Collaborating to Conserve Large Mammals in Southeast Asia

ROBERT STEINMETZ,* WANLOP CHUTIPONG, AND NARET SEUATURIEN

World Wide Fund for Nature-Thailand Office, 104 Outreach Building, P.O. Box 4, Asian Institute of Technology, Klong Luang, Patumthani 12120, Thailand

Abstract: *Depressed mammal densities characterize the interior of many Southeast Asian protected areas, and are the result of commercial and subsistence hunting. Local people are part of this problem but can participate in solutions through improved partnerships that incorporate local knowledge into problem diagnosis. The process of involving local people helps build a constituency that is more aware of its role (positive and negative) in a protected area and generates site-specific conservation assessments for management planning. We illustrate the practical details of initiating such a partnership through our work in a Thai wildlife sanctuary. Many protected areas in Southeast Asia present similar opportunities. In local workshops, village woodsmen were led through ranking exercises to develop a spatially explicit picture of 20-year trends in the abundance of 31 mammal species and to compare species-specific causes for declines. Within five taxonomic groups, leaf monkeys (primates), porcupines (rodents), tigers (large carnivores), civets (small carnivores), and elephants (ungulates) had declined most severely (37–74%). Commercial hunting contributed heavily to extensive population declines for most species, and subsistence hunting was locally significant for some small carnivores, leaf monkeys, and deer. Workshops thus clarified which species were at highest risk of local extinction, where the most threatened populations were, and causes for these patterns. Most important, they advanced a shared problem definition, thereby unlocking opportunities for collaboration. As a result, local people and sanctuary managers have increased communication, initiated joint monitoring and patrolling, and established wildlife recovery zones. Using local knowledge has limitations, but the process of engaging local people promotes collaborative action that large mammals in Southeast Asia need.*

Keywords: hunting, local knowledge, mammal conservation, protected areas, wildlife management

Colaboración para la Conservación de Mamíferos Mayores en el Sureste de Asia

Resumen: *Densidades deprimidas de mamíferos son características de muchas áreas protegidas del sureste de Asia y son el resultado de la cacería comercial y de subsistencia. Los habitantes locales son parte de este problema pero pueden participar en las soluciones por medio de asociaciones que incorporen el conocimiento local al diagnóstico del problema. El proceso de para involucrar a los habitantes locales ayuda a construir una comunidad que está más conciente de su papel (positivo o negativo) en un área protegida y genera evaluaciones locales para la planificación de la gestión. Ilustramos los detalles prácticos del inicio de esa asociación con nuestro trabajo en un santuario de vida silvestre tailandés. Muchas áreas protegidas en el sureste de Asia presentan oportunidades similares. En talleres locales, los leñadores fueron conducidos por una serie de ejercicios de clasificación para desarrollar una visión espacialmente explícita de las tendencias de la abundancia de 31 especies de mamíferos durante 20 años y comparar las causas específicas de las declinaciones. En cinco grupos taxonómicos, monos (primates), puerco espines (roedores), tigres (carnívoros mayores), civetas (carnívoros pequeños) y elefantes (ungulados) declinaron más severamente (37 a 74%). La cacería comercial contribuyó significativamente a declinaciones poblacionales extensivas de la mayoría de las especies, y la cacería de subsistencia fue significativa localmente para algunos carnívoros pequeños, monos*

*email rob@wwfthai.org
Paper submitted February 21, 2005; revised manuscript accepted January 10, 2006.

y venados. Por lo tanto, los talleres evidenciaron qué especies tenían mayor riesgo de extinción local, donde estaban las poblaciones más amenazadas y las causas de estos patrones. De mayor importancia, desarrollaron una definición compartida del problema, con lo que identificaron oportunidades de colaboración. Como resultado, los habitantes locales y los administradores del santuario han incrementado la comunicación, iniciado monitoreo y patrullaje conjunto y establecido zonas de recuperación de vida silvestre. La utilización del conocimiento local tiene limitaciones, pero el proceso de involucrar a los habitantes locales promueve acciones de colaboración que los mamíferos mayores del sureste de Asia requieren.

Palabras Clave: áreas protegidas, cacería, conocimiento local, conservación de mamíferos, gestión de vida silvestre

Introduction

Although many countries in Southeast Asia have designated significant proportions of their remaining forested land as protected areas (Thailand 17%, Prayurasiddhi et al. 1999; Lao People's Democratic Republic 14%, Robichaud et al. 2001; Cambodia 24%, WRI 2004), recent field work in many of these areas has revealed that densities of large mammals, especially ungulates, carnivores, and primates, are extremely low (Desai & Vuthy 1996; Duckworth & Hedges 1998; Duckworth et al. 1999; Steinmetz 2004). Tigers (*Panthera tigris*), for example, are much rarer than previously expected in large Thai and Burmese protected areas (Lynam et al. 2001; Lynam 2003), despite the physical potential of some areas and their prior recognition as high-priority locations for tiger conservation (i.e., level 1 tiger conservation units, Dinerstein et al. 1997). The depressed mammal densities that characterize the interior of many Southeast Asian protected areas are largely the result of commercial poaching to supply regional and international markets (Srikosamatara & Suteethorn 1994, 1995; Rabinowitz 1999; Nooren & Claridge 2001; Sodhi et al. 2004). Subsistence hunting generally has a smaller impact but can be unsustainable particularly for preferred food species already targeted by commercial hunters.

The complex challenges of conserving Southeast Asia's large mammals amidst this expanding crisis will require new and dedicated collaborations between biologists, governments, conservation organizations, and local people. Conservation biologists must learn to blend biological information with other sources of knowledge (Macdonald 2001; Lovejoy 2004), and innovate cooperative problem-solving approaches that are informed by shared definitions of conservation problems (Clark et al. 2001). Doing this is difficult, but can result in increased ability and confidence of diverse groups to address complex conservation problems. For example, traditional ecological knowledge of Cree hunters in Canada provided new perspectives about habitat changes and human impacts that helped biologists and local people understand and conserve declining bird populations (Gadgil et al. 2003). Examples of such partnerships from Southeast Asia, however, are rare (Poffenberger 1998; Oli 1999; Beltran 2000; Carey et al. 2000). So far, most efforts to link local people with biodiversity conservation in Southeast Asia have emphasized economic development to reduce resource use within protected areas. Such projects, broadly known as integrated conservation and development projects (ICDPs), have met with mixed success (Sayer 2001). Although important, interactions with local people need not revolve solely around economic incentives. Rural communities elevate social and political benefits—such as equity, fairness, and empowerment—in addition to economic ones (Berkes 2004), and they respond to education and awareness in support of conservation if given the confidence and opportunity to act (Salafsky et al. 2001; Sillero-Zubiri & Laurenson 2001).

Local people in Southeast Asia are often keenly aware of changes in the status of wildlife species around their communities (Griffon & Griffon 2000; Johnson et al. 2001; Steinmetz 2004). The current status of wildlife at a site is determined by a combination of historical and ongoing processes that could include commercial poaching, subsistence hunting, habitat loss and fragmentation, ecological succession, and natural disturbances. Local people with a long history in an area will have insights into the spatial extent, intensity, duration, and range of variability of such processes (Berkes et al. 2000). These details are important for site-specific conservation planning (Poiani et al. 2000) but are unavailable to protected-area staff and conservation biologists (who are relative newcomers to an area). At the same time, however, local people do not necessarily perceive the consequences (positive and negative) of their land use or hunting practices for wildlife at the broader spatial scales of concern to biologists. Thus, local people and conservation biologists have much to learn from each other. Conservation action based on the combined knowledge of these stakeholders might more effectively target root causes of mammal declines and be better understood and supported by local people.

Collaboration to conserve wildlife in Southeast Asia must occur at multiple geographic and institutional scales, but what happens in and around protected areas is especially critical. This is the scale at which large mammal populations are presently being conserved or lost, and where the potential for collaboration among local

people, protected-area staff, and conservation biologists is least explored. Conservation biologists and local people do not share the same agenda (Redford & Sanderson 2000). But what are the boundaries and depth of common ground that might exist between them? Local people are part of the problem of wildlife decline in Southeast Asia. How can they also be part of solutions? We explore these questions and offer practical methodologies to initiate and develop collaborative wildlife conservation at the local level. We illustrate these ideas with detailed examples from our work in a Thai wildlife sanctuary. Since 2000, we have engaged local people and protected-area staff in a collaboration to protect and restore the area's populations of large mammals. Many aspects of this experience will be relevant for other parts of Southeast Asia.

Study Area

Thung Yai Naresuan Wildlife Sanctuary (3622 km^2) is in western Thailand adjacent to Myanmar (14° 55′−15° 45′ N, 98° 25′ −99° 05′ E) (Fig. 1). It is part of Thailand's first Natural World Heritage Site and forms the core of the largest forested complex in mainland Southeast Asia (the Western Forest Complex). Major habitats are mixed deciduous, semi-evergreen, and hill evergreen forest types (Nakhasathien & Stewart-Cox 1990). The sanctuary is characterized by rugged mountainous terrain with elevations up to 1811 m and receives 2000 to 2400 mm of rain annually.

Thung Yai is officially managed by the Department of National Parks, Wildlife, and Plant Conservation, and has been inhabited by an indigenous minority known as the Karen for over 200 years. Human population density is low (1.1/km^2). Twelve villages occur within the sanctuary; their accessibility is mainly by foot, requiring walks of 2 hours to 3 days. Most Karen are subsistence farmers, practicing long-fallow rotational rice and vegetable cultivation (swidden agriculture). They gather food, medicines, and building materials from the forest. Fishing is a major source of protein. The Karen hunt and trap small and medium-sized mammals for food, especially around cultivated areas in response to crop raiding. Resource use occurs within traditional village territories (90–300 km^2). These are delineated mostly by streams and ridges and are not recognized officially. Village councils and elders assume overall responsibility for monitoring land use and maintaining resources within their territories.

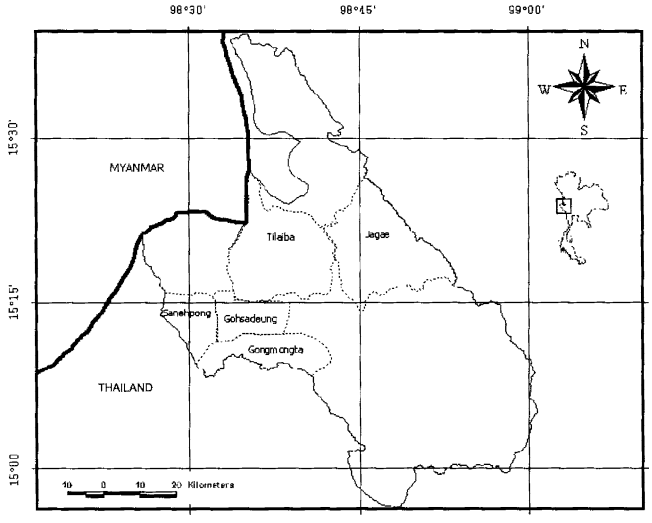

Figure 1. Map of western Thung Yai Naresuan Wildlife Sanctuary (thin solid line), showing village zones (dotted lines) in which local people subjectively assessed trends in wildlife abundance.

National law forbids habitation in wildlife sanctuaries, and the Karen have been threatened with relocation from Thung Yai since its establishment in 1974. Relations between the Karen and Thung Yai authorities have alternated between periods of avoidance and conflict. Most management activity to date has focused on constricting the practice of swidden farming, which is commonly viewed by outsiders as environmentally destructive. Swidden fields and the resulting secondary forest covered 4% of the sanctuary in the early 1990s (Nakhasathien & Stewart-Cox 1990). Since then, many families have abandoned swiddens in favor of cultivation of wet rice, and swidden availability remains high (M. Bey, personal communication). Over the past 20–30 years, commercial poaching of large mammals has become prevalent in the sanctuary in response to outside market demand for meat, hides, trophies, and medicine. Poaching is conducted mostly through organized networks of urban Thai traders who hire hunters from surrounding villages in Thailand and Myanmar.

Methods

Building Bridges

Karen villagers and Thung Yai officials tended to avoid and distrust each other. Bridges between them are needed if they are to cooperate to protect wildlife. We used five working principles to guide bridge building. These are presented here as methods because, in our experience, they prepared local conditions that helped the collaboration proceed.

First, we realized that stakeholders (including the authors) needed practice working together, so we did not attempt to institute a preplanned scheme of collaborative management. Instead, we initiated a learning process directed toward incremental improvement of the status of wildlife. Second, we made values explicit. In village meetings we told the Karen that we intended to revive large mammal populations in Thung Yai and

wanted their help. Acknowledging values strengthens the practice of conservation biology and facilitates constructive relationships even when conflict seems intractable (Barry & Oelschlaeger 1996; Maguire 1996). Third, we proceeded with a small nucleus of about 30 Karen villagers, despite initial apathy by others toward the issue of wildlife decline. Village communities are heterogeneous and dynamic, and the indifference of some members does not devalue the efforts of others. Fourth, we focused on one issue—conservation of mammals. This helped break the quandary of conservation and conflict into smaller, more manageable parts, thus enabling stakeholders to develop solutions to part of a problem at a time (Gray 2003). Fifth, we began to reframe management questions. In general, resource managers in the region tend to ask how can we limit local resource extraction from this protected area? Such a question focuses on a specific and predetermined solution and blocks discussion (Wondolleck & Yaffee 2000). We tried changing the question to how can we respond effectively to shrinking populations of different species of mammals? Thus, we tried to focus stakeholders' interactions on the problem of declining mammal populations rather than on who to blame.

Wildlife Workshops

Collaborative workshops were organized with the intention of (1) combining the knowledge of local woodsmen into an information base about the conservation status of mammals, (2) developing a shared understanding of conservation problems, and (3) identifying opportunities for collaborative action. These events became known locally as wildlife workshops.

Two workshops were conducted, each requiring 2 days. Five villages participated overall. For each workshop, 5–10 elders and hunters from two to three villages were invited as chief participants. Village headmen also participated, and young people were encouraged to come as observers. Two to three rangers from nearby ranger stations and officers from Thung Yai headquarters attended. Thirty-one mammal species were selected for analysis, covering a wide range of body sizes, life history characteristics, habitat preferences, range requirements, and resilience to hunting and disturbance. The list included species sought exclusively by outside poachers for sale (tigers, gaur [*Bos gaurus*]), species killed only for local consumption (porcupines, civets), and species killed by subsistence hunters and outside poachers (leaf monkeys, cervids). Small mammal species were included in the analysis if local woodsmen would be expected to have knowledge of their status (e.g., diurnal squirrels).

Workshops consisted of three parts: wildlife status assessment, impact assessment, and conservation planning. We first mapped the zones to which village groups would refer in their analyses (Fig. 1); these zones matched traditional village territories.

Wildlife Status Assessment

Within each village zone, wildlife status was assessed as a function of magnitude of decline over time. On the basis of our field experience in the sanctuary and discussions with rangers and villagers, it was agreed that there had been no increases among focal species (with the localized exception of wild pigs [*Sus scrofa*]), so workshops focused on declines only. We asked participants to estimate present abundance of each species relative to its abundance 20 years ago (all local participants were over 35 years old).

To accomplish this, species names were written on large charts in the local language. Next to each name were three unfilled circles that participants filled in according to the proportion of the population that remained. For example, species that had not declined were represented by three fully filled-in circles; those completely extirpated were represented by three unfilled circles. Participants separated into village focus groups for this exercise, reviewing individual opinions to reach a consensus on percent decline. Conclusions pertained only to each focus group's zone. We averaged percent decline among village zones to illustrate the overall status of each species in Thung Yai. To compare differences among sites and expose common patterns, a group discussion followed the exercise. Each group was asked to describe the evidence they used in their assessment. The most common were frequency of direct observations of animals and frequency of encounters with signs.

Impact Assessment

Next, we asked participants to identify the processes or events (i.e., impacts) that had caused the population changes for each species. They provided six major impacts: commercial poaching, subsistence hunting, civil war in Myanmar, road building, mining, and hydropower development. The latter three impacts were related historically, so we grouped them into a category called infrastructure development for analysis. Other processes were not considered influential because there was no evidence for their occurrence within the period of analysis (disease, habitat change, severe drought) or because they were in place long before mammal declines began (fire in savanna forest, swidden agriculture). Village focus groups scored the severity of each impact for each species, from zero (no impact) to five (critical impact). As before, analyses pertained to respective village zones and a 20-year time period.

Impact scores were summed first across species, to reveal the most critical impacts overall on wildlife populations, and then across impacts, to derive species-specific scores that showed how severely each species had been affected. An index of hunting intensity was calculated for each species by summing commercial and subsistence hunting scores across village zones. Next, participants

were asked to describe the basis for their scores. These were spatial extent (i.e., localized, widespread), intensity (number of animals killed per unit time), technology (i.e., rifle, musket), and motivation (i.e., profit, food). We referred to these criteria during discussions of results to qualitatively compare the mechanisms by which different impacts affected wildlife. Lastly, participants established a species-specific chronology of the appearance and duration of each impact.

Workshop participants were not provided with prior criteria by which to assess mammal population changes or score threats. The workshop process was approached as an experiment, and we wished to see which criteria would naturally emerge without controlling local peoples' inputs.

Exchange of Knowledge

During the final day of each workshop, we described the international conservation status (e.g., distribution, abundance) of selected species and biological characteristics that affect a species' resilience to disturbance and prospect for population recovery (e.g., gestation length, interbirth interval, estimates of density, and home range size). This scientific information (compiled from the literature) was intended to introduce participants to life history characteristics likely to elude their scales and methods of observation, but that are important to consider in planning for species recovery.

During group discussions, we referred to this information and specific research on mammals in Thung Yai to complement, challenge, or expand on local people's assessments. For example, density of the white-handed gibbon (*Hylobates lar*) in Thung Yai (1.4 groups/km^2) is lower than in an unhunted adjacent sanctuary (Steinmetz & Mather 1996); this difference is likely due to the hunting pressure identified by workshop participants. However, Karen speculations that gibbons flee hunting disturbance through permanent, long-distance movements contradicted scientific understanding of gibbon territorial behavior and their poor dispersal capability. This discrepancy was discussed.

Results

Workshops resulted in a spatially explicit picture of trends in the status of 31 mammal species, covering an area of ~800 km^2. Most species that had declined still retained their historic distribution. The exception was elephants (*Elephas maximus*): large portions of their historical local range were no longer occupied. Status assessments for many species were qualitatively similar among village zones. In each zone, elephants suffered the greatest percent decline among all species (50–100%), whereas populations of some carnivores such as Eurasian otters (*Lutra lutra*), dholes (*Cuon alpinus*), and yellow-throated martens (*Martes flavigula*) experienced minimal decline (Table 1). Muntjacs (*Muntiacus muntjak*) and sambar (*Cervus unicolor*) declined by half to two-thirds in most areas. Declines of other species showed marked differences between village zones. For example, leopards (*Panthera pardus*) were rare in two village areas, but populations remained robust in three others. Mean decline within each of five taxonomic groups was most severe for leaf monkeys (37–38%; primates), porcupines (40%; rodents), tigers (50%; large carnivores), palm civets (43%; small carnivores), and elephants (74%; ungulates).

Commercial and subsistence hunting were the predominant impacts, combining for 79–97% of each village's total impact score (Fig. 2). Other impacts, such as infrastructure development and war, contributed strongly to population decline only for elephants, whose historical wide-ranging movements were severed by these permanent disruptions. Commercial poaching was very severe for tigers (24 of 25 possible points) and Asiatic black bears (*Ursus thibetanus*) (20 points), whereas subsistence hunting contributed little to population declines of these species (4 and 5 points, respectively). In contrast, participants considered that subsistence hunting contributed strongly to population declines of leaf monkeys, muntjacs, and sambar (14–15 points each), though commercial hunting was judged to be the main impact (17–19 points each). Across all species and in every village zone, commercial hunting contributed more heavily to population declines than subsistence hunting (Fig. 2). The least accessible village (Gohsadeung) suffered least from commercial hunting (31% of total impact score), and the most accessible village (Gongmongta) suffered most (76%).

The extent of a species population decline was correlated with hunting intensity (Spearman correlation: $r = -0.87$, $p < 0.001$). The outlier was elephants, whose population suffered additionally from infrastructure development. Hunting was therefore a relatively smaller proportion of the total impact score for elephants than it was for other species.

Impacts were not evenly distributed, so the spatial extent of population declines differed greatly between species. For example, although palm civets and tigers declined by similar percentages in three village zones (Table 1), civet reduction was limited to areas near agricultural fields where they tended to be trapped, whereas tiger reduction was much more widespread.

Older participants provided a chronology of impacts. Prior to the 1970s, there was little outside demand for wildlife products, except elephant ivory and rhinoceros (*Rhinoceros sondaicus*) horn. Beginning about 20 years ago, market demand grew rapidly for trophies such as gaur heads and sambar antlers, and meat of ungulates to supply emerging wildlife restaurants that encircle the sanctuary. These events promoted the expansion of commercial

Table 1. Results of mammal status assessments conducted with local people in Thung Yai Naresuan Wildlife Sanctuary, showing percentages of each species population remaining within five village zones (each 90–300 km^2) compared with those 20 years ago.*

Common name	*Scientific name*	*Sanehpong*	*Gongmongta*	*Goh sa deung*	*Tilai ba*	*Jagae*	*Mean % remaining*
Slow loris	*Nycticebus coucang*	83	100	66	50	83	76.4
Pig-tailed macaque	*Macaca nemestrina*	66	66	100	100	100	86.4
Stump-tailed macaque	*M. arctoides*	66	83	100	66	66	76.2
Assamese macaque	*M. assamensis*	83	66	100	100	83	86.4
Silvered langur	*Semnopithecus cristata*	66	50	66	66	66	62.8
Phayre's langur	*S. phayrei*	data missing	50	66	66	66	62.0
White-handed gibbon	*Hylobates lar*	100	33	100	66	83	76.4
Malayan pangolin	*Manis javanicus*	33	100	100	100	100	86.6
Black giant squirrel	*Ratufa bicolor*	83	66	66	50	83	69.6
Gray-bellied squirrel	*Callosciurus caniceps*	100	100	83	100	100	96.6
Malayan porcupine	*Hystrix brachyura*	83	50	50	66	50	59.8
Bush-tailed porcupine	*Atherurus macrourus*	66	50	66	50	66	59.6
Dhole	*Cuon alpinus*	100	100	100	100	100	100.0
Asiatic black ear	*Ursus thibetanus*	33	50	66	66	66	56.2
Sun bear	*U. malayanus*	50	50	66	66	66	59.6
Yellow-throated marten	*Martes flavigula*	100	83	100	100	100	96.6
Hog badger	*Arctonyx collaris*	100	66	83	83	100	86.4
Eurasian otter	*Lutra lutra*	100	100	100	100	100	100.0
Oriental small-clawed otter	*Aonyx cinerea*	66	100	100	100	100	93.2
Large Indian civet	*Viverra zibetha*	66	66	83	83	83	76.2
Palm civets	*Paradoxurus hermaphroditus, Paguma larvata,* possibly *Arctogalidia trivirgata*	50	33	100	50	50	56.6
Leopard	*Panthera pardus*	33	50	83	100	100	73.2
Tiger	*Panthera tigris*	66	33	50	33	66	49.6
Asian elephant	*Elephas maximus*	0	33	50	33	16	26.4
Asian tapir	*Tapirus indicus*	not present	66	100	100	100	91.5
Eurasian wild pig	*Sus scrofa*	66	50	100	100	83	79.8
Lesser mouse deer	*Tragulus javanicus*	50	66	66	100	83	73.0
Indian muntjac	*Muntiacus muntjak*	33	33	50	66	data missing	45.5
Sambar	*Cervus unicolor*	33	33	50	50	83	49.8
Gaur	*Bos gaurus*	not present	33	50	83	66	58.0
Southern serow	*Naemorhedus sumatraensis*	66	33	66	66	100	66.2

**Trends are based on local observations of changes in encounter frequency with animals and their signs.*

hunting among outsiders and some villagers. Subsistence hunting has remained focused on wild pigs, leaf monkeys, civets, and large rodents.

Collaborative Conservation Planning and Action

The assessment of trends by workshop participants clarified which species were at highest risk of local extinction in Thung Yai, where the most threatened populations were, and the causes for these patterns. Once in place, this new information led to discussions about how to improve the status of wildlife. The final part of each workshop thereby became a collaborative planning exercise, without being proclaimed as such. Karen participants and Thung Yai officials agreed that

(1) they share similar concerns about the declining status of wildlife, wish to face the problem, and recognize the need to work together;
(2) commercial poaching has had the biggest impact historically and is the most pressing current threat;
(3) subsistence hunting is unsustainable for some species (muntjacs, sambar), especially where it overlaps with areas of heavier mortality caused by commercial poaching;
(4) villages should form conservation committees (of elders, active woodsmen, and young people) to participate in future activities and communicate with outsiders;
(5) conservation problems must be addressed on both local and regional scales (e.g., at the regional level, wildlife-meat restaurants outside the protected area have become a major market for ungulates, and inside Thung Yai, managers and local Karen agree that joint patrols be initiated and targeted at poaching hotspots identified in the workshops);
(6) villagers should designate "wildlife recovery zones" as a form of spatial harvest management (McCullough

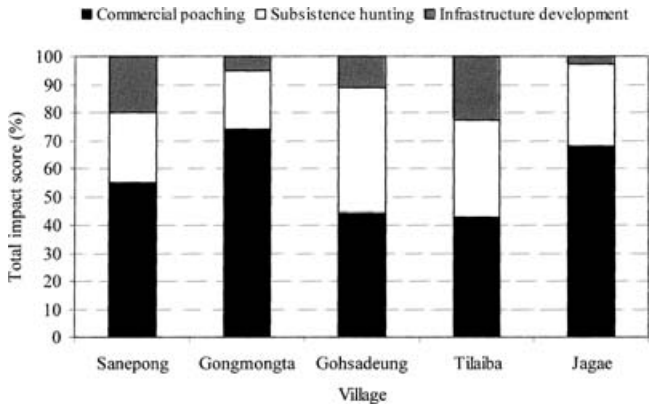

Figure 2. Results of impact assessments from wildlife workshops conducted with local people in Thung Yai Wildlife Sanctuary. Bars show percentage of each village's total impact score (summed across 31 mammal species) attributed to three major types of impacts that have affected mammals over the past 20 years.

1996) to provide a refuge from hunting for ungulates and primates, from which populations can expand to support sustainable subsistence hunting and increase prey density for endangered large carnivores; and

(7) a joint monitoring system to track the distribution and relative abundance of 11 focal species should be established for locally threatened species (e.g., sambar, tigers), whose status we hope to improve, and locally healthy species (e.g., tapirs *Tapirus indicus*), whose positive status we want to preserve.

These ideas were subsequently written into Thung Yai's first collaborative management plan. In the 3 years since wildlife workshops were held, each component has been implemented. Most villages now have officially recognized conservation committees. Two joint monitoring teams have been trained and equipped. They have conducted 12 sign surveys along 250 km of trails, generating information on the status of large carnivores and ungulates, the distribution of poaching activity, and recolonization of one area by elephants. One wildlife recovery zone (30 km^2) has been established and another surveyed. The zone has received increased publicity, management attention, and patrols, and there are fewer reports of either subsistence or commercial hunting in the area. Communication has increased, mostly through quarterly village meetings that protected-area officials now frequently attend.

Discussion

Assessing the status of species and diagnosing causes of their declines (i.e., defining the problem) are essential first steps toward planning for species recovery (Sutherland 2000; Peery et al. 2004). Wildlife workshops are a tool to elicit and synthesize hard-to-find ecological information useful for such planning. They also initiate the intellectual involvement of local people in problem analysis, develop their role and responsibility as management partners, and thus promote collaborative problem solving. Wildlife workshops generate information that is context-specific, accounts for multiple scales, evaluative, and accessible. These are important qualities of "public ecology" that can empower diverse groups to identify mutual conservation goals (Robertson & Hull 2001). The general goals of wildlife workshops—assessing distribution and abundance, identifying priority areas, and building consensus—were similar to other species-conservation workshops, such as for jaguar (*Panthera onca*) (Sanderson et al. 2002). Here, however, the spatial scale was smaller, the temporal scale extended, and local people were included in the plenary of experts. Hess and King (2002) described a conceptually similar approach in the United States, in which expert judgement was applied to a conservation problem characterized by a lack of empirical data, high levels of uncertainty, and the need to act quickly. As with wildlife workshops, this Delphi method provided a common framework in which people of different backgrounds could cooperate on a complex problem (Hess & King 2002).

The strongest indicators of extinction risk for mammals (and birds) are the size of a population and population trend over time (O'Grady et al. 2003). These two parameters are the basis for IUCN criteria used to rank species according to extinction risk on a global scale (Baillie et al. 2004). Evidence used to determine the severity of a declining population (criterion A1, Baillie et al. 2004) includes direct observations, abundance indices, and assessments of exploitation. Wildlife workshops elicit qualitatively similar information, but at the scale of an individual protected area.

The evidence that participants relied on to determine population changes (encounter frequency with animals and their signs) and criteria used to score impacts (spatial extent, intensity, technology, and motivation) were similar in many ways to what biologists would use for such an assessment. For example, the IUCN assesses global threats to birds as a function of three components: timing (i.e., past, continuing, and future), scope (i.e., proportion of population affected), and severity (i.e., magnitude of decline) (Baillie et al. 2004). Impact assessments conducted in Thung Yai encompassed these same components, although not explicitly. Timing was captured in the chronology of impacts that participants outlined. Scope was equivalent to spatial extent, and severity of decline was determined by intensity combined with type of technology. Local people added motivation as a final component. In their opinion, motivation affected both the scope and severity of different forms of hunting.

A powerful approach to diagnosing population declines is to relate their timing to that of environmental change or human impact, but this is obviously impractical without historical data (Sutherland 2000; Peery et al. 2004). Local historical knowledge is an overlooked source of information for this approach; it helps link extant patterns with key historical and ongoing processes. In Thung Yai for example, the simultaneous ascendancy of two types of commercial poaching (meat and trophies) to supply regional markets has influenced most mammals more than any other factor. Understanding the history of ecological systems can help managers interpret previous human impacts (Alagona 2004), establish a frame of reference for assessing current patterns (Swetnam et al. 1999), set realistic management goals (Landres et al. 1999), and prioritize conservation efforts (Patton et al. 1998).

The graphic combination of spatially explicit trend information from wildlife workshops arranges local knowledge in a powerful new way: individual observations aggregate into village-level assessments that in turn combine to illustrate the overall magnitude of changes across the protected area. This new context expands the awareness of local people and becomes a compelling basis for discussions of what to do about impacts—including theirs—because it is generated from their own observations. At the same time, protected-area staff benefit from an expanded temporal and spatial understanding of the status of wildlife in their area.

The conservation assessments elicited in wildlife workshops can be compared with areas outside the protected area as well. For example, by comparing the status of species at local, national, and global levels (Table 2), Karen villagers became aware for the first time of the precarious status of tigers and elephants within Thailand and the region. The downward population trends they identified attain a new relevance when viewed in this context. Positive trends also became apparent. In Thung Yai, some globally threatened species, such as tapirs and dholes, appear locally healthy. As with tigers, Karen villagers (and rangers) were unaware that these species were rare elsewhere. A sense of positive involvement can follow from such comparisons.

Environmental education that bridges spatial scales can inspire confidence to confront local conservation problems. Although people in any one area can do little to improve the global red-list status of a species, they can make a difference for individual populations within their homelands. Local populations are fundamental ecological and conservation units by which a species is saved or lost (Meffe & Carroll 1997; Berryman 2002; Ceballos & Ehrlich 2002) and are sensitive to short-term changes in human behavior (Balmford et al. 2003).

Local Ecological Knowledge

To interact most constructively with local people, biologists need to appreciate the similarities and differences between local and scientific ecological knowledge. Both systems are based on accumulated observations (Berkes et al. 2000), around which hypotheses are formed to explain ecological phenomena (Steinmetz 2000). Local knowledge is part of a complex that includes practice and belief (Berkes et al. 2000), and diverse functions such as resource use, biological monitoring, and ecosystem management may be carried out by the same person. Local knowledge develops less through spatial replication than does scientific knowledge. However, its incremental accumulation and transmission across generations produces special temporal insights, for example, about the ecological roles of slow, intermittent, or rare processes (e.g., succession and fire) (Steinmetz 1999; Berkes et al. 2000).

There is no way to actually validate local perceptions about past changes. Population trends identified in the workshops were derived from subjective estimates of

Table 2. Comparison of conservation status of selected mammals at local (Thung Yai Naresuan Wildlife Sanctuary), national, and global spatial scales.

Species	*Global status (Baillie et al. 2004)*	*Thailand status (OEPP 1996)*	*Thung Yai status* (this study)*
Pig-tailed macaque	vulnerable	not threatened	little threatened
Assamese macaque	vulnerable	endangered	little threatened
Phayre's langur	not threatened	vulnerable	threatened
White-handed gibbon	lower risk–near threatened	vulnerable	little threatened
Dhole	vulnerable	vulnerable	little threatened
Asiatic black bear	vulnerable	vulnerable	threatened
Tiger	endangered	vulnerable	very threatened
Asian elephant	endangered	endangered	very threatened
Asian tapir	vulnerable	endangered	little threatened
Wild pig	not threatened	not threatened	little threatened
Sambar	not threatened	not threatened	very threatened
Gaur	vulnerable	not threatened	threatened

**Thung Yai status is based on the average of village trend assessments conducted in wildlife workshops (see Table 1): little threatened, >75% remaining; threatened, 50–75% remaining; very threatened, <50% remaining.*

relative abundance at different points in time. Such estimates have an unknown relationship to true population size and suffer from an unknown bias (Wehausen 1999), but can roughly indicate gross changes in population status (e.g., Wikramanayake et al. 1998; Greenburg & Droege 1999). Local knowledge is thus a valuable complement to data derived from biological surveys and research, especially when generated by people familiar with local conditions (Caughley 1977).

In Thung Yai, the criteria that local woodsmen used to assess changes were empirical observations that are familiar to biologists in the region—frequency of encounters with animals and their signs. This is a commonly used metric by local people in Southeast Asia (personal observation). Wildlife workshops relied on village focus groups composed of woodsmen with experience within a defined spatial area. This arrangement allowed participants to cross-check themselves and come to general agreement, thus mitigating subjectivity arising from different levels of observer skill and memory.

Ingredients for Success

Wildlife workshops resulted in action to improve the status of wildlife in Thung Yai. Why did these positive outcomes arise? And why were the Karen interested in working with sanctuary staff after decades of conflict? The answers to these questions are related and apply widely to other protected areas and ethnic groups in Southeast Asia.

The Karen regard Thung Yai as their home and do not separate wildlife conservation from perceived political and moral rights to participate in decision making there. Similar perspectives—of social justice, cultural survival, and sense of place—are held by local people in many places of concern to conservation biologists (Borrini-Feyerabend 1999). The Karen are accustomed to being accused of causing problems but not being invited to define or solve them. When this imbalance shifted, many came forward to participate in an opportunity they believed they deserved all along (Yehmyah, personal communication).

Stakeholders may be unable to collaborate without successful examples that demonstrate an approach and build their confidence to act (Fisher 2001). Many Karen villagers resent (what they consider) the intrusion of outside poachers, and are concerned about localized effects of their own subsistence hunting, but feel powerless to address these issues. At the same time, Thung Yai staff are sometimes discouraged because the magnitude of problems seem to overwhelm their capacity. Prior to wildlife workshops, we sponsored four Karen-ranger expeditions to break the inertia resulting from the situation and develop a history of joint fact-finding. Confidence to come together more formally in workshops may have grown through these activities. The strongest demonstrations of success have been the outcomes of wildlife workshops themselves. The initiation of joint patrolling, for example, has inspired two additional villages to request assistance to start similar activities. Also, concern has grown among previously indifferent or antagonistic village headmen, who now take time to discuss species population changes even though it is not their first priority.

The involvement, persistence, and 6-year time commitment of a third party (in this case, a nongovernmental organization) were instrumental. Where mistrust and conflict predominate, and communication has broken down, a third party is often necessary to bring stakeholders together (Gray 2003). Protected-area managers and local people may have difficulty visualizing collaborative wildlife conservation, because there are few working examples. Wildlife workshops are likely to be most successful where local people have a long history in the area and a strong stake in the shape of their relationship with protected-area authorities. In fact, this is the case for many protected areas in Southeast Asia, although local peoples' initial reasons to participate will vary. For example, unlike the Karen in Thung Yai (motivated mainly by perceived moral right and sense of place), some local communities in Lao People's Democratic Republic participated in joint activities mainly to be accepted as legitimate stakeholders in the protected area (Steinmetz 2000). The approach we outline may be least successful where local people have recently migrated to an area because they are likely to have only a vague understanding of historical trends (Nyhus et al. 2003).

Conclusion

The collaborative planning and joint activities that emerged from wildlife workshops have generated wide interest within village society and have been noticed by national-level conservation officials. Conflict between local people and Thung Yai authorities has not disappeared, especially regarding agriculture, but there is fresh confidence to work together on wildlife issues. For example, the superintendent of the sanctuary has conferred with village conservation committees about the historical role of fire in structuring wildlife habitats, and villagers more openly discuss their subsistence hunting patterns with sanctuary staff.

The problem of declining wildlife populations in Southeast Asia is being confronted through economic incentives, education and awareness campaigns, buffer-zone management, and law enforcement, among other measures. New partnerships are also required, in which local people, protected-area staff, and conservation biologists cooperate in problem solving based on shared knowledge, despite their different backgrounds and motivations. Approaches that incorporate local peoples' historical perspective and ecological knowledge, such as the

wildlife workshops described here, generate a shared conservation assessment that leads to better planning. Most important, the process of engaging local people unearths previously unrecognized common ground, builds a local constituency more aware of its role in the protected area, and promotes collaborative action that large mammals in Southeast Asia need.

Acknowledgments

We thank P. Sawetmelanon and E. Chuengsaat, previous and current superintendents of Thung Yai Naresuan Wildlife Sanctuary, for their effort and collaboration in this project. We thank M. Bey, M. Tu-u, and other Karen participants for their hard work and joyful spirit. We thank the rangers of Thung Yai for working against odds to protect wildlife. We thank the Department of National Parks, Wildlife, and Plant Conservation for their support. We thank J. Parr, J.L.D. Smith, and two anonymous reviewers for comments that greatly improved the final version of this paper.

Literature Cited

Alagona, P. S. 2004. The ghosts of endangered species past: recent lessons at the intersection of history and biology. BioScience **54:**984–985.

Baillie, J. E. M., C. Hilton-Taylor, and S. N. Stuart, editors. 2004. 2004 IUCN red list of threatened species: a global species assessment. World Conservation Union, Gland, Switzerland, and Cambridge, United Kingdom.

Balmford, A., R. E. Green, and M. Jenkins. 2003. Measuring the changing state of nature. Trends in Ecology & Evolution **18:**326–330.

Beltran, J., editor. 2000. Indigenous and traditional peoples and protected areas: principles, guidelines, and case studies. World Conservation Union, Gland, Switzerland.

Berkes, F. 2004. Rethinking community-based conservation. Conservation Biology **18:**621–630.

Berkes, F., J. Colding, and C. Folke. 2000. Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications **10:**1251–1262.

Barry, D., and M. Oelschlaeger. 1996. A science for survival: values and conservation biology. Conservation Biology **10:**905–911.

Berryman, A. A. 2002. Population: a central concept for ecology. Oikos **97:**439–442.

Borrini-Feyerabend, G. 1999. Collaborative management of protected areas. Pages 224–234 in S. Stolton and N. Dudley, editors. Partnerships for protection: new strategies for planning and management for protected areas. Earthscan Publications, London.

Carey, C., N. Dudley, and S. Stolton. 2000. Squandering paradise? The importance and vulnerability of the world's protected areas. World Wide Fund for Nature, Gland, Switzerland.

Caughley, G. 1977. Analysis of vertebrate populations. John Wiley & Sons, New York.

Ceballos, G., and P. R. Ehrlich. 2002. Mammal population losses and the extinction crisis. Science **296:**904–907.

Clark, T. W., D. J. Mattson, R. P. Reading, and B. J. Miller. 2001. Interdisciplinary problem solving in carnivore conservation: an introduction. Pages 223–240 in J. L. Gittleman, S. M. Funk, D. Macdonald, and R. K. Wayne, editors. Carnivore conservation. Cambridge University Press, Cambridge, United Kingdom.

Desai, A. A., and Lic Vuthy. 1996. Status and distribution of large mammals in eastern Cambodia. World Conservation Union /Flora and Fauna International/World Wildlife Fund Large Mammal Conservation Project, Phnom Penh, Cambodia.

Dinerstein, E., E. Wikramanayake, J. Robinson, U. Karanth, A. Rabinowitz, D. Olson, T. Mathew, P. Hedao, and M. Conner. 1997. A framework for identifying high priority areas and actions for the conservation of tigers in the wild. World Wildlife Fund and Wildlife Conservation Society, Washington, D.C.

Duckworth, J. W., and S. Hedges. 1998. A review of the status of tiger, Asian elephant, gaur and banteng in Vietnam, Lao, Cambodia and Yunnan Province (China), with recommendations for future conservation action. World Wide Fund for Nature Indochina Program, Hanoi, Vietnam.

Duckworth, J. W., R. E. Salter, and K. Khounboline. 1999. Wildlife in Lao PDR: 1999 status report. World Conservation Union, Wildlife Conservation Society, Center for Protected Areas and Watershed Management, Ventiane, Lao People's Democratic Republic.

Fisher, R. J. 2001. Experiences, challenges, and prospects for collaborative management of protected areas: an international perspective. Pages 81–97 in L. E. Buck, C. C. Geisler, J. Schelhas, and E. Wollenberg, editors. Biological diversity: balancing interests though adaptive collaborative management. CRC Press, Boca Raton, Florida.

Gadgil, M., P. Olsson, F. Berkes, and C. Folke. 2003. Exploring the role of local ecological knowledge in ecosystem management: three case studies. Pages 189–209 in F. Berkes, J. Colding, and C. Folke, editors. Navigating social-ecological systems: building resilience for complexity and change. Cambridge University Press, Cambridge, United Kingdom.

Gray, B. 2003. Framing of environmental disputes. Pages 11–34 in R. J. Lewicki, B. Gray, and M. Elliott, editors. Making sense of intractable environmental conflicts: concepts and cases. Island Press, Washington, D.C.

Greenberg, R., and S. Droege. 1999. On the decline of the rusty blackbird and the use of ornithological literature to document long-term population trends. Conservation Biology **13:**553–559.

Griffon, P. B., and M. B. Griffon. 2000. Agta hunting and sustainability of resource use in northeastern Luzon, Philippines. Pages 325–335 in J. G. Robinson and E. L. Bennett, editors. Hunting for sustainability in tropical forests. Columbia University Press, New York.

Hess, G. R., and T. J. King. 2002. Planning open spaces for wildlife I. Selecting focal species using a Delphi survey approach. Landscape and Urban Planning **58:**25–40.

Johnson, A., P. Igag, R. Bino, and P. Hukahu. 2001. Community-based conservation area management in Papua New guinea: adapting to changing policy and practice. Pages 351–368 in L. E. Buck, C. C. Geisler, J. Schelhas, and E. Wollenberg, editors. Biological diversity: balancing interests though adaptive collaborative management. CRC Press, Boca Raton, Florida.

Landres, P. B., P. Morgan, and F. J. Swanson. 1999. Overview of the use of natural variability concepts in managing ecological systems. Ecological Applications **9:**1179–1188.

Lovejoy, T. E. 2004. Dreaming the impossible. Conservation Biology **18:**1465.

Lynam, A. J. 2003. A national tiger action plan for the Union of Myanmar. Myanmar Forest Department and Wildlife Conservation Society, International Program, New York.

Lynam, A. J., K. Kreetiyutanont, and R. Mather. 2001. Conservation status and distribution of the Indochinese tiger (*Panthera tigris corbetti*) and other large mammals in a forest complex in northeastern Thailand. Natural History Bulletin of the Siam Society **49:**61–75.

Macdonald, D. W. 2001. Postscript-carnivore conservation: science, compromise and tough choices. Pages 524–538 in J. L. Gittleman, S. M. Funk, D. Macdonald, and R. K. Wayne, editors. Carnivore conservation. Cambridge University Press, Cambridge, United Kingdom.

Maguire, L. A. 1996. Making the role of values in conservation explicit: values and conservation biology. Conservation Biology **10:**914–916.

McCullough, D. R. 1996. Spatially structured populations and harvest theory. Journal of Wildlife Management **60:**1–9.

Meffe, G. K., C. R. Carroll, and contributors. 1997. Principles of conservation biology. Sinauer Associates, Sunderland, Massachusetts.

Nakhasathien, S., and B. Stewart-Cox. 1990. Nomination of the Thung Yai-Huai Kha Khaeng Wildlife Sanctuary to be a UNESCO World Heritage Site. Royal Forest Department, Bangkok, Thailand.

Nooren, H., and G. Claridge. 2001. Wildlife trade in Laos. The end of the game. Netherlands Committee for IUCN, Amsterdam.

Nyhus, P. J., Sumianto, and R. Tilson. 2003. Wildlife knowledge among migrants in southern Sumatra, Indonesia: implications for conservation. Environmental Conservation **30:**192–199.

OEPP (Office of Environmental Policy and Planning). 1996. The status of biological resources in Thailand. Ministry of Science, Technology, and Environment, Bangkok, Thailand.

O'Grady, J. J., D. H. Reed, B. W. Brook, and R. Frankham. 2003. What are the best correlates of predicted extinction risk? Biological Conservation **118:**513–520.

Oli, K. P., editor. 1999. Collaborative management of protected areas in the Asian region. World Conservation Union, Kathmandu, Nepal.

Patton, T. M., F. J. Rahel, and W. A. Hubert. 1998. Using historical data to assess changes in Wyoming's fish fauna. Conservation Biology **12:**1120–1128.

Peery, M. Z., S. R. Beissinger, S. H. Newman, E. B. Burkett, and T. D. Williams. 2004. Applying the declining population paradigm: diagnosing causes of poor reproduction in the Marbled Murrelet. Conservation Biology **18:**1088–1098.

Poffenberger, M., editor. 1998. Stewards of Vietnam's upland forests. Asia Forest Network, Berkeley, California.

Poiani, K. A., B. D. Richter, M. G. Anderson, and H. E. Richter. 2000. Biodiversity conservation at multiple scales: functional sites, landscapes, and networks. BioScience **50:**133–146.

Prayurasiddhi, T., S. Chaiwatana, and S. Naporn. 1999. Forest complexes in Thailand (in Thai). Royal Forest Department, Bangkok, Thailand.

Rabinowitz, A. 1999. The status of the Indochinese tiger: separating fact from fiction. Pages 148–165 in J. Seidensticker, S. Christie, and P. Jackson, editors. Riding the tiger: tiger conservation in human-dominated landscapes. Cambridge University Press, Cambridge, United Kingdom.

Redford, K. H., and S. E. Sanderson. 2000. Extracting humans from nature. Conservation Biology **14:**1362–1364.

Robertson, D. P., and R. B. Hull. 2001. Beyond biology: toward a more public ecology for conservation. Conservation Biology **15:**970–979.

Robichaud, W., C. W. Marsh, S. Southammakoth, and S. Khounthikoummane. 2001. Review of the national protected area system in Lao PDR. Lao-Swedish Forestry Programme, Department of Forestry, Vientiane, Lao People's Democratic Republic.

Salafsky, N., H. Cauly, G. Balachander, B. Codes, J. Parks, C. Margoluis, S. Bhatt, C. Encarnacion, D. Russell, and R. Margoluis. 2001. A systematic test of an enterprise strategy for community-based biodiversity conservation. Conservation Biology **15:**1585–1595.

Sanderson, E. W., K. H. Redford, C. B. Chetkiewicz, R. A. Medellin, A. R. Rabinowitz, J. G. Robinson, and A. B. Taber. 2002. Planning to save a species: the jaguar as a model. Conservation Biology **16:**58–72.

Sayer, J. A. 2001. Learning and adaptation for forest conservation. Pages 69–80 in L. E. Buck, C. C. Geisler, J. Schelhas, and E. Wollenberg, editors. Biological diversity: balancing interests though adaptive collaborative management. CRC Press, Boca Raton, Florida.

Sillero-Zubiri, C., and M. K. Laurenson. 2001. Interactions between carnivores and local communities: conflict or coexistence? Pages 282–312 in J. L. Gittleman, S. M. Funk, D. Macdonald, and R. K. Wayne, editors. Carnivore conservation. Cambridge University Press, Cambridge, United Kingdom.

Sodhi, N. S., L. P. Koh, B. W. Brook, and P. K. L. Ng. 2004. Southeast Asian biodiversity: an impending disaster. Trends in Ecology & Evolution **19:**654–660.

Srikosamatara, S., and V. Suteethorn. 1994. Wildlife conservation along the Thai-Lao border. Natural History Bulletin of the Siam Society **40:**1–47.

Srikosamatara, S., and V. Suteethorn. 1995. Populations of gaur and banteng and their management in Thailand. Natural History Bulletin of the Siam Society **43:**55–83.

Steinmetz, R. 1999. The ecological science of the Karen in Thung Yai Naresuan Wildlife Sanctuary, western Thailand. Pages 84–105 in M. Colchester and C. Erni, editors. Indigenous peoples and protected areas in south and southeast Asia. International Working Group for Indigenous Affairs, Copenhagen, Denmark.

Steinmetz, R. 2000. Ecological surveys, monitoring, and the role of local people in protected areas of Lao PDR. International Institute for Environment and Development, London.

Steinmetz, R. 2004. Gaur (*Bos gaurus*) and banteng (*B. javanicus*) in the lowland forest mosaic of Xe Pian Protected Area, Lao PDR: abundance, habitat use, and conservation. Mammalia **68:**141–157.

Steinmetz, R., and R. Mather. 1996. Impact of Karen villages on the fauna of Thung Yai Naresuan Wildlife Sanctuary: a participatory research project. Natural History Bulletin of the Siam Society **44:**23–40.

Sutherland, W. J. 2000. The conservation handbook, research, management, and policy. Blackwell Science, Oxford, United Kingdom.

Swetnam, T. W., C. D. Allen, and J. L. Betancourt. 1999. Applied historical ecology: using the past to manage for the future. Ecological Applications **9:**1189–1206.

Wehausen, J. D. 1999. Rapid extinction of mountain sheep populations revisited. Conservation Biology **13:**378–384.

Wikramanayake, E. D. et al.. 1998. An ecology-based method for defining priorities for large mammal conservation: the tiger as case study. Conservation Biology **12:**865–878.

Wondolleck, J. M., and S. L. Yaffee. 2000. Making collaboration work: lessons from innovation in natural resource management. Island Press, Washington, D.C.

WRI (World Resources Institute). 2004. Biodiversity and protected areas—Cambodia. WRI, Washington, D.C. Available from http://earthtrends.wri.org/country_profiles (accessed October 2004).