture of a Saola (from *A Field Guide to the Large Mammals of Vietnam*, Parr and Xuan, PanNature) and asked if the individual was familiar with the animal. Main questions posed to individuals who reported knowledge of Saola were: (i) Does Saola occur in this area? (ii) Where is the best place to find Saola? and (iii) When was the last that time you or others in the village saw a Saola? The first village we stopped at was Ban Pannon on 17.05.14. I spoke with two men, one the village schoolteacher and the second a resident whose occupation was unclear. Both men accurately described large ungulates in the forest—including serow, muntjac, and wild pig—but were unfamiliar with Saola. As we travelled northeast from Ban Pannon to Ban Kalo, the first village with individuals familiar with Saola was Ban Pale. On 18.05.14 I spoke with the village headman and a younger hunter, both of whom claimed to spend significant time in the forest, for approx. two hours after the evening meal. Even here, however, the two hunters I talked

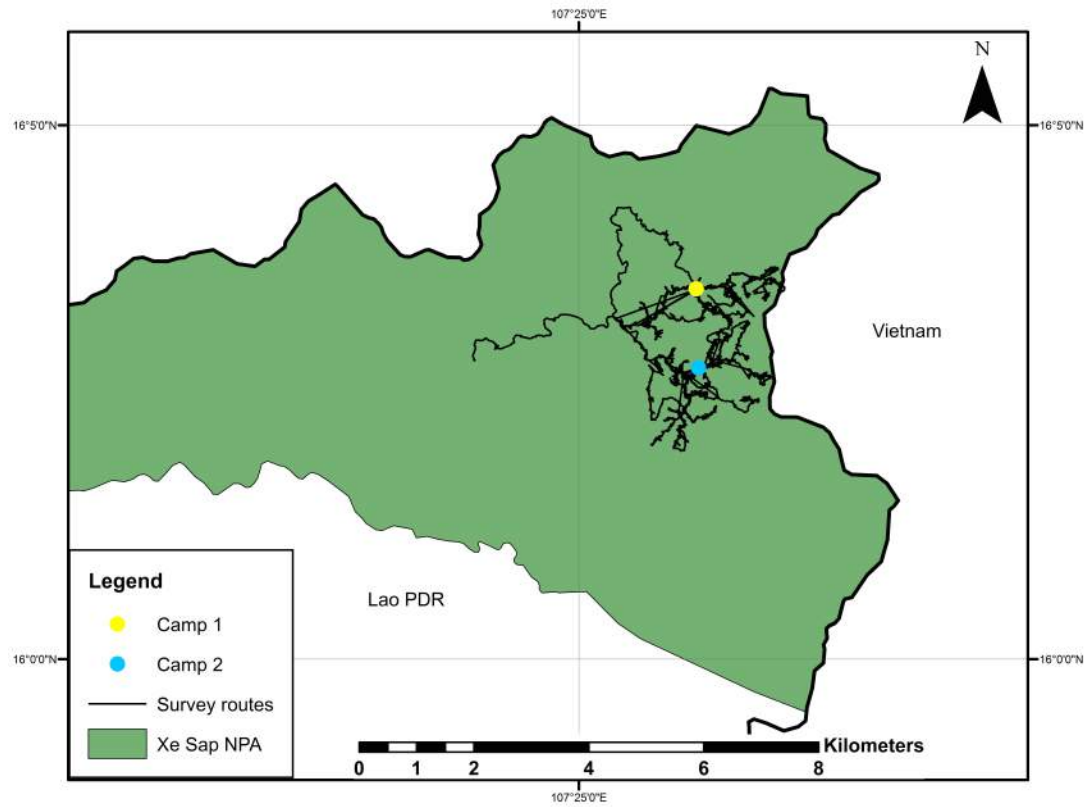


Figure 6: Survey routes

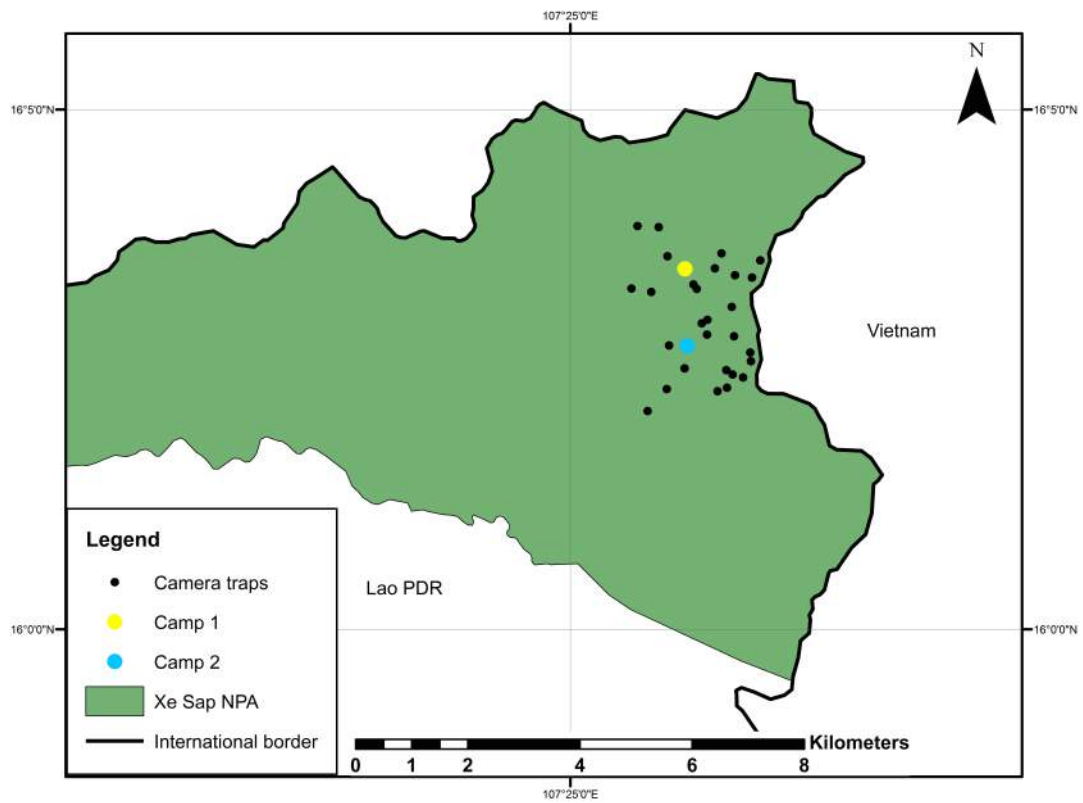


Figure 7: Camera trap locations

with said that the species did not occur near their village, but were found “far to the east,” near the Vietnam border. The village headman said he thought Saola occurred around the village a long time ago. When asked when this would have been he indicated that it would have been from the older generations. The younger hunter referred to Saola by the Katu name *soong sor*. He said the animal was very rare and that it had been 15 years since a Saola had been caught in the region. That incident, he said, occurred close to the border, many kilometers away from the village. The villagers that Timmins (2012) spoke to in the village (spelled “Ban Bhale”) were generally not familiar with Saola, though he notes that some vague reports may refer to this species, suggesting that it was known to the east by the oldest generation.

On 19.05.14 we spent one night at a mining camp along the Pale River. There a group of Vietnamese miners, working under a Laotian boss, had set up a temporary camp. It was obvious that the group was hunting in the area; when we arrived at the camp the Vietnamese miners were skinning a recently killed muntjac. (Permission to examine the specimen was not given). The Vietnamese miners would not answer questions about the area or its wildlife. The Laotian boss, however, claimed to have seen a Saola four months previously while driving at night. He gave the location of the sighting as two kilometers south of the mining camp along the same road we had walked in on. When asked for descriptive features of the animal he saw, he noted two parallel horns that were many times longer than those of a serow, and distinct white facial markings. On 20.05.14 we arrived in Ban Kalo. Villagers in Ban Kalo were familiar with Saola. I met on two occasions with the village headman and two other hunters. The villagers emphasized many times that Saola was rare, but insisted that it existed along the border with Vietnam. The headman said that Vietnamese hunters from A’Luoi had killed Saola in recent years. He also claimed that in the past the best area to find Saola (presumably based on his hunting experience) was immediately along the border with Vietnam, but that now, with the influx of hunters coming over the border, it may be better to look in other areas of XS. At this point another villager agreed that hunting had reduced Saola populations, but insisted that the area straddling the border was the best place to find Saola, even with increased hunting pressure by Vietnamese poachers. It is possible, of course, that as a result of increased poaching pressure near the Vietnam border, Saola are more abundant today in sub-optimal habitat—though without data from the field this remains speculative. I did not get a clear answer regarding the last time a villager from Ban Kalo had seen or hunted a Saola. The village headman only repeated that Vietnamese poachers had recently snared Saola in the northeast corner of XS. Particularly intriguing was an incident that occurred on 28.05.14 in A’Luoi, where three of our team members had gone to buy supplies between the first and second surveys. While in

A’Luoi, one of our Katu guides visited a friend, and in his friend’s house was a Saola trophy (SI, photo 5). The man claimed that the Saola was snared in 2008 in the northeast corner of XS. Although there is no way to verify that the Saola was killed inside the protected area, the date provided is plausible given that advanced decomposition had not yet set in.

Status of other select mammals

Three primates were recorded during the survey. Red-shanked douc (*Pygathrix nemaeus*) were encountered by the second survey team on two occasions. Macaques (*Macaca spp.*) were encountered by the second survey team on several occasions (exact number of sightings unclear). I viewed a troop of 4-6 stump-tailed macaques (*Macaca arctoides*) on 04.06.14 at a distance of 20 m. Pale-cheeked gibbons (*Nomascus spp.*) were heard early in the morning on two days at the first campsite, and three days at the second campsite. However, it should be noted that ambient noise from nearby streams and the other team members could have significantly reduced our ability to detect singing gibbons.

My survey team saw Black Giant Squirrel (*Ratufa bicolor*) on four occasions. All were clear views. Although the Black Giant Squirrel is one of the more common arboreal mammals in the central Annamites, this relatively high concentration of sightings could indicate that populations in this area have not been severely depressed—at least not to the extent that they have been in some adjacent areas of central Vietnam. For comparison, in more than two months of fieldwork in Bach Ma National Park in the fall of 2014, I had only two Black Giant Squirrel sightings.

The second survey team reported encountering bear (*Ursus thibetanus* or *Helarctos malayanus*) sign twice: once, the team found claw marks on a tree that the local guides assessed to be less than 6 months, and again a fresh footprint that was assessed to be no more than three days old. Unfortunately, photographs were not taken, so I cannot verify the veracity of these records. However, given that the local guides appeared knowledgeable of the forest and its wildlife, it seems unlikely that there could be a misidentification. Khamhou’s description of the print matches that of a bear. That we did not find more sign, especially claw marks, is at first surprising. I have encountered fresh (less than 6 months old) bear sign on several occasions in adjacent areas of the Hue Saola Nature Reserve forest compartment 352. Here again, it seems, the lack of bear sign could be attributed to the disproportionate time we spent searching streams. In my experience in the Hue and Quang Nam SNRs and Pu Mat NP, bear sign is usually found on slopes and ridges. On one occasion on the second part of the survey our team encountered three wild banana trees (*Musa spp.*) that had trunks broken at their bases. The breaks were ragged and therefore not the result of a machete. One of our Katu guides claimed that a bear had pushed the tree over to eat the inner pith

and ripe banana fruit. Although this was the first time I had heard this explanation, it is consistent with bear feeding ecology (Steinmetz pers. comm.) However, it should also be noted that macaques have also been known to exhibit this behavior.

No evidence of Gaur (*Bos gaurus*) was found during the survey. Previous surveys have recorded Gaur sign in XS (Steinmetz 1999, Timmins 2012). However, the lack of evidence is not surprising given that Gaur populations are severely depressed in the neighboring Hue and Quang Nam SNRs (refer to Fig. 2), and may even be extirpated from those areas. If Gaur occur inside the boundaries of eastern XS their numbers are low. Villagers in Ban Pannon and Ban Pale were familiar with Gaur and reported that the species was occasionally seen in the surrounding forest. Gaur were reported to be rare around Ban Kalo.

No evidence of large cats was found during the survey. Although Tiger and Leopard (*Panthera pardus*) were historically present in the region, the species may now be extirpated within the eastern section of XS. Indeed, based on a complete absence of sign from surveys in adjacent areas of Vietnam, it seems increasingly unlikely that either Tiger or Leopard are present in the neighboring Hue and Quang Nam SNRs. At Ban Pannon, locals claimed that both Tiger and Leopard were present in the area, based on tracks, but were seldom encountered in the forest. The men said that the best place to search for Tigers would be to the north of Ban Pannon. In Ban Pale, villagers said that Tigers had been extirpated in the surrounding areas for many years, but that Leopards were still present. The younger hunter had a necklace featuring the canine of a large cat. He said it had come from a Leopard that he had recently killed. Locals at Ban Kalo said Tiger were no longer present in the area, having been poached out by Vietnamese hunters years before. The villagers I interviewed were uncertain if Leopard were still present in the area and suggested that if the species was present it was rare. Steinmetz (1999) found evidence of large cats in western XS. The findings of the current survey are consistent with those of Timmins (2012), indicating that large cats in the region have undergone a significant decline.

No evidence of medium-sized cats was found on the survey. However, locals at Ban Pannon and Ban Pale reported that both Asiatic Golden Cat (*Catopuma temminckii*) and Clouded Leopard (*Neofelis nebulosa*) occurred in the forested areas around their village. Interviewees at Ban Kalo said the species occurred south of XS where they hunted, but that they were seldom encountered. Extensive camera trapping (> 15,00 nights) by WWF between 2012 and 2014 in the Hue and Quang Nam SNRs has failed to record these species, indicating that they might be extirpated from neighboring central Vietnam. If so, it is likely that they are gone, or at least very rare, in the extreme eastern section of XS.

No evidence of Otters (subfamily Lutrinae) was found on the survey. If otters are in the area, spraints should have been easy to find given the abundant time that our teams spent searching streamside areas. Because much of our work around streams was focused on collecting leeches, we moved slowly and searched the surroundings thoroughly; it is unlikely that we would have missed spraints. Indeed, primate and small carnivore dung was regularly found on rocks along streams. The lack of sign is worrying, and may indicate that otters are not present in the eastern corner of XS. In contrast, Timmins (2012) viewed otters on one occasion and found spraints while surveying south of our study site.

Steinmetz (1999) found evidence of Dhole (*Cuon alpinus*) in western XS. I did not find evidence of Dhole. These results match those of Timmins (2012). Again, extensive camera trapping by WWF between 2012 and 2014 in the Hue and Quang Nam SNRs failed to record this species, indicating that it might be extirpated, as have virtually all other large to medium-sized carnivores in central Vietnam.

Discussion

General findings

The area we surveyed in eastern XS appears to have higher ungulate density than sites I have surveyed in Vietnam. From my field experience, the best places in the Hue and Quang Nam SNRs for large ungulates, and potentially Saola, are forest compartments 352 in the Hue SNR and compartments 14 and 20 in the Quang Nam SNR. (Note: These priorities could change as more fieldwork is conducted in the landscape, especially in the remote regions on the Hue / Quang Nam border). Based on ungulate sign, the area we surveyed in eastern XS appears to be at least as good as these areas. In particular, the presence of Sambar prints in both survey areas is an encouraging sign that hunting has not been as intense in eastern XS as other areas: information from camera trapping, field observations and villager interviews in Vietnam, and elsewhere in Southeast Asia (T Gray in litt.), suggests that this is one of the first large mammals to be extirpated through hunting. Studies by Steinmetz et al (2010) further indicate that Sambar are one of the least resilient large ungulates to hunting pressure. It is possible that the presence of this species indicates a more intact ungulate community, which in XS would, at least historically, have included Saola. (Note: The ability of Sambar and other large-bodied ungulates such as the Large-antlered Muntjac to serve as “indicator species” for other species that may be more susceptible to hunting pressure, including Saola, is often assumed, but should be quantitatively tested.) Available evidence suggests that eastern XS should be considered a high priority for Saola conservation in the Central Annamites

landscape. Poaching pressure was lower than areas I have surveyed in the Bach Ma NP extension and Pu Mat NP, and moderate in comparison to areas I have surveyed in the Hue and Quang Nam SNRs. However, given the rarity of Saola, even moderate levels of snaring could extirpate the few individuals that survive in the region.

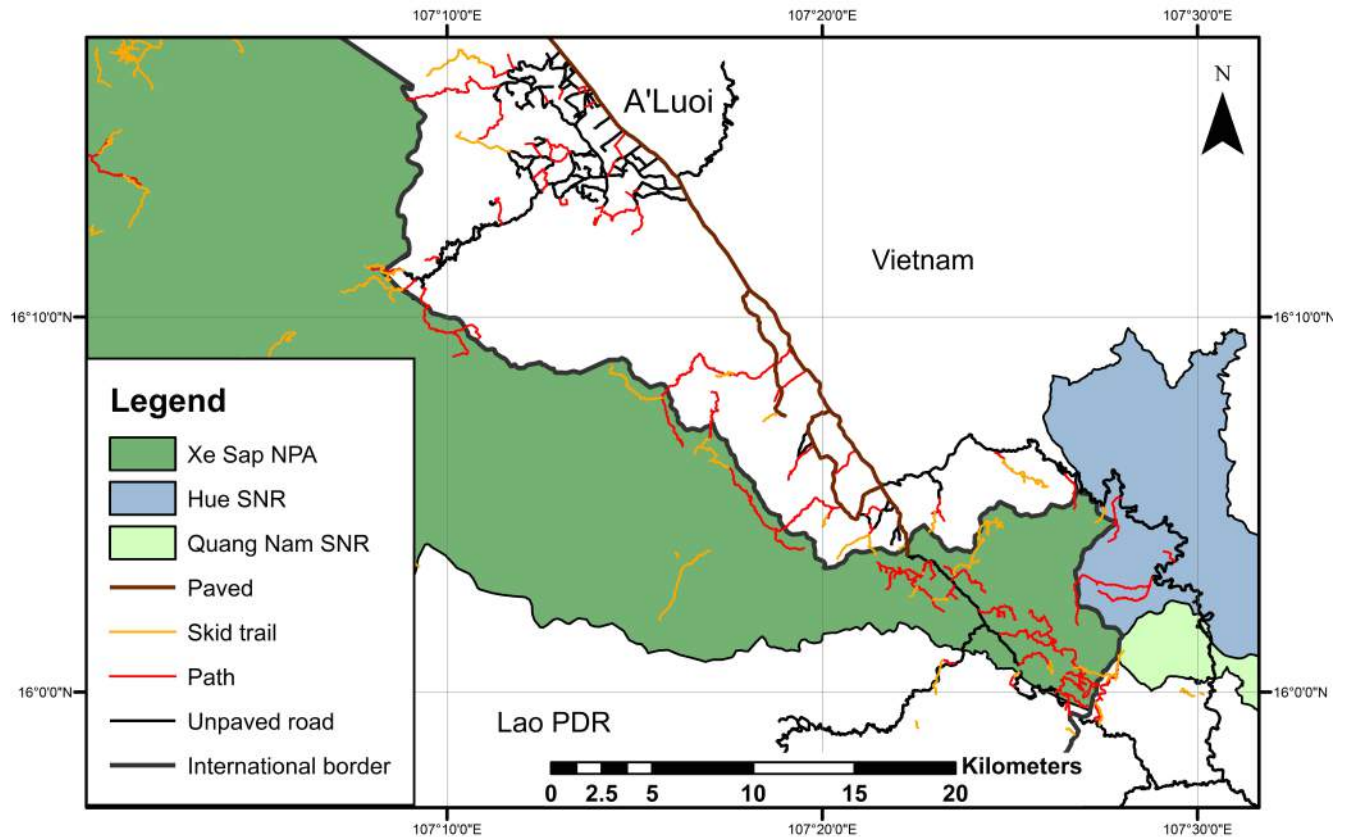


Figure 8: Travel routes and access points around eastern Xe Sap NPA (adapted from Bender 2012)

This survey eliminated the notion that eastern XS is a remote region—if it is accessed from Vietnam (Fig 8). There was moderate poacher presence in the areas we surveyed. According to the Katu villagers of Ban Kalo, the poachers are accessing the protected area from neighboring towns in Vietnam, particularly from A’Luoi. Furthermore, with the road bisecting the eastern section of XS and going into Vietnam, it is easy to access even the most remote parts of that region. From the road it would take a poacher less than three hours of hiking to get into the “remote” areas along the border with Vietnam. Our team found recent snares in these areas. Also surprising was how little effort it took to get from the survey site to A’Luoi: members from our survey were able to leave our first campsite, go to A’Luoi to buy supplies via the road that bisects the eastern corner of XS, and return within the span of eight hours. A one-way trip from A’Luoi could be accomplished in four. To get from A’Luoi to the “remote” places along the border with Vietnam would take a mere

six hours. Coming directly through the Hue SNR might take even less time. Although I did not encounter logging roads in the current survey, I know from previous work across the border that there is a network of old logging trails through the Hue SNR forest compartment 352, all of which facilitate access through otherwise dense tropical forest. These trails could facilitate access to XS. The newly completed Ho Chi Minh highway, which runs through forest compartment 352, also allows easy access to the western section of the Hue SNR, and therefore potentially into eastern XS.

Recommendations

Increased anti-poaching efforts in XS are urgently needed. Across the border in the neighboring Hue and Quang Nam SNRs, snaring levels have decreased due to the continued diligence of WWF Forest Guards. A similar program should be set up in XS. A first step would be the establishment of one or more permanent outposts in the Kalo district, from which routine anti-poaching patrols could be launched. Beyond simple snare collection, it would be essential to apprehend offenders. This situation becomes complicated if the poacher is a Vietnamese national. Little is accomplished if the poacher is simply deported back to Vietnam. The only disincentive here is lost time. However, prosecution of foreigners in the Kalo district is currently not feasible due to logistical difficulties associated with transportation and legal constraints. Managers should search for a practical middle-ground solution.

This survey focused on a relatively small area in extreme eastern XS. It is critical that additional surveys are conducted in other areas of XS. Given the limited resources for such surveys, and the difficulty Western biologists have accessing the Kalo district, care should be taken prioritizing these areas. I provide my recommendations with the caveat that the survey time was brief, interviews were informal, and total area covered was insufficient for a comprehensive prioritization of survey sites for eastern XS. Satellite imagery analysis should form a core component of any future prioritization scheme. However, satellite imagery is not a substitute for information collected on the ground. The findings from the current survey should be combined with remote sensing data to select future survey areas.

Additional surveys should be conducted along the border with Vietnam where there is a large tract of wet evergreen forest. The area south—southeast of the area surveyed on this trip, to the east of Ban Kalo (refer to Fig 5), is a top priority. All areas adjacent to the Hue SNR forest compartment 352 remain a high priority for future work. The current survey covered the central region of area no. 1 as identified by RJT. An earlier survey, conducted in 2014 by WWF, covered the northern section of this polygon. The southern part remains unexplored. However, future efforts should also

concentrate on areas further from the border, where the habitat might be sub-optimal for Saola (given our current understanding of Saola habitat preferences), but which experience much lower levels of poaching pressure. Indeed, given that poaching is the primary threat to remaining Saola, it makes sense to give priority to areas further from the border. This brings up an important point: If the goal of future surveys is to record Saola presence in the region, these efforts should not overlook areas outside the boundaries of the XS protected area. The area west—southwest of Ban Kalo, between Ban Kalo and the mining camp, is a high priority. Area no. 2 as identified by RJT should also be given high priority, as this region may be the most isolated wet forest habitat in the XS region. It is probably more isolated from poaching by gold miners working along the Pale river than similar forest tracts to the southwest of area no. 2.

Future surveys using leeches to detect Saola should be conducted during the height of the rainy season to maximize leech collection. The importance of targeted leech collection during the rainy season is difficult to overemphasize. There are drawbacks to working during the rains: access to eastern XS during this time is difficult. However, the trade-off is necessary, given the fact that number of leeches collected is much greater (i.e. potentially an order of magnitude) after the rains have come. In my experience in central Vietnam, dry-season leech numbers may be a mere 50 leeches per day, but in the same area in the wet season, this number can be upwards of 500. Of course, to detect Saola, it is essential to maximize the number of leeches collected per day in the field. There is no way to know how many leeches are needed to detect Saola if the species is present in an area. I believe, however, that the number will probably be in the thousands, and may be in the tens or even hundreds of thousands, to detect one individual in an area of forest similar in size to the area we surveyed on this trip.

These numbers also give perspective to the collection efforts of the current survey: given the enormous amount of effort likely needed to detect Saola, the failure to detect the species in leeches collected on this trip should not be taken as evidence that Saola do not exist in eastern XS. Even with the advent of this promising new detection method, searching for Saola is still a “needle in a haystack” situation. There is a real danger of underestimating the amount of effort needed to detect Saola and then erroneously concluding that the species is not present in an area. This also applies to camera trapping, and it should be noted again that the level we were able to employ on this survey may not be sufficient to detect Saola if present. Given the enormous effort needed to detect Saola, either by leech collection or camera trapping, I recommend that one to three areas be chosen for intensive and sustained survey efforts. There is a real danger of many small-scale surveys being conducted in various parts of the landscape, each with insufficient effort to detect Saola, and erroneous conclusions being drawn about the likelihood of Saola presence in a particular location.

To detect Saola, biologists must invest considerable effort and resources in the field for extended periods of time.

Finally, the Laos PDR government should consider adding an extension to XS to include forest tracts to the south of the protected area. As noted above, these areas likely experience much lower poaching pressure than areas closer to the Vietnam border, and probably have more intact large mammal communities. There is, at present, no reason to believe that areas inside XS are better for priority species, including Saola, than areas outside the protected area. It seems likely that the southern areas outside of the protected area are at least as promising, and perhaps even better, for large mammals. Any efforts to gazette further land into XS should be done in close collaboration with local people living in and around these areas, many of whom express a legitimate desire to have their traditional lands protected from encroachment from outsiders (including poachers).

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Appendix 1: The identification of potential priority areas for Saola in Xe Sap NPA and adjacent areas; rationale and discussion

contributed by: Robert Timmins

The potential for Saola presence in any particular forest sector depends on several factors, all of which vary with location. At present the most significant factor, assuming some ecological suitability of the area (presence of Wet-evergreen Forest [WEF] or forests transitional with WEF and retaining some characteristics of WEF), is prior hunting pressure. The primary proxy for hunting pressure is the ease, in its broadest sense, with which the area can be accessed by hunters. Other factors include ecological suitability (still poorly understood) and habitat connectivity (a proxy for potential Saola population continuity).

Using satellite imagery (primarily Landsat) to visualize differences in vegetation cover, especially between WEF and Semi-evergreen Forest, and topographic data (topographic maps and SRTM digital elevation model) to visualize both probable rain-shadowing and cloud passage, the approximate extent of WEF and transitional WEF was mapped by RJT. This area of potentially suitable Saola habitat was then further subdivided into eight sectors based on presumed differences in hunting pressure, ecological suitability and habitat connectivity.

The ecological suitability of eastern Xe Sap NPA is likely to be complex due to the relatively complex topography of the area in combination with significant river valleys that essentially cut east-to-west through the main spine of the Annamites. During November to April the Wet-evergreen Forests (WEF) of the eastern slopes of the Annamites depend on cloud and rain coming from the South China Sea. Unlike the summer monsoon these cool season weather patterns are far more localized, low in altitude and low energy, not generating the huge thunderstorms typical of the monsoon. Areas of high elevation (1000 m +) topography block and divert cloud movements during this time of year. Clouds move essentially in a southwest direction from the Thua Tien Hue coastal plain following to some extent the main river valleys. By the time the A'Luoi valley has been reached significant rain-shadowing has already occurred, although rainfall is still sufficient to support WEF. The 2000 m + peak on the Lao-Vietnamese border adjacent to A'Luoi forms an effective cloud barrier preventing further movement westwards; however, the valleys of the upper Xe Kong (river) system, both to the north and south of this peak, provide corridors to allow cloud movement westwards, although further high elevation topography around these valleys probably significantly impedes any further cloud movement westwards.

Hunting pressure depends on many factors, but significant proxies for the degree of hunting pressure in any given forest area include human population density in adjacent areas, transportation infrastructure within and adjacent to the forest, connectivity to major wildlife trade networks, and cultural factors. The first two of these factors are likely to be the most significant determinants of differences in hunting pressure between different areas of forest in and around Xe Sap NPA. The A'Luoi valley is heavily settled and has a population density several magnitudes higher than any area of Laos in or adjacent to Xe Sap NPA, and because of the extensive wildlife trade network that exists in Vietnam and the prevalence of wildlife trade in Vietnamese culture the vast majority of the hunting pressure in the Xe Sap area stems from Vietnam. As such the areas that are the remotest from this Vietnamese centered influence are likely to have the lowest hunting pressure. The northern fringe of Xe Sap NPA in Somoy and Taoy districts supports the highest human density of Lao areas, as well as reasonably good

transportation infrastructure and thus this northern fringe is likely to have experienced higher hunting pressure than areas to the south. The Xe Sap valley potentially facilitates access into eastern areas of Xe Sap NPA, as does the newly upgraded road from Ban Kalo to Kaleum, otherwise southeastern Xe Sap NPA and adjacent areas to the south of the Xe Kong are probably relatively difficult to access due to the high elevations and steep terrain.

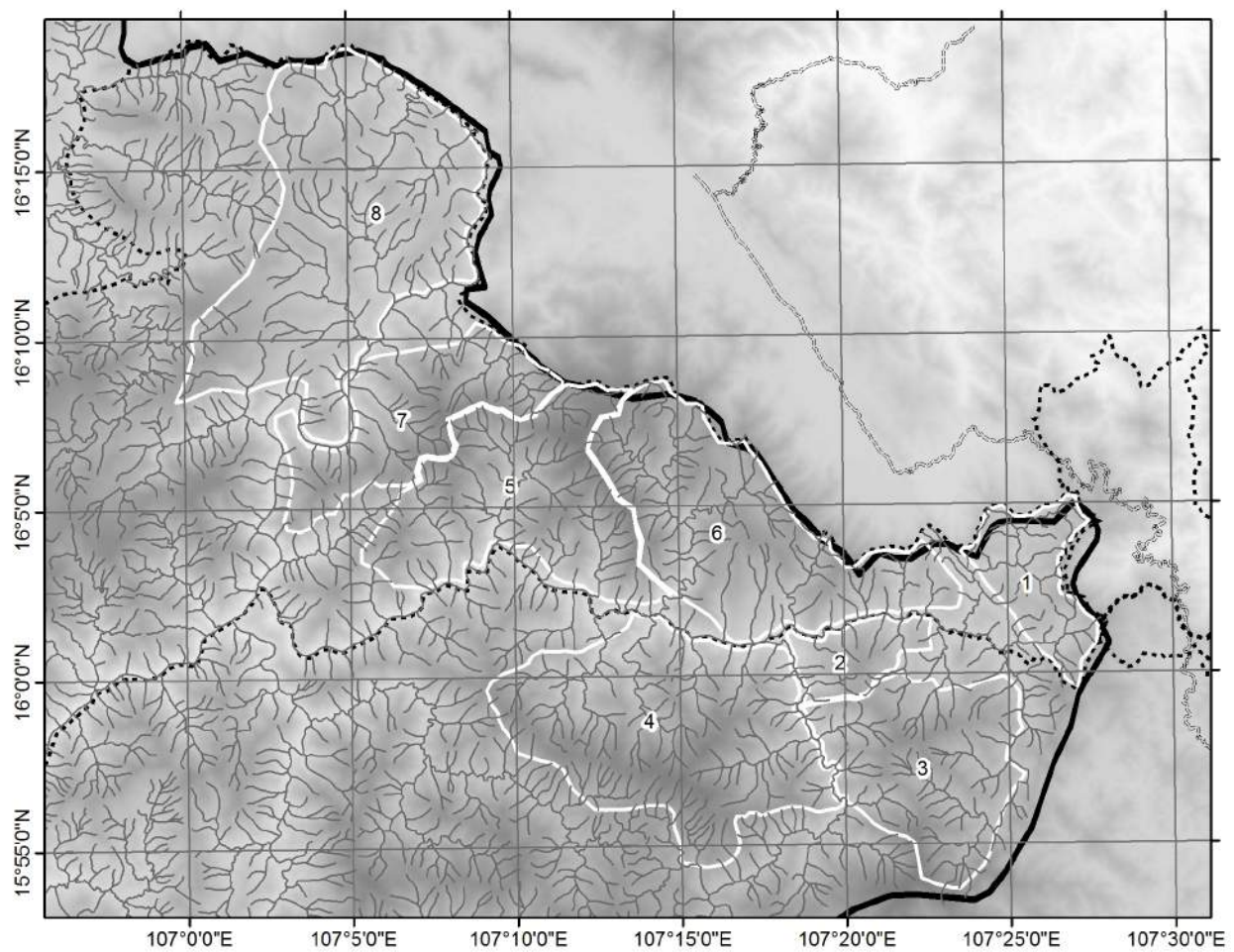


Figure 9: Potential priority sectors for Saola in Xe Sap NPA and adjacent areas.

Legend: Potential priority sectors are outlined in white and numbered 1–8 following the text. Protected area boundaries are marked by black dashed lines. The international border is a thick black line. Streams (in Lao only) are marked by grey lines. The Ho Chi Minh Highway in Vietnam is shown as a double dashed line. The background for the map shows elevation with darker greys indicating higher altitudes.

XS priority area*	Hunting pressure	Ecological suitability	Saola population continuity	Saola priority potential	Range wide prioritization score[§]
1	Medium	High	High	High-Medium	4.5
2	Medium	High-Medium	High-Medium	High-Medium	6.0
3	Low	Medium	High-Medium	High	6.0
4	Low	Medium	Medium-Low	High	8.0
5	Medium-High	Medium-Low	Medium	Medium-Low	4.9
6	Medium-High	High	High-Medium	Medium	4.9
7	Medium	Medium	Medium	Medium	4.9
8	Medium-High	Low	Low	Low	2.8

Potential Saola priority assessment of eastern forest sectors based on three factors. See text for the discussion of each factor

§Represents an assessment of the potential presence of Saola based on Timmins (in prep.); higher scores indicate higher potential for Saola presence in significant numbers. Sectors 2 and 3, and sectors 6, 7 and 8 were each assessed as single units.

The potential priority sectors for Saola in Xe Sap NPA and adjacent areas

Sector #1 (the area surveyed by A. Tilker in 2014; area XS5 in the range wide prioritization).

This sector bordering the Hue and Quang Nam SNRs is likely to be somewhat more remote from hunting than sector #6, but like that sector the forest in this sector is probably the closest approximation of WEF within the Xe Sap NPA area. This sector also has the added bonus in terms of Saola conservation potential of being contiguous with the regularly patrolled sectors of the Hue and Quang Nam SNRs. Enforcement activities in this sector is a high priority.

Sector #2 (the northern section of area XS3 in the range wide prioritization). This sector is somewhat more remote from hunting pressure, lying some distance from the international border and south of the upper Xe Kong, than sectors #1 and 6, yet is likely to be only marginally more rain-shadowed than these sectors. Surveying this sector for Saola presence is a very high priority.

Sector #3 (area XS3 in the range wide prioritization; the western part of the sector was surveyed by Timmins (2012)). The western section is somewhat transitional WEF, but is also with the exception of sector #4 almost certainly the least hunted sector with Saola potential in the Xe Sap NPA region. The eastern section probably has greater WEF affinity, but also somewhat higher

hunting levels; lower hunting levels however than is likely to be the case in any of the sectors abutting the international border with Vietnam. Surveying this sector for Saola presence is a very high priority.

Sector #4 (area XS2 in the range wide prioritization). The remotest sector with almost certainly the lowest hunting pressure of any of the sectors, however ecologically the forest is likely to be strongly transitional WEF. The sector also is to a degree naturally ecologically isolated from other areas of WEF to the north and east by the upper reaches of the Kong and Pale rivers. It is possible that Saola would have occurred at naturally lower densities in this suboptimal habitat, and that due to the relative ecological isolation they could have been hunted out over the millennia as dispersion of Saola into the sector from WEF areas to the north and east may have been limited. Surveying this sector for Saola presence is a very high priority.

Sector #5 (the central section of area XS4 in the range wide prioritization). High elevation and significant rain-shadowing suggest the sector is probably suboptimal habitat. Hunting pressure may be relatively high especially on the northeastern slope due to the proximity of the A'Luoi valley. Although the southwestern slopes are likely to have significantly lower hunting pressure due to the high topography separating them from the A'Luoi valley, they probably support only suboptimal habitat due to strong rainshadowing effect of this same topography.

Sector #6 (the southern section of area XS4 in the range wide prioritization). These forests are likely to approximate true WEF along the international border, however their proximity to the A'Luoi valley suggest that hunting pressure is likely to be high. This and sectors # 5 and 7 have been ecologically isolated to a degree from the WEF forests of the Vietnamese SNRs by forest clearance and other human activities in the upper parts of the A'Luoi valley and Xe Kong valley. Enforcement activities in this sector is a high priority.

Sector #7 (the northern section of area XS4 in the range wide prioritization). This sector to the south of the Xe Sap is probably significantly less rain-shadowed than the sector #8, and also somewhat remoter from human pressures, as well as being ecologically less isolated from other WEF sectors than sector #8, however the large border peak and its rain-shadowing effect (sector #6) probably creates some impediment to the potential continuity of this sector with local Saola populations to the south and east. This sector is a high priority for further investigation to determine if there is any evidence to suggest Saola presence based on a combination of interviews in villages in Vietnam and Laos and field surveys to assess habitat suitability and ungulate population abundance.

Sector #8 (area XS1 in the range wide prioritization). This sector to the north of the Xe Sap is significantly degraded presumably as a result of a long history of shifting cultivation. The

relatively low terrain in combination with the surrounding settled lowlands of Somoy District and the upper A'Luoi valley suggest hunting pressure has probably been relatively high. Ecologically the sector is probably significantly rainshadowed by the Phong Dien—Dak Rong hills, whilst the forest block has been relatively isolated from other areas of WEF by human settled areas to the west, north and east, whilst the Xe Sap forms a natural impediment to Saola movement to the southeast. The sector probably has the least potential for Saola presence of the candidate sectors. However this sector is a high priority for further investigation to determine if there is any evidence to suggest Saola presence based on a combination of interviews in villages in Vietnam and Laos and field surveys to assess habitat suitability and ungulate population abundance.

Additional recommendations

Establishment of a permanently staffed protected area office in the Ban Kalo region, with good means of communication to the Xe Sap NPA headquarters, is essential to achieving Saola conservation goals within Xe Sap NPA.

Exhaustive surveys of sectors # 2, 3 and 4 to the south of the current NPA boundary where the potential for Saola presence is high and hunting pressure is relatively low is highly recommended. However it might be more cost effective to simply establish enforcement patrols in these sectors on the assumption that Saola presence is likely, but detecting Saola would require very significant resource input.

Extending the protected area boundary to incorporate sectors # 2, 3 and 4 should be thoroughly considered.

Appendix 2: Supplementary Information



Photo 1: Brown (left) and tiger (right) leeches.



Photo 2: Muntjac hoofprint found along stream.



Photo 3: Ungulate feeding sign.



Photo 4: Destroying a poacher camp found in the second survey area.



Photo 5: GWC camera trap set over an animal trail showing recent ungulate feeding sign.



Photo 6: Saola trophy in A'Luoi.

Camera trap	Location
WWF 09	107.427198 °E 16.064753 °N
WWF 24	107.430833 °E 16.064545 °N
WWF 30	107.440178 °E 16.038367 °N
WWF 31	107.429587 °E 16.054058 °N
WWF 33	107.441528 °E 16.041805 °N
WWF 34	107.434882 °E 16.042013 °N
WWF 36	107.438620 °E 16.049801 °N
WWF 37	107.442670 °E 16.051877 °N
WWF 38	107.441632 °E 16.038794 °N
WWF 39	107.432390 °E 16.045647 °N
WWF 41	107.428963 °E 16.035160 °N
WWF 42	107.432286 °E 16.059873 °N
WWF 44	107.443189 °E 16.056654 °N
WWF 45	107.426471 °E 16.054785 °N
WWF 47	107.441216 °E 16.060392 °N
WWF 48	107.445785 °E 16.056654 °N
WWF 49	107.436544 °E 16.055408 °N
WWF 50	107.439970 °E 16.057900 °N
WWF 51	107.445681 °E 16.044505 °N
WWF 52	107.442774 °E 16.040767 °N
WWF 53	107.447135 °E 16.059354 °N
WWF 54	107.437478 °E 16.049178 °N
WWF 55	107.431975 °E 16.038586 °N

GWC 1	107.445577 °E	16.043155 °N
GWC 2	107.442981 °E	16.047101 °N
GWC 3	107.436959 °E	16.054577 °N
GWC 4	107.444435 °E	16.040248 °N
GWC 5	107.438516 °E	16.047309 °N

Camp	Location	
XS no. 1	107.435090 °E	16.057692 °N
XS no. 2	107.435401 °E	16.045647 °N