



The environmental history of Chatthin Wildlife Sanctuary, a protected area in Myanmar (Burma)

Myint Aung^a, Khaing Khaing Swe^a, Thida Oo^a, Kyaw Kyaw Moe^a, Peter Leimgruber^b,
Teri Allendorf^c, Chris Duncan^d, Chris Wemmer^{b,*}

^aChatthin Wildlife Sanctuary Headquarters, Kanbalu, Sagaing Division, Myanmar

^bConservation and Research Center, 1500 Remount Center, Front Royal, VA 22630, USA

^c110 Elm St., Mazomanie, WI 53560, USA

^dDepartment of Anthropology, Smithsonian Institution, National History Museum, MRC 112, 10th and Constitution Ave., NW, Washington, DC 20560, USA

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Abstract

We reconstructed the history of Chatthin Wildlife Sanctuary (CWS) to understand how social and economic events, and policy changes affected the sanctuary's condition. We surveyed 25 villages surrounding CWS to evaluate past and present ecological conditions, compare the results with historical accounts and identify causal relationships. During the first half of the 20th century, the primary threat was the government's reduction of old growth forest to supply fuel wood for the British-built railway. The railroad opened the area to colonization, but the villagers' impact on timber and wildlife was low. From 1945 to 1988, villagers became the primary force of landscape degradation. The post-war windfall of firearms increased hunting pressure, and populations of large mammal started to decline. With the economic decline of the 1970s and 1980s, the community's demand for game and forest products intensified, and the large mammal fauna was reduced from eleven to four species. From 1988–2003, the forests surrounding the sanctuary were fragmented and degraded. The absence of large predators rendered the park safe for livestock, and the combined effects of grazing and removal of forest products seriously degraded habitat within CWS. Major threats to CWS during the past two decades have resulted from land use decisions in which government-planned economic enterprises caused encroachment by villagers. Stabilization and recovery of this sanctuary will require management compatible with human needs, including expanded buffer zones, better core area protection, community forestry projects, and probably relocation of villages within the park.

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1. Introduction

There is an ongoing discussion about the role of protected areas in conserving biodiversity and addressing social needs (Wells et al., 1992; Brandon et al., 1998), but assessments of protected areas often ignore past events that shaped current conditions (Brunner et al., 2001; Rao et al., 2002). This is especially true of older parks in the developing world. Social and economic events, often resulting from policy, drive the engine of human use that degrades protected areas. While historical ecological

changes may be pronounced, these may be forgotten in only a few generations, and the resultant reductions in biodiversity mistakenly accepted as the status quo (Jackson et al., 2001).

Myanmar's Chatthin Wildlife Sanctuary (CWS), 241 km NNW of Mandalay, provides an illuminating case study of the dynamics between parks and people, and how historical events ultimately determine the effectiveness of a protected area in fulfilling its purpose. CWS was designated as a wildlife sanctuary in 1941, 22 years after the British set aside the area from reserve and unclassified forests (Salter and Sayer, 1983). It is one of two areas in Myanmar designated to conserve the brow-antlered deer or Thamin (*Cervus eldi thamin*), an endemic species once widespread

* Corresponding author. Address: 6125 Tom's Trail, Magalia, CA 95954, USA. Tel.: +1-530-873-0837.

E-mail address: chindwin@earthlink.net (C. Wemmer).

across Southeast Asia (Wemmer, 1998; McShea et al., 1999). The sanctuary is a fragment of a monsoon dipterocarp ecosystem known locally as indaing (Stamp, 1925). Although the size of original area (269 km^2) has remained unchanged, the large mammal fauna and the forest's composition have been altered significantly. The area is rural, relatively inaccessible to foreigners, and tourism is virtually nil. The Yangon–Myitkyina railway passes within 2 miles of the Sanctuary boundary and is the most reliable means of access. During the dry season CWS can also be reached by a narrow road and dirt track. Bullock carts are the main source of transportation within the sanctuary, where deeply rutted tracks crisscross the landscape.

Myanmar's complex history during the past 175 years can be divided into three periods. The colonial period began in the 1826 when the British annexed the peninsular Tenasserim and the coastal Arakan (Davies, 1949). The British employed the German forester Dietrich Brandis to establish scientific forestry in the India and Burma, and intensive but largely regulated extraction of timber and other natural resources commenced (Hoe, 1956; Bryant, 1997). These activities expanded with the annexation of lower and upper Myanmar after the second and third Anglo-Burmese wars in 1856 and 1886 (Pye, 1969). The administration classified forests and protected areas for human use, and incorporated indigenous practices. The Myanmar nationalist movement arose early in the 20th century, but independence did not come until 1948, which marked the beginning of the second period (1948–1958). This relatively brief interval was one of political power struggles and social unrest. The third period began in 1958 when a caretaker government, which later became the Burma Socialist Programme Party, assumed power under General Ne Win. Growth in agriculture, industry, and trade decelerated during the next 20 years due to a variety of factors, including rigid management systems, and short supplies of fuel and raw materials (see UNDP, 1988). The political crisis of 1988 marked the beginning of the fourth period in which various solutions to economic hardship are being attempted.

We reconstructed the environmental history of CWS to examine how the sanctuary's ecology has been affected by social and economic events, policy changes, and management activities. We hypothesized that the sanctuary has undergone a progressive shift towards degraded forests and a depauperate fauna through time. We also hypothesized that the rates of these environmental changes were accelerated by economic and political events that influenced the density and behavior of the local human population. In the words of Gamez (1991) and Janzen (1992), 'Use it or lose it' is an advisory on how to plan, use and manage biodiversity of natural areas. As our results show, Chatthin Wildlife Sanctuary is a protected area where use proceeded without planning and management.

2. Background and methods

2.1. Chatthin wildlife sanctuary—characteristics and location

CWS lies at the northern edge of the central dry zone of Upper Myanmar and is named after the adjacent village of Chatthin, a railroad station along the Yangon–Myitkyina railway (Fig. 1A). Situated within the rain shadow of the Chin Hills to the west, the area is characterized by a cool dry season (October–January), a hot dry season (February–May) and a monsoon season (June–September), when most of the average annual rainfall ($\sim 0.4 \text{ m}$) occurs. During the monsoon, about 60% of the sanctuary is flooded, particularly the low-lying areas adjacent to creeks (or chaungs). During the dry season, these same areas become extensive grasslands, and the chaungs are reduced to dry beds and a few isolated pools. There are three permanent bodies of water: the Mu River, located near CWS's eastern boundary and draining into the Irrawaddy; its tributary, the Daung Yu Chaung; and the Kye-in, a 485-ha impoundment created by the British prior to World War II (Fig. 1B).

CWS has a flat to gently undulating topography with an average elevation of about 200 m (UNDP/FAO, 1983). The soil is alluvial sands and gravels, mixed with sandstones (Chibber, 1933). The indaing forest is dominated by *in* (*Dipterocarpus tuberculatus*), a slow-growing, large-leaved, deciduous hardwood. Other dominant species include ingyin (*Pentacle suavis*), taukkyan (*Terminalia tomentosa*), and thitsi (*Melanorrhoea usitata*) (Stamp, 1925). The sanctuary is largely a matrix of second-growth forest scattered with grasslands. Tall khaing grasses (*Saccharum* spp.) dominate the areas around water holes, whereas shorter thekke/thamin-mwe grasses dominate the seasonally flooded forest. Fires are especially common from January to March. CWS lies in Myanmar's principal agricultural region, and people have used and farmed the area for centuries. Croplands and degraded forests occur along the sanctuary boundaries. Presently, 34 villages (3045 households) border the sanctuary, and three villages (269 households) are located within its boundaries.

2.2. Chatthin wildlife sanctuary history

We reconstructed the history of Chatthin Wildlife Sanctuary by using villagers, sanctuary staff, village headman, and local economic and political leaders as primary sources. This information was supplemented with the senior author's first-hand knowledge of the sanctuary's recent past, which he accumulated over the past 9 years as the CWS warden. Secondary sources of information are published accounts about Burma's landscapes, several of which include information on the region around the sanctuary (White, 1913; Scott, 1921; Stamp, 1933).

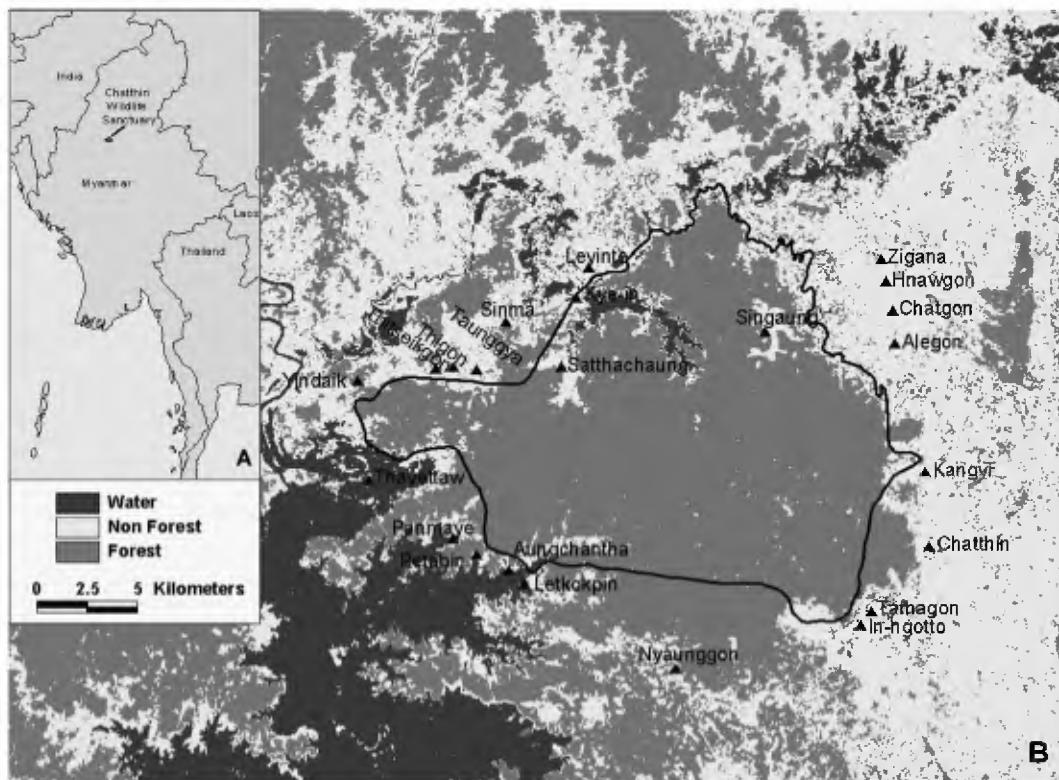


Fig. 1. Location of villages surrounding Chatthin Wildlife Sanctuary at the northern edge of Myanmar's Central Dry Zone.

2.3. Interview-based surveys

We conducted three surveys in 25 villages outside and three villages inside CWS to evaluate our hypotheses, establish and compare historical accounts, and identify probable causal relationships between the sanctuary's past and present ecological conditions (Appendix A). These surveys included: a survey of the historical changes in CWS and its wildlife populations based on interviews with villagers; a survey of wildlife law offenses based on records compiled by CWS staff; and a demographic survey based on interviews with village headmen.

2.4. Historical wildlife survey

To standardize interview procedures for historical wildlife surveys among WCS staff, we conducted trial interviews at Chatthin village and compared the results among the three interviewers, authors KKS, TO, and KKM, who are local school teachers. After correcting inconsistencies, our staff conducted the interviews in Burmese and subsequently translated the results into English. In April and May 2000, we interviewed 230 (176 men, 54 women) villagers from 28 villages about the presence of large mammals and other species suspected to have occurred in the area in the past, based on historic distributions given by Corbett and Hill (1992). All villagers we interviewed had gathered forest products in and around CWS, but only 28 (12%) admitted to hunting in the area. The mean age of

interviewed villagers was 69 ± 9.6 SD years old and ranged from 17–95 years. We interviewed 3–14 people per village, and for each interviewee recorded their name, date and place of birth, their duration of residency in the village, and the years that they visited forests in and around the sanctuary. We queried them about 12 species of vertebrates, including gaur (*Bos gaurus*), banteng (*Bos banteng*), sambar (*Cervus unicolor*), hog deer (*Axis porcinus*), muntjac (*Muntiacus muntjak*), tiger (*Panthera tigris*), leopard (*Panthera pardus*), clouded leopard (*Neofelis nebulosa*), bear (*Ursus thibetanus* or *U. malayanus*), wild dog

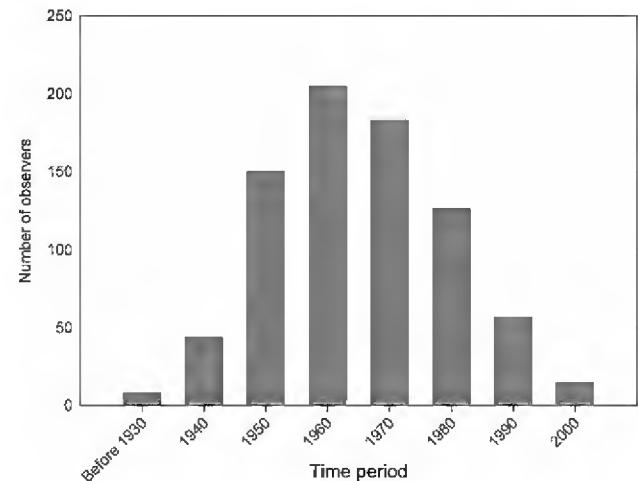


Fig. 2. Number of observers interviewed who visited the forests of Chatthin Wildlife Sanctuary during the past eight decades.

(*Cuon alpinus*), hog badger (*Arctonyx collaris*), and macaque (*Macaca* spp.). We did not ask about the thamin, as its presence is well established. For each species they had seen, we asked the observer their age when they last detected animals in the forest.

Based on birth date and years that the villagers visited the forest, we calculated the number of active observers visiting the forests for 10-year time periods starting in 1911 and ending in 2000 (Fig. 2). We then calculated the percent of the active observers who reported a species to be present during each of the 10-year time periods.

2.5. Demographic survey

In 1994 and 1995, we trained CWS ranger staff to gather demographic statistics from 28 village headmen, who have maintained records on village population, land use, and livestock since 1974. In five villages we were unable to get accurate data on the village population and these villages were excluded from demographic analyses. The State Peace and Development Council (SPDC) requires all headmen to maintain these records, which are based on a count of the number of households. Headmen calculate village population size by multiplying the average number of family members times the number of households.

2.6. Illegal use of sanctuary resources

We consulted CWS patrolling reports (Anonymous, 1993–2001) of Wildlife Division staff maintained at the CWS headquarters in Kanbalu for information about human disturbance, encroachment, and other illegal activities within the sanctuary and its buffer zone. These reports give a general idea of the relative frequency of different forest offences, but are not an accurate record of all illegal activity conducted in the sanctuary.

3. Results

3.1. Chatthin wildlife sanctuary history (1886–2000)

3.1.1. Opening the land: 1886–1945

The Burma Railway Authority began construction of the Yangon to Myitkyina railroad in 1886, in the wake of the third Anglo-Burmese War (1885–1887) and the British annexation of Upper Burma, (White, 1913). Its construction set the stage for the emergence of a chain of villages and supply-stops along the 1600-km route. In 1893, it proceeded through the Mu Valley where CWS is now located, which ‘opened up the fertile land locked plains of Wuntho’ (White, 1913, p. 239). Scott (1921) noted that some thousand square miles of forests were protected east of the Mu River and in the Ye U Subdivision immediately east of the area. Most villages surrounding CWS were established between 1825 and 1930 (Fig. 3). The major period of colonization, however, was the first three decades of the 20th century when fourteen new villages (41%) were established in the vicinity of the Chatthin fuel wood reserve. In 1921 the human population in the 9065 km² of the district was between 31 and 36 people/km² (ibid, and Stamp, 1933).

As early as 1919, the railroad authority relocated a Burmese labor force from large population centers in the vicinity of Sagaing and Mandalay to new settlements along the railway line to supply fuel. The contractor, U Ba Din, held the lease in the Shwebo Division, and established temporary work camps within Chatthin fuel wood reserve for the extraction of wood (U Ba Win, personal communication). These camps developed into the villages of Satthachaung (est. 1919), Singoung (est. 1920), and Kye-in (est. 1923). Around 1925, Singoung consisted of about seven temporary dwellings (Daw Pwa Hmon, pers. comm.). Ten years later it had 30 houses, and the railway had an extraction tram into the forest. The landscape was

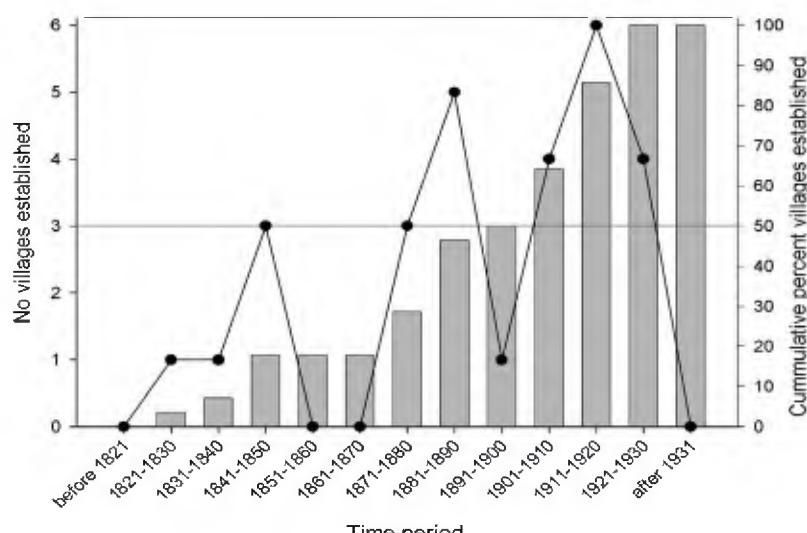


Fig. 3. Village establishment at Chatthin Wildlife Sanctuary. Date of establishment was determined through discussions with village headmen during site visits in 2000.

more extensively forested even as late as the 1930s, with small villages connected by cart tracks (Collis, 1956).

The British disarmed the local people after the third Anglo-Burmese War as a policy of ‘pacification’ (White, 1913), but with the expansion of agriculture and the colonization of the dry zone, guns were licensed for crop protection. Though game was protected at that time by three pieces of legislation (Smith, 1935), some species already were beginning to decline in the area. Evans (1911, p. 149) noted, the thamin “used to be very numerous throughout the dry zone, and though he is still fairly plentiful in certain localities, his numbers have sadly dwindled during the last decade...”. There are no reliable statistics on the large mammal populations of that period, but some species, such as thamin, were already declining, due to the widespread practice among gun owners of lending firearms permitted for crop protection to professional hunters (Collis, 1956; Stebbing, 1962). In 1927, the Imperial Forest Service ordered the control of such firearms, and outlawed lending of guns (Stebbing, 1962). In outposts such as CWS, the Divisional Forest Officer had difficulty enforcing the law because of limited staffing, transportation, and communication.

In 1935, Smith noted that sanctuaries were urgently required to protect thamin in central Burma in the Katha-Shwebo area. In 1936, the Burma Wildlife Protection Act (Union of Myanmar, 1990) gave the species protected status in unclassed forests, meaning that thamin could be hunted only outside of protected areas.

CWS was gazetted in September 1941, and was managed under the Divisional Forest Officer. The Sanctuary headquarters was located on the railroad line in Shwebo, a straight-line distance of about 100 km to the Sanctuary boundary. Three months later the Japanese bombed Rangoon (Yangon). Forestry and wildlife protection halted with the threat of war, and not surprisingly, Forest Department authorities failed to evacuate the villages that had grown from the fuel wood extraction camps created 20 years earlier. By May 1942, the British and allies had been routed, and Japanese forces occupied Burma (Moser, 1978). During the next 3 years of occupation, the Japanese conscripted 5–10 men from each village as laborers, and required a supply of cattle, wood and food for the army (U Ba Han, personal communication). The impact of the war was greater on the local people than it was on wildlife, because people had less time to devote to hunting and gathering (U Ba Win, personal communication).

3.1.2. From post-war years to economic recession 1945–1980

When the war ended, a windfall of firearms and ammunition fell into the hands of villagers. Social unrest and militarization of rival political parties followed independence from British rule in 1947, but the social and economic impact was minimal in the predominantly Burmese ethnic region around Chatthin.

Protected area management was not a priority after Myanmar’s independence, because of economic and institutional difficulties (Aung, submitted). No specific division within the Forest department had oversight of protected area management. The Burma Wildlife Protection Act of 1936 was amended in 1954 to increase protection of wildlife species, but still allowed hunting in forest reserves by permit and did not protect wildlife habitats (Gutter, 2001). We believe that the widespread availability of firearms and the lack of protection allowed villagers to hunt large mammals in the rural areas, and that shooting of large ungulates in particular was unabated between 1945 and the mid-1960s. Forest management resumed in 1955, when the first Game Forester, Saw Phoe Kok, was assigned to CWS wildlife. During the next 17 years, like the Divisional Forest Officer who preceded him, he conducted all patrols on foot, unaided by additional staff.

When the Socialist Party assumed rule in 1962, the government began to confiscate firearms. Although weapons that escaped notice became useless as time passed, the ban was not complete. Additionally, local military authorities in Kawlin Township, west of CWS, issued three rifles to each village as a deterrent to chronic robbery in 1972 (U Hta Ne Soe, personal communication).

3.1.3. Changing land use and increasing pressure on natural resources (1980–1995)

Beginning in the 1980s, the prevailing economic conditions, extant land-use policies, and lax enforcement of wildlife laws adversely affected CWS in several ways. The CWS Game Forester reported an increase in poaching as early as 1982 (Myint, 1982–1987). Three factors seem to have been responsible. First, the market for live and dead thamin increased in China and Thailand. Second, reduced monsoon rainfall in 1983 and 1984 resulted in diminished crop yields. Finally, the national currency was demonetized in 1985 and 1987. Families lost their lifetime savings, and the resulting recession reduced communities to a barter economy throughout the country. This stimulated local hunting of thamin, and precipitated local migration toward CWS. In 1985 and 1986, 35–50 families from the villages of Zigana, Nawgon, Chatgon and Alekon migrated to the banks of Thaw Chaung, a stream on the northeast CWS boundary, and began to cultivate land bordering and within the sanctuary (Myint, 1986, and personal communication).

During this period of escalating threats, Forestry Department began revamping its policies to include conservation activities. In collaboration with the Union of Myanmar, the United Nations Development Programme (UNDP) initiated a Nature Conservation and National Park’s Project in 1980 (Blower, 1980). This project established the Nature and Wildlife Conservation Division (NWCD) within the Forest Department as the unit responsible for nature conservation and protected areas. CWS was among the protected areas accorded priority conservation status, because thamin were still fairly

abundant there, but virtually extinct elsewhere in Southeast Asia (Blower, 1980; Wemmer, 1998). The State Law and Order Restoration Council (SLORC) subsequently issued a new wildlife and protected areas law in 1992 (SLORC, 1994).

SLORC had introduced market economy principles to the country in 1988, and as a result, newly legalized economic ventures began to affect the environment. Due to increasing demand for sugar in China, India and Thailand, the Myanmar Agricultural Enterprise began a campaign in 1987–88 to encourage villagers to plant sugar cane in Kanbalu Township (Soe Tint and Aung Than, personal communication). When the Ministries of Forestry and Agriculture subsequently created the Sugarcane Plantation Enterprise in 1994 to supply sugar to China, the government constructed a factory in Kanbalu Township that employed more than 200 local people. Because sugarcane sold for 2–3 times the price of rice, and other traditional crops, villagers eagerly adopted this new crop. This stimulated a second migration to CWS. Between 1987 and 1994 villagers crossed the Daung Yu Chaung and Thaw Chaung, and, felled approximately 200 ha of timber in the CWS core area to plant sugarcane in the clear cuts (Aung, 1987–1994).

CWS was administered by a succession of six wardens between 1986 and 1995. These ranked from staff officers to Assistant Directors. Because the latter were responsible for administering several parks, their effectiveness in law enforcement was limited by the broad scope of their duties and the small number of staff actually working in CWS. The staffing of CWS grew from 26 in 1980 to 91 personnel in 1992, but by 1994 over 50% of the staff assigned to CWS worked at the headquarters in Kanbalu. The senior author transferred half of the Kanbalu staffers to CWS in 1996. Since then, CWS has had an average of 78 staff members, divided between the headquarters at Kanbalu (25%) and the sanctuary (75%).

When the government requisitioned railroad sleepers for railroad renovation in 1992, the forests within CWS became an inviting source for supplying needed timber for cash. Local merchants established sawmills within CWS, and villagers began harvesting hardwoods exceeding one meter in diameter for both railroad sleepers and domestic consumption. Warden Tin Aung alerted the Minister of Forestry of this situation in 1994, and a month later the local SLORC commander was requested to withdraw all firearms that had been issued to village paramilitary teams in 1972. The SLORC commander then trained CWS law enforcement staff in weapons use, during a two-month training course. Simultaneously, the township court began prosecuting all offenders under the new 1994 wildlife protection law. These actions alerted both local authorities and communities to the warden's awareness of ongoing illegal activities and potential ramifications.

Because resource demands and agricultural conversion by local communities continued to threaten CWS, 13 villages, comprising 110 households and 2273 ha, in the north

and northeast sectors within CWS were relocated. The squatters appealed the decision to the district military court arguing that the three villages already existing within the Sanctuary boundaries set a precedent for settlement. Although the appeal was eventually denied, the Divisional Commander in the interim instructed the headmen of the three internal villages to comply fully with the extant wildlife laws.

In 1998, the current warden requested and received permission from the Ministry of Forestry to designate 5909 ha of reserve forest as a buffer zone for villages in the southern sector. Four months after permission was granted, authorities in the vicinity of Nyaunggone began a welfare project for township employees converting buffer zone lands for agriculture. While this activity ceased upon the orders of the Divisional Commander, the local authorities of Sagaing Division began a search for one million acres of undeveloped land in 2000 for agricultural conversion in response to the State Peace and Development Council (SPDC) Cabinet's initiative to respond to the nation's anticipated food requirements. In June 2000, CWS, and its newly created buffer zone and surrounding reserve forests, were identified as prime sites for agricultural development. The plan was fortunately averted when the Ministry of Forestry announced its opposition to the plan.

CWS was also affected in 1996 by the construction of the Thapanseik Dam on the Mu River for irrigation and electrical power. Although the Mu was located 20 km from the CWS boundary, the project entailed the relocation of 52 villages. Six villages (1225 households) were moved to within 6–9 km of the CWS's southern boundary, and four villages (Panmaye, Ywathit, Aungchantha, and Petabin) were relocated to the western boundary where buffer forest is absent. Although major building materials (i.e. house posts, planking, etc.) were relocated to the new locations, CWS became their only source of forest products and fodder. In August 2001, when the dam's catchment reached its maximum, flooded areas reached within 1 km of CWS's western boundary, reducing its buffer zone by about 300 ha. All electrification irrigation benefits went to neighboring areas.

3.1.4. Foreign assistance-building capacity for long-term protected area management (1995–2000)

In late 1994, the Smithsonian Institution selected CWS for a multi-year ecological study of the thamin, and initiated training courses in ecology and biodiversity inventory methods (Wemmer, submitted). Over the next eight years, 25 specialists conducted nine training courses for staff of CWS and other protected areas. These activities have had a number of unexpected, but beneficial impacts on CWS. By building guard posts and creating various field research teams, the program increased the presence of park staff throughout CWS, and this has deterred poaching and other illegal activities. Ongoing field projects reinforced both the staff's income and work ethic, and the warden's

establishment of a Pagoda Trust also has increased the staff incomes and motivation. Perhaps most importantly, educational activities and community surveys have improved park-people relations while the aforementioned immigration to the area has placed additional pressures on CWS staff and resources.

3.2. Historical wildlife surveys

Our interviews revealed that all of the large mammals included in the survey, except the clouded leopard, were present in the past and declined between the 1940s and the 1980s (Fig. 6). We detected dramatic declines in large mammal species between 1911 and 2000. All of these species were either entirely extirpated from the area or critically endangered by 2000 (Fig. 6A and B). Predator declines coincided with the declines of the prey species.

The four species of medium-sized mammals (hog deer, muntjac, macaque, and wild dog) also showed marked declines, with lowest estimates of presence during the 1970s and 1980s. During the 1990s, these species appear to have recovered in abundance (Fig. 6C).

Few villagers reported sighting bears and hog badgers (Fig. 6D). Corbett and Hill (1992) reported these species in

the region, but their populations were probably scarce because the infauna is atypical of the habitats where these species are found today.

3.3. Demographic surveys

CWS villages have increased in population size since the first censuses in 1989 and 1999 (Fig. 4). The mean population size of villages inside the Sanctuary is smaller than that of villages outside. During the past ten years, however, mean percent growth is significantly higher inside CWS than outside. The higher population growth rates of villages within CWS may be reflect their more ready access to critical resources such as timber for construction, fuel wood, and grazing areas.

The mean size of individual family farms differs considerably between villages, and between regions surrounding and within the Sanctuary (Fig. 5). Villages in the North have significantly larger family farms than villages in the West. The largest family farms (3–8 ha) are located in the northern and eastern sections, and in one village (Singoung) within the sanctuary. Nearly all other farms are less than 4 ha in area.

Rice is the primary food crop of farmers living in and around the sanctuary. The crop is well suited to the setting, and large areas are cultivated as rice paddies. Of the 18 rice varieties cultivated, 16 are wet weather crops, and two varieties (kyaw-hkaw and tit-sain) are most commonly planted. Non-rice crops include maize, sugar cane, and several varieties of groundnuts, which are planted as a source of cooking oil. In the northeastern region of the Sanctuary, sugarcane cultivation is common, and this crop yields much higher income than rice and other crops. In addition, households supplement their diets and on occasion their incomes by planting fruit trees and other plants such as bananas, mango, papaya, tamarind, coconut, vegetables, chili, and assorted medicinal plants. Domestic livestock include cattle, water buffaloes, goats, pigs, chickens, and ducks.

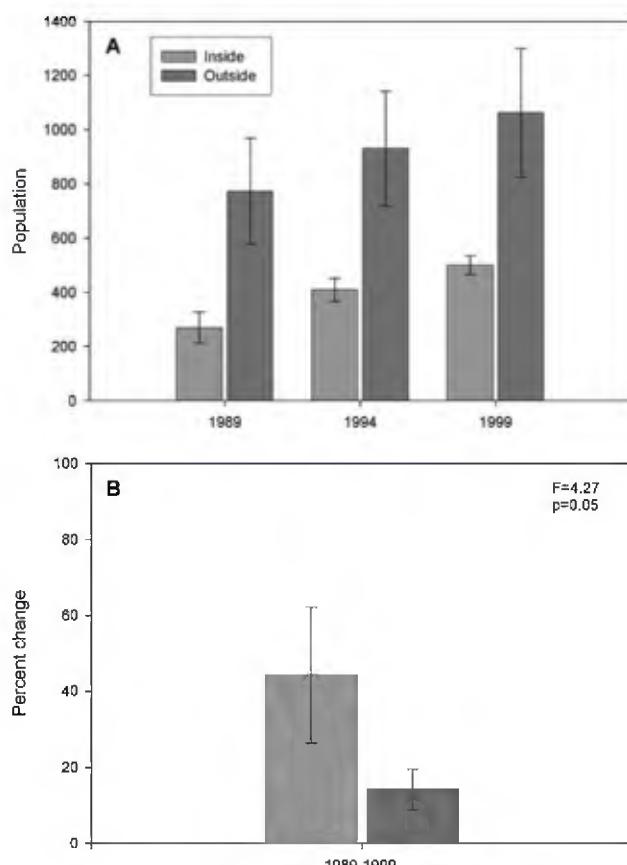


Fig. 4. Mean village population and percent change over a 10-year period at Chatthin Wildlife Sanctuary. (inside = villages within the park; outside = villages outside the park).

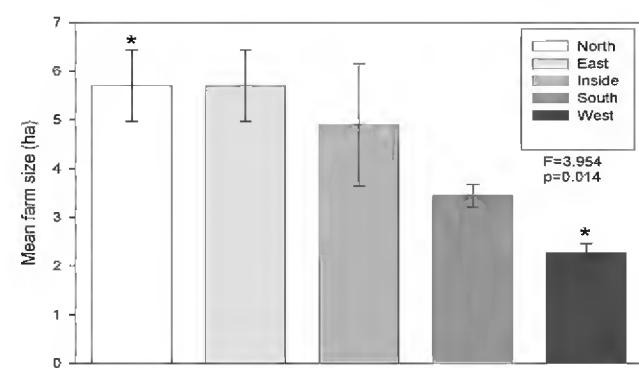


Fig. 5. Mean farm sizes in the four major regions surrounding Chatthin Wildlife Sanctuary and inside the protected area.

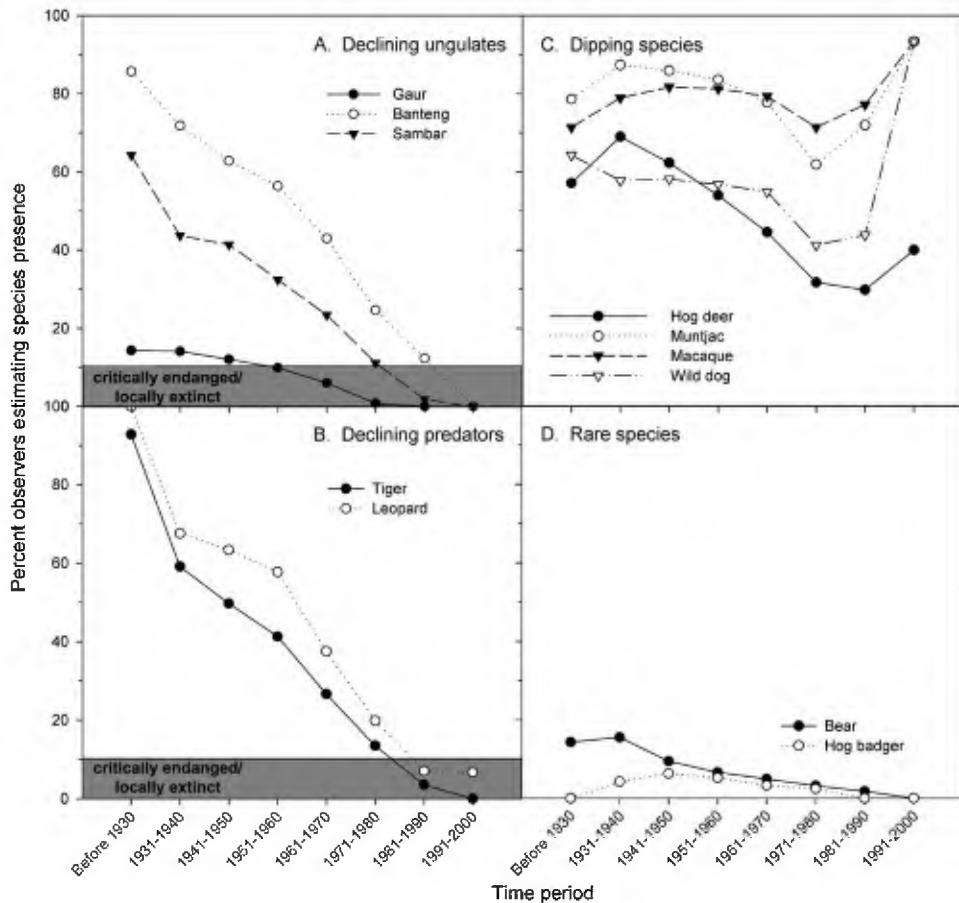


Fig. 6. Decline and plight of mega-vertebrates at Chatthin Wildlife Sanctuary. Based on interviews with 230 local villagers.

3.4. Illegal use of sanctuary resources

Sanctuary staff registered 113 offenses between 1993 and 2000, involving 301 people from 19 villages. Chatthin, the largest village in the vicinity and in close proximity to the Sanctuary's base camp in San Myanng, had the highest number of violations per town. Many staff of CWS have families living in Chatthin, and we believe that the number of offenses in Chatthin is also a function of anti-poaching patrol members being more aware about activities in their own village than other places surrounding the Sanctuary. Single individuals committed most offenses, but as many as 38 villagers participated in one offense. Logging and processing timber within the sanctuary accounted for 72% of the offenses, while poaching game and fish accounted for 11% of the offenses (Fig. 7). Encroachment in the sanctuary resulted in a further 9% of the offenses.

The number of recorded offenses peaked in 1996, shortly after the current warden increased patrolling activities (Fig. 8A). Prior to 1996, few or no illegal activities were recorded. Initially, patrolling had a dramatic effect in depressing offenses, but villagers seemed to adapt to increased patrolling, and offenses increased again and reaching a second peak in 2000.

Seasonal records show that offenses occurred in April through May during the dry hot season, and in September as the monsoon ended (Fig. 8B). Very little poaching was noted during the peak of monsoon in August when farmers tend the paddy crop, and during the cool hot months of December to February, when the harvest takes place.

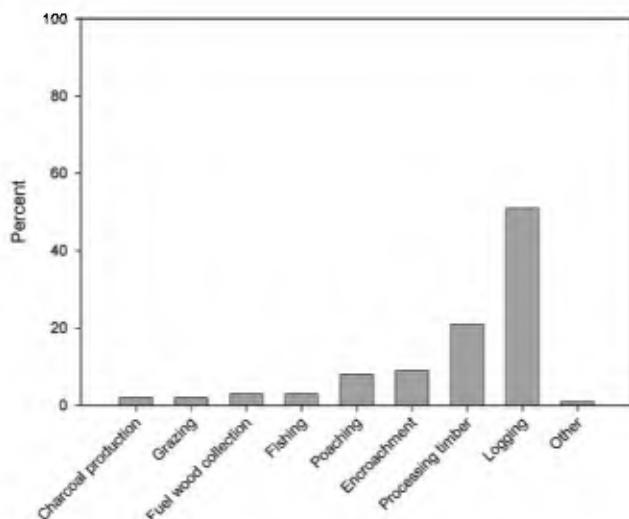


Fig. 7. Percent offenses for different offense categories recorded at Chatthin Wildlife Sanctuary between 1993 and 2001.

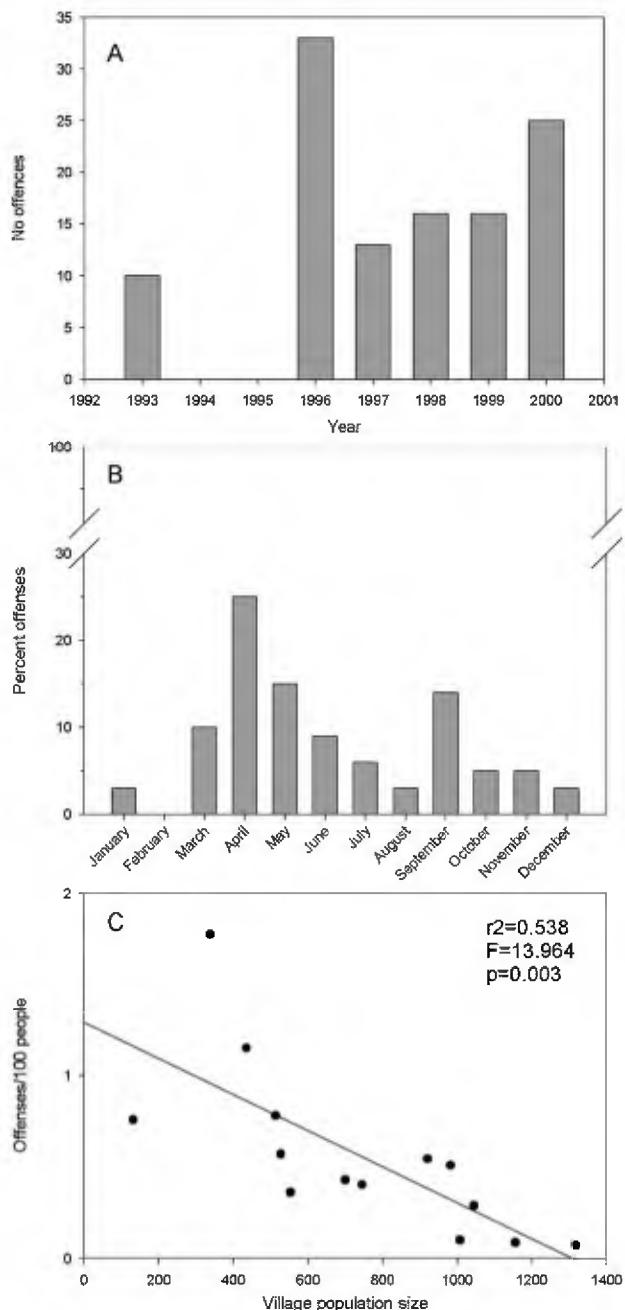


Fig. 8. Annual (A) and monthly (B) patterns of illegal use of Sanctuary resources and the relationship between population size and per capita illegal activities caused by different villages (C).

Per capita offenses are significantly correlated with village population size (Fig. 8C). Smaller villages tend to have fewer agricultural resources and rely more heavily on hunter/gatherer activities leading to a higher per capita offense record. However, while the three villages inside CWS are among the villages with the smallest but fastest growing population, there was insufficient evidence to prove that these villages had a significantly stronger impact on the Sanctuary. The activation of anti-poaching patrols and expanded wildlife research activities in CWS resulted in the apprehension of deer poaching rings from five villages.

4. Discussion

The ecological degradation of what was to become CWS commenced over 100 years ago, when the British constructed the railroad from Yangon to Myitkyina. The impact of the ensuing events on the biodiversity of CWS will never be known completely. The historical evidence seems to confirm our hypothesis that the ecological degradation of CWS proceeded in three stages of increasing intensity. During the first phase (1893–1945), the primary ecological effect was the government's systematic reduction of old growth forest to supply fuel wood for the railway. The railroad opened the area to human colonization, but the villagers' impact on timber and wildlife was relatively low. The extraction of timber evidently did not have an immediate affect on the large mammal fauna, such as carnivores and ungulates, because the villagers had limited access to firearms. Elderly informants assured us that large game was still abundant before the Second World War.

During the second phase (1945–1988), local villagers became the primary force of landscape degradation. The post-war windfall of firearms undoubtedly increased hunting pressure, and large mammal populations started to decline. Smith (1935, p. 168) observed that, "The average villager has always been accustomed to obtain plenty of everything with very little trouble and is quite oblivious of the fact that supplies must soon come to an end unless their use is systematically controlled". Clandestine hunting of game, therefore, likely continued after 1962 when the government confiscated firearms. In addition, the decline of the economy intensified the demand for game meat and forest products for domestic use. In the 1970s and 1980s, the large mammal fauna was reduced from eleven to four species. The last sighting of tiger was reported in 1985, which roughly coincides with the time when the traditional Chinese medicine industry began to seek new sources of tiger products (Hemley and Mills, 1999).

At the beginning of the third phase (1988–2003), the forests surrounding the sanctuary were fragmented and degraded, and CWS had become a true refuge for a remnant community of large mammals. The absence of large predators rendered the park safe for livestock, and the combined effects of grazing and removal of forest products started to seriously degrade habitat within the sanctuary. The major threats to CWS during the past two decades have resulted from economic and land use decisions. A series of government-planned economic enterprises incited regional authorities to challenge the Ministry of Forestry's legal claim to CWS, and caused encroachment by human populations.

In the course of one century, the landscape of CWS changed from a relatively pristine (old growth) forest to a patchwork of degraded second growth forest, the large mammal fauna declined, and a growing human population became a dominating factor of local ecology. During the first 75 years, the ecological changes were reversible.

Restoration of the area is a more formidable task today than it would have been in the past.

CWS was created as a conventional park, and though its landscape was wild, the seeds of change were sowed when the railroad was constructed. Its geographic circumstances-rich farmland, proximity to rail transportation, and ample forests-attracted rural communities in response to government decisions. CWS and nearby reserve forests are critical but vulnerable ecological assets that buffer the effects of the dry season and provide needed resources to the human community. CWS shares these conflicting features with many other parks, and has serious challenges to overcome if it is to survive. As Brandon (1997, p. 425) noted, "...initiating management as a conventional park in the midst of rapid social change presents a more complicated process of park management and is likely to be more intensive (in terms of technical and financial resources) and extensive (in terms of the geographic area and the time required to stabilize the park)". Hart and Hart (1997) observed that in a climate of regional instability, the best insurance for conservation is professional development of national staff and strong site-based conservation programs. The Smithsonian Institution's scientific assistance to CWS allowed the staff to overcome some negative consequences of policy change, but it was inadequate to support major initiatives in park management needed to integrate CWS and the local community.

Our assessment demonstrates the importance of understanding the historical context for protecting CWS and its ecosystems. CWS has undergone dramatic changes, developing from a fuel reserve to a severely degraded protected area that may well be the 'best of the rest'. These developments originated at different levels of authority during different times. Understanding who are the drivers behind social and ecological change and their motivations for initiating change is essential to developing effective protected area management strategies (Christen, 1995; Brandon et al., 1998). These management strategies must take into account the rural-agricultural context of CWS and the needs of local communities. They also need to be rooted in a clear understanding of the political and administrative context and knowledge of the appropriate channels to increase authority of park staff in the management of CWS resources. The Smithsonian Institution's projects at CWS have been instrumental in many of these processes and have helped to underline the importance of these issues but much remains to be done.

Protecting CWS as a wildlife sanctuary will depend on making it compatible with human needs, and this will require significantly expanded buffer zones, better protection of the core area, community forestry projects to supply village needs, and probably relocation of the three villages within the park. Integrating community development with park management is also necessary to secure CWS and the ecosystem services it provides to the human population. This is an area in which the wildlife division has limited experience,

and policy on integrated development is only vaguely embodied in existing law within different government sectors. Lastly, there is a compelling need for integrated land use planning among ministries. Regional authorities have been successful in aborting a number of illegal actions, but coordinated planning would be more effective in preventing assaults on CWS's ecology for development. In the absence of better coordination between ministries, successful efforts to stabilize relations between the park and the community will be at risk.

To gain local support for natural resource conservation, the Ministry of Forestry should encourage experimental co-management of buffer zones by parks and local communities. If successful, such programs could attract foreign support. In this connection, eco-tourism, a much-vaunted solution to a variety of complex environmental issues merits discussion. With the demise of large mammals, CWS lost much of its potential appeal to foreign tourists. Nonetheless, it is still an excellent venue for birding, particularly during the dry season when a large number of migrants, including significant numbers of waterfowl, complement the nearly 300 resident species. It also remains a window on the Burmese agrarian lifestyle with its traditional connections to the natural landscape for foods and materials. The development of comfortable family-based housing on a small scale could supplement local income in response to limited infrastructure, and the absence of tourist lodges. The wildlife studies of the area could also prove an asset by allowing tourists to see secretive wildlife, such as radio-collared thamin, and providing knowledgeable nature guides.

5. Conclusions

Chatthin Wildlife Sanctuary, a degraded fragment of a formerly extensive landscape is representative of many protected areas in South and Southeast Asia. The history of its environmental change began over a hundred years, before it was protected as a fuel wood reserve for the Rangoon to Myitkyina railway. Human colonization of the area during the first three decades of the 1900s did not affect the large mammal populations in any major way, and in 1941 the area was designated as a wildlife sanctuary. The widespread availability of firearms following WWII gave villagers a particularly effective means to hunt wildlife. Even so, the large mammal species did not begin to disappear until the 1980s, 20 years after Socialist Party rule. During these conditions of dire economic decline and despite firearm control, villagers found the means to hunt game, and the large mammal community was reduced from eleven to four species. By the 1990s, the forests surrounding CWS were fragmented and degraded, which created greater dependence on the park for forest products. Major threats to CWS during the past two decades have resulted from economic and land use

decisions, including economic enterprises that incited regional authorities to challenge the Ministry of Forestry's legal claim to CWS. The future of CWS, and other similar parks in Myanmar will depend on implementing innovative practices and new policies, and addressing the needs of human communities.

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Appendix A

Table A1

Overview of information collected for each village

Village name	Village establishment	Inside sanctuary	Historical wildlife survey	Number of historical wildlife interviews	Farm survey	Violations
Gwetauktaw	1915	x	8	x	1	
Zigana	1930	x	10	x	1	
Hnawgon	1910	x	9	x	3	
Chatgon	1890	x	7	x	—	
Alegon	1840	x	10	x	—	
Lwingyi	1910	x	4	x	—	
Paukseingon	1910	x	7	x	3	
Kangyi	1890	x	8	x	1	
Chatthin	1850	x	14	x	11	
Tamagon	1910	x	6	x	6	
Magyigon	1928	x	10	x	—	
In-ngoto	1850	x	6	x	5	
Nyaungkantha	1850	x	7	x	—	
Palutha	1825	x	3	x	1	
Nyaunggon	1879	x	10	x	3	
Lekokpin	1875	x	10	x	—	
Aungchantha	1915	x	7	x	—	
Paytapin	1890	x	10	x	—	
Panmaye	1915	x	7	x	—	
Ywathit	1930	x	8	x	—	
Thitseingon	1915	x	9	x	—	
Thigon	1890	x	9	x	5	
Taunggya	1880	x	10	x	3	
Sinma	1895	x	10	x	4	
Leyinte	1890	x	7	x	—	
Kyein	1923	x	10	x	2	
Singaung	1920	x	x	4	x	4
Satthachaung	1919	x	x	10	x	5

References

- Anonymous, 1993–2001. Chatthin Wildlife Sanctuary Patrolling Reports. Chatthin Wildlife Sanctuary, Wildlife and Nature Conservation Division, Ministry of Forestry, Kanbalu, Sagaing Division, Myanmar (in Burmese).
- T. Aung, 1987–1994. Report of the Warden, Chatthin Wildlife Sanctuary, Kanbalu, Sagaing Division, Myanmar (in Burmese).
- Blower, J., 1980. Nature conservation in Burma, Office of the FAO Representative, Rangoon, Burma.
- Brandon, K., 1998. Parks in peril: the social context of threats. In: Brandon, K., Redford, K.H., Sanderson, S.E. (Eds.), *Parks in Peril: People, Politics, and Protected Areas*, The Nature Conservancy, Island Press, Washington, D.C. pp. 415–439.
- Brandon, K., Redford, K.H., Sanderson, S.E., 1998. *Parks in Peril: People, Politics, and Protected Areas*, The Nature Conservancy and Island Press, Washington, DC.
- Brunner, A.G., Gillison, R.E., Rice, R.E., Rice, da Fonseca, G.B., 2001. Effectiveness of parks in protecting tropical biodiversity. *Science* 291, 125–127.
- Bryant, R.L., 1997. *The political ecology of forestry in Burma 1824–1994*, Hurst and Company, London.
- Chibber, H.L., 1933. *The Physiography of Burma*, Longmans, Green and Company, Calcutta.
- C.A. Christen, 1995. Development and conservation of Costa Rica's Osa Peninsula, 1937–1977. PhD Dissertation. The Johns Hopkins University.
- Collis, M., 1956. *Last and first in Burma (1941–1948)*, Faber, London.
- Corbett, G.B., Hill, J.E., 1992. *The Mammals of the Indomalayan Region*, Oxford University Press, New York.
- Davies, C.C., 1949. *An Historical Atlas of the Indian Peninsula*, Oxford University Press, Oxford.
- Evans, G.P., 1911. *Big Game Shooting in Upper Burma*, Longmans, Green and Company, London.
- Gamez, R., 1991. Biodiversity conservation through facilitation of its sustainable use: Costa Rica's National Biodiversity Institute. *TREE* 6, 377–378.
- Gutter, P., 2001. Environment and law in Burma. *Legal Issues on Burma Journal* 9, 1–28.
- Hart, T., Hart, J.A., 1997. Zaire: new models for an emerging state. *Conservation Biology* 11(2), 308–309.
- Hemley, G., Mills, J.A., 1999. The beginning of the end of tigers in trade?. In: Seidensticker, J., Christie, S., Jackson, P. (Eds.), *Riding the Tiger, Tiger Conservation in Human Dominated Landscapes*, Cambridge University Press, Cambridge, pp. 217–229.
- Hoe, T.C., 1956. One hundred years of forestry in Burma. *Burmese Forester* 6(1), 45–53.
- Jackson, J.B.C., Kirby, M.X., Berger, W.H., Bjorndal, K.A., Botsford, L.W., Bourque, B.J., Bradbury, R.H., Cooke, R., Erlandson, J., Estes, J.A., Hughes, T.P., Kidwell, S., Lange, C.B., Lenihan, H.S., Pandolfi, J.M., Peterson, C.H., Steneck, R.S., Tegner, M.J., Warner, R.R., 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293, 629–637.
- Janzen, D.H., 1992. A north-south perspective on science in management, use, and economic development of biodiversity. In: Sandlund, O.T., Hindar, K., Brown, A.H.D. (Eds.), *Conservation of Biodiversity for Sustainable Development*, Scandinavian University Press, Oslo, pp. 27–52.
- McShea, W., Leimgruber, P., Aung, M., Monfort, S.L., Wemmer, C., 1999. Range collapse of a tropical cervid (*Cervus eldi*) and the extent of remaining habitat in central Myanmar. *Animal Conservation* 2, 173–183.
- Moser, D. (Ed.), 1978. *World War II, China–Burma–India*, Time-Life Books, Alexandria, p. Inc.
- Myint, M., 1982–87. Monthly Reports. Forest Department Files, Shwebo District, Myanmar (in Burmese).

- Pye, L.W., 1969. Politics, Personality, and Nation Building. Burmas's Search for Identity. Yale University Press, New Haven.
- Rao, M., Rabinowitz, A., Khaing, S.T., 2002. Status review of the protected area system in Myanmar, with recommendations for conservation planning. *Conservation Biology* 16, 360–368.
- Salter, R.E., Sayer, J.A., 1983. Kyatthin Wildlife Sanctuary, Draft Management Plan, Food and Agriculture Organization of the United Nations, Rangoon.
- Scott, J.G., 1921. Burma, A Handbook of Practical Information, Alexander Moring Ltd. The de la More Press, London.
- Smith, H.C., 1935. No. 6. Wildlife Protection in Burma. *Journal of the Bombay Natural History Society XXXVII*, 167–188.
- Stamp, L.D., 1925. The Vegetation of Burma from an Ecological Standpoint, Thacker, Spink and Company, Calcutta.
- Stamp, L.D., 1933. Burma: an undeveloped monsoon country. *Geographical Review* 20, 86–109.
- State Law and Order Restoration Council, 1994. The protection of wildlife and Wild Plants and conservation of Nature Areas Law. (The State Law and Order Restoration Council Law No. 6/94).
- Stebbing, E.P., 1962. The forests of India, vol. 4. Oxford University Press, Oxford.
- Union of Myanmar, Ministry of Agriculture and Forests, Forest Department, 1990. The Burma Wild Life Protection Act, 1936, and The Burma Wild Life Protection Rules, 1941 (Reprint). Planning and Statistics, Forest Department.
- United Nations Development Programme/Food and Agriculture Organization, 1983. Nature Conservation and National Parks, Burma, Interim Report, pp. 142.
- United Nations Development Programme, 1988. Selected Sectoral Reviews: Burma. United Nations Development Programme, New York.
- Wells, M., Brandon, K., Hannah, L., 1992. People and Parks. Linking Protected Area Management with Local Communities. The World Bank, World Wildlife Fund, and U.S. Agency for International Development, Washington, DC.
- Wemmer, C., 1998. Deer Specialist Group Action Plan, International Union for the Conservation of Nature (IUCN), Gland, Switzerland.
- White, H.T., 1913. A civil servant in Burma, Edward Arnold, London.