defined home range (G. Schaller pers. comm., 2002). These transient individuals might cover relatively large areas in search of food and mates, returning to a place only after a lengthy period of time. This would explain their absence during the surveys but infrequent recent reports from locals.

Differences in survey technique or skill levels are unlikely to explain the differences between tiger occurrence at Myanmar and Thailand sites. Training for field staff was standardized and given by the same trainer (A.J. Lynam). Sign surveys were conducted with the same degree of rigor and camera-trap locations chosen in the same ways by teams in the different countries. If tigers were present they should have turned up in the surveys in Myanmar. However, if tigers are absent or not continuously present at a site, then their probability of detection by any survey method would be less than one. Where tigers occur at very low density e.g. <0.38tigers/ 100 sq. km, a mammoth survey effort is required with camera-traps to detect tigers (Carbone et al. 2001). That tigers were found in only three of 17 areas surveyed, whereas other large mammals were detected at frequencies similar to the Thai reserves, suggests that the observations are real. Tigers were either absent or non-resident, or occurred at very low density at most of Myanmar survey sites, at the time of survey. Since the sites chosen were the best potential sites given all the information available prior to the surveys, the suggestion is that the tiger in Myanmar has suffered a range collapse and is in an advanced state of decline towards extinction.

Important to note is that the Thailand sites were all established protected areas with a history of protection. Only two Myanmar sites were protected areas, and tigers were found in one of the areas. Protection at Thai sites, combined with a lower intensity of directed poaching for tigers there explains why tigers have persisted there better than at Myanmar sites. Despite the differences in occupancy patterns for tigers, sites in both countries had similar richness and abundance of large mammals, suggesting similar availability of prey for tigers. Therefore, Myanmar the sites have good potential for the recovery of tiger populations.

4.2 Tiger population size

It is impossible to know the true number of tigers remaining in Myanmar and difficult to estimate numbers. Because of their rarity and cryptic behavior, tigers cannot be directly counted, and sampling is required to estimate numbers. However,

it is impossible to sample every square mile of every potential habitat using camera-traps.

Despite these limitations, the Tiger Team attempted to estimate very roughly how many tigers might be present across the suite of available habitats. They did this not by considering the extent of available habitat, assuming a density and a correction factor, and extrapolating tigers numbers (Rabinowitz 1993; Uga and Than, 1998). Instead they used a subjective approach, by sitting down at a table, poring over maps, and field notebooks, considering information from sign surveys and locations of camera-trap captures, and the most reliable interview data, and arriving at a consensus among themselves. Given their expert knowledge - they know more about the recent natural history of the study sites than any other workers - they estimated the numbers in Table 3. These numbers are one estimate of the remaining tiger population Myanmar.

In the absence of independent verification, the numbers are educated "guesstimates". However, it is possible to independently estimate tiger numbers for the Hukaung Valley using a modification of the approach of Rabinowitz (1993), and the estimate of tiger density (0.91 – 1.29 tigers/100 sq. km; see section 6.8.7). If one assumes a 50% reduction in tiger density because of direct poaching of tigers within the reserve (the most serious threat to tigers in Myanmar), and an additional 20% reduction due to hunting, forest fires, smaller settlements and human access provided by the Ledo Road, the number of tigers in the reserve (6,460 sq. km) is 18 – 25. This estimate is strikingly similar to that derived by the consensus approach (15 – 20; Table 3). While the estimates may have some validity, carefully designed mark-recapture studies will however be needed to determine the size of tiger subpopulations in the areas in Table 3.

Table 3. Status of tigers in Myanmar*

Tiger status	Sites (estimated numbers)
1. Tigers confirmed	Htamanthi (5); Hukaung Valley (15-20) and adjacent areas (15-20); Htaung Pru (5), Pe Chaung (5), other areas of N.and S. Tanintharyi Division (55)
2. Tiger not recorded but possibly present in low numbers	N. Rakhine and S. Chin State (3-5), Sumprabum (3-5), Khaunglanphu (1-2), Paunglaung (2-4), Momeik-Mobain (2-3), Bago Yoma (2-3), S. Rakhine Elephant Range (1-2), Shan Yoma (Kayah-Kayin)(5-7), S. Kachin (3-5), Saramati Taung and area (5-7)
3. Tigers not recorded and assumed absent	Alaungdaw Kathapa, Thaungdut, Mahamyaing, Nankamu, Panlaung-Pyadalin

* Numbers are estimates based on consensus approach of Myanmar Tiger Team surveyors.

PART 5: Rationale for a National Tiger Action Plan for Myanmar

Potentially tigers are recoverable to their former abundance across their range in Myanmar. In practice however, full recovery is unlikely. This section describes a Plan for recovering tigers to a semblance of their former abundance in key parts of their range where they still exist, and restoring areas where tigers have been lost so that natural recolonization might in future occur in those places. Broadly, the Plan will work towards increasing tigers, prey and habitat, which are "measurable currencies" for tiger conservation (Ginsberg 2001).

The Plan will be implemented over a 5 year period between 2003-2007. This will allow a number of targets to be achieved over spatial scales relevant to tiger conservation (Ginsberg 2001);

- Site (an area containing at least several breeding female tigers) e.g. Htamanthi Wildlife Sanctuary is a tiger site.

- Landscape (a larger area containing several populations of females and habitat connections between the populations) e.g. the Hukaung Valley, and forest reserves in Tanintharyi Division are tiger landscapes
- Tiger Conservation Units (TCU's) (areas encompassing several landscapes) e.g. the Northern Triangle TCU (60) which contains Hukaung Valley, Huai Kha Khaeng – Thung Yai Naresuan TCU (73) which includes Tanintharyi Division

The targets for tiger conservation will vary according to timeframes and spatial scales but fit into the general framework given in Table 4. By the end of the implementation period, the short-term targets should be realized. An annual review of progress is suggested with a comprehensive review of progress towards achieving the short-term goals at the end of 2007. Success at reaching the short-term targets will set the stage for meeting the longer-term (10 – 20 years) targets. Important to recognize is the fact that efforts to save tigers in Myanmar are part of a larger global effort to save the species. The recovery of tigers in Myanmar will contribute towards the larger goal of species recovery across the range.

The Plan addresses the key threats to achieving these goals for tigers in Myanmar, described in section 3 (above); (a) Hunting for commercial trade in tiger products, (b) Prey depletion, (c) Habitat loss, degradation and fragmentation, (d) Harrassment and displacement, (e) Illegal trade in tiger products, (f) Genetic erosion, (g) Protected Area management, (h) Social perception.

Specifically, implementation of the Plan will reduce the key threats by;

1. Suppressing all killing of tigers, and the illegal trade in tiger products
2. Reducing killing of tiger prey species, suppress associated illegal trade.
3. Improving forestry management to stop further loss of tiger habitat and to restore degraded habitat
4. Improving forestry management to reduce intrusions of local people into tiger habitat, and improve planning to avoid development in tiger critical areas
5. Establishing protected areas, ecological corridors and priority management areas to protect wild tigers and their habitat
6. Improving international cooperation and establish transboundary protected areas to maintain connectivity of tiger habitat across international boundaries
7. Monitoring the status of the tiger and prey population to assess the effectiveness of conservation efforts

8. Improving public awareness of the importance of tiger conservation to increase support from local people
9. Defining roles and responsibilities of personnel responsible for tiger conservation

Table 4. Targets for tiger conservation at different time and spatial scales (*adapted from Ginsberg, 2001*).

	TARGETS	
	SHORT TERM (2 – 5 YEARS)	LONG TERM (10 – 20 YEARS)
SITE (an area containing several breeding females) e.g. Htamanthi Wildlife Sanctuary, forest reserves in Tanintharyi Division	• Maintain occupancy of tiger habitat • Define critical areas within sites • Stabilize present tiger populations • Prevent loss of tigers	• Maintain potentially breeding populations of tigers at maximum density • Maintain expanding population (at r>1) • Strictly protect core areas
LANDSCAPE (a larger area containing several populations of breeding females) e.g. Hukaung Valley, Tanintharyi Division	• Maintain potential for dispersal between sites	• Maintain ecologically functioning viable tiger populations • No human intervention required to achieve stable/growing populations • Recolonization of empty habitat
TIGER CONSERVATION UNIT (an area containing several landscapes) e.g. the Northern Tfiangle TCU (60), Huai Kha Khaeng – Thung Yai Naresuan TCU (73)	• Maintain integrity of intact habitat • Maintain sufficient prey base • Maintain multiple landscapes including transboundary landscapes in each TCU • Coordinate establishing protected areas across boundaries • Promote tiger friendly conservation in each country in TCU	• Reestablish connections between sites and landscapes to ensure genetic exchange • Maintain heterogeneity of ecoregion

Specific issues and action items for achieving the targets of tiger conservation in Myanmar are detailed as follows. For ease of reference the action items are also listed in Table 1 along with a proposed timetable for their implementation, and responsible agencies.

5.1 Suppressing all killing of tigers and the illegal trade in tiger products

5.1.1 Key issues

a) The trade in tiger products is part of the illegal trade in wildlife worth an estimated US$7 billion annually.

b) Myanmar is one of the countries supplying the tiger trade and has a well-developed network involving poachers, middlemen and trafficking routes to move tiger products from forest to market.

c) The hunting of tigers to supply the trade has been the ultimate cause of extirpation of wild tigers from multiple forest and nature reserves e.g. Alaungdaw Kathapa, and entire regions e.g. northern Myanmar.

d) Knocking off the top predator can have destabilizing effects at lower trophic levels in tropical ecosystems (Seidensticker 2002).

e) Tiger populations that exist today are being decimated by hunting and face certain extirpation in the short-term if action is not taken.

5.1.2 Key actions

a) Modify the Protected Wildlife and Protected Areas Law (SLORC, 1994) to enable the enforcement of CITES laws within Myanmar. This would include laws prohibiting the sale or purchase of products suggesting or implying content of tiger bone, hair, organs, blood, teeth, claws or hide. Completion date: December, 2003

b) Impose heavy fines for offenders and use partial proceeds towards implementing CITES legislation. Completion date: December, 2003

c) Conduct wildlife conservation and awareness training for 100 government personnel, including military, customs, police, immigration and local administrative staff in Yangon, Mandalay, Myitkyina and other internal transit points for wildlife. This would include basic training in identifying wildlife listed in the Myanmar Protection of Wildlife and Protected Areas Law 1994, and knowing their protection status. Completion date: December, 2003

d) Conduct wildlife conservation and awareness training for all protected area staff. Completion date: December, 2003

e) Recruit local government staff to help identify tigers in trade and encourage them to report their observations to relevant authorities. Completion date: December, 2003

f) Create a Wildlife Investigations Unit to investigate and suppress crime against wildlife, including trade, trafficking, illegal killing and capture, habitat destruction, and other persecution. The unit will enforce domestic and CITES legislation. The unit would include staff of the Ministries of Interior, Forestry and Tourism and would report directly to the Minister of Forestry. Completion date: June, 2004

g) Train and recruit government staff to join the Wildlife Investigations Unit. Form mobile units to suppress wildlife crime across the country. Completion date: June, 2004

5.2 Reducing killing of tiger prey species and associated trade.

5.2.1 Key issues

a) "Tigers cannot survive where they lack access to ungulate prey that is at least about half their own body mass because of mass-specific energy needs." (Seidensticker 2002)

b) Because tropical forests support ungulates at relatively low densities, the killing of prey has been the proximate cause of the decline in tiger populations in Mainland Asia.

c) Few if any ethnic communities rely on large mammals as a subsistence source of protein but trade in wild meat, horns, fur, hides and other products is part of a massive illegal trade in Myanmar, and is well developed in border areas where enforcement is difficult.

d) The commercial farming of wildlife encourages poaching of wild individuals to supply the trade and may contribute to the extirpation of some species.

e) Evidence suggesting that hunting can be sustainably managed exists for a few tropical wildlife species but evidence that wildlife harvest is unsustainable exists for a vast number of species (Robinson and Redford 1994; Robinson, and Bennett 1999).

f) Protected areas are currently understaffed and ill-equipped to prevent the loss of wildlife to poachers (Bennett and Rao 2002).

g) The presence of forest guards in sufficient numbers can mitigate against hunting of wildlife (Bruner et al. 2001)

h) Outside of protected areas, how wildlife is protected by law is unclear, and the responsibility for enforcing the Wildlife Law is unclear among government staff.

5.2.2 Key actions (in addition to those described above for tigers but are generally relevant)

a) Modify the Protected Wildlife and Protected Areas Law (SLORC 1994) to enable the enforcement of CITES laws within Myanmar. Modify Chapter V, Article 15 to recognize the IUCN and CITES classifications of wildlife species, and their associated protection status. Completion date: June, 2003.

b) Ban the commercial farming of all wildlife species. Revoke Articles 17 and 18, Chapter V in the Protected Wildlife and Protected Areas Law (SLORC 1994). Completion date: June, 2003.

c) Ban the hunting of all wildlife species pending scientific evidence that proves it can be done sustainably. Revoke Chapter VI in the Protected Wildlife and Protected Areas Law (SLORC 1994). Completion date: June, 2003.

d) Suppress all killing of prey species at tiger sites and landscapes. Completion date: December 2007.

e) Train all government staff at Hukaung Valley and Htamanthi, in anti-poaching and anti-trafficking techniques. Where possible involve local military personnel as instructors. Completion date: December 2003.

f) Recruit teams of EcoRangers whose sole responsibility is protection. Numbers of EcoRangers should at least 3 guards/100 sq. km for effective management . Provide EcoRangers with necessary equipment, and salary incentives to motivate them to combat poaching. Completion date: June 2004.

g) Develop systematic patrolling inside all protected areas using EcoRangers. Make patrolling a mandatory management activity with a monthly schedule and budget. Completion date: December 2004.

h) Update the Wildlife Law to include protection for wildlife outside protected areas, and empower government staff to enforce the legislation. Completion date: December 2004.

i) Outside protected areas, study patterns of hunting and consumption of wildlife to determine its sustainability, especially for prey species. Completion date: December 2005.

j) In the List of Protected Animals (Ministry of Forestry, 1994), promote the following tiger prey species from Protected status to Completely Protected status; Sambar (*Cervus unicolor*) and Wild buffalo (*Bubalus bubalis*). Completion date: June 2003.

k) In the List of Protected Animals (Ministry of Forestry, 1994), promote the following tiger prey species from Seasonally Protected status to Completely Protected status; Hog deer (*Axis porcinus*) and Barking deer (*Muntiacus muntjak*). Completion date: June 2003.

l) Compulsory wildlife conservation and awareness training for all wildlife offenders. Completion date: June 2003.

m) Impose heavy fines for wildlife offenders in protected areas with partial proceeds towards supporting antipoaching activities. Completion date: June 2004.

5.3 Improving forestry management to stop further loss of tiger habitat and to restore degraded habitat

5.3.1 Key issues.

a) Extraction of non-timber forest products, fuelwood collection, shifting cultivation and livestock grazing disturbs tigers, damage tiger habitat, and depletes prey resources.

b) Clear cutting, especially associated with harvest of teak and other economically valuable hardwoods seriously compromises tiger habitats.

c) There exist no economic incentives for conducting environmentally sound forest use practices

5.3.2 Key actions

a) Traditional Myanmar forest harvest practices involving 30 year cutting cycles, and use of elephants for removal of logs reduce environmental damage over

other practices. Review forest harvest practices of all concessions in Myanmar forests. Provide incentives to logging companies to adopt traditional harvest practices. Completion date: December 2005.

b) Provide incentives to logging companies to prevent the use of firearms by their staff, and encourage them not to kill, eat or sell wildlife. Completion date: December 2005.

c) Provide special tiger conservation training to site managers in forest concessions. Completion date: December 2004.

d) Revoke concessions which violate regulations governing forest harvest practices. Completion date: December 2005.

e) Impose fines or revoke concessions which fail to provide adequate protection for wildlife. Completion date: June 2005.

f) Introduce a Wildlife Conservation Tax on all forest concessions to compensate for damage done to wildlife habitats. Use the tax towards wildlife management activities. Completion date: December 2005.

g) Define Strict Conservation Zones for Hukaung Valley and Htamanthi where no human use of natural resources is allowed. Create buffer areas to allow restricted use by local people including extraction of non-timber forest products, fuelwood collection, and livestock grazing. Ban shifting cultivation and hunting of all kinds in the buffer area. Use EcoRanger patrol teams to enforce the restrictions. Completion date: December 2003.

5.4 Improving forestry management to reduce intrusions of local people into tiger habitat, and improve planning to avoid development in tiger critical areas

5.4.1 Key issues

a) Plantations and mines disturb tigers, pollute watersheds and damage tiger habitat

b) Military camps and permanent settlements seriously compromises tiger habitat

c) Road construction internally fragments and damages tiger habitat, facilitates intrusions by poachers, and opens up remote areas to wildlife trade

5.4.2 Key actions

a) Reclaim plantations and revoke all mining licences in Hukaung Valley and Htamanthi Wildlife Sanctuaries. Completion date: December 2007.

b) Relocate any military camps and permanent settlements outside of these reserves. Completion date: December 2007.

c) Ban the construction of roads in the reserves. Completion date: December 2004.

d) Close or limit access along logging roads in Tanintharyi Division to reduce the risk of collisions with tigers. Completion date: December 2005.

e) Include wildlife assessment in land development programs for Tanintharyi Division. Completion date: December 2003.

f) Develop education programs to improve awareness about wildlife for local people living in and around forest reserves in Tanintharyi Division. Completion date: December 2004.

5.5 Establishing protected areas, ecological corridors and priority management areas to protect wild tigers and their habitat

5.5.1 Key issues.

a) The minimum area required to support a genetically viable population of large predators would be the area that supports 300 breeding females (Barbault & Sastrapradja 1995).

b) If female tigers in Myanmar have home ranges the size of Nepali tigers (10-50 sq. km; (Smith 1987)), the area required would be 3,000 – 15,000 sq. km.

c) Landscapes of this size exist in Myanmar but most are not yet protected for wildlife. The largest intact forest expanses in Myanmar are in Kachin State, Sagaing and Tanintharyi Divisions.

d) Tigers may use forest reserves as movement corridors between the Hukaung Valley and Sumprabum, and possibly as far east as Kaunglamphu; within Tanintharyi Division, and across the Thai-Myanmar border, and; between north-eastern Sagaing Division and western Kachin State.

e) There is a lack of landscape level planning and analysis for wildlife conservation in Myanmar.

f) Management plans for sites containing tigers do not specifically define actions necessary to conserve tigers

5.5.2 Key actions

a) Revise or create management plans for the Hukaung Valley and Htamanthi to include specific actions for conserving tigers, including recommendations in 5.2.2, 5.3.2, and 5.4.2, and below. Completion date: December 2003.

b) Expand Htamanthi Wildlife Sanctuary to increase its size to at least 3,000 sq. km to ensure long-term survival of tigers. Completion date: December 2004.

c) Create a dedicated tiger reserve including the Hukaung Valley and adjacent forest reserves. The reserve will serve to link tiger populations in India with those in Myanmar. Expand the eastern border of Hukaung Valley Wildlife Sanctuary to protect potential tiger habitat in the Sumprabum area. Completion date: June 2004.

d) Establish limited human use zones (buffers) that will "soften" the edges of Hukaung Valley and Htamanthi reserves reducing the risk of mortality for tigers. Completion date: June 2004.

e) Create new protected areas or special tiger management zones in the Tanintharyi Division, including the Lenya River, Greater and Lesser Tanintharyi River catchments. These sites will protect tigers and their habitats and allow limited human use of natural resources around the reserves in a manner complementary to tiger conservation. Completion date: December 2007.

f) Use existing GIS capabilities in the Forest Department to identify and demarcate special management zones and corridors for tigers. Completion date: December 2003.

5.6 Improving international cooperation and establish transboundary protected areas to maintain connectivity of tiger habitat across international boundaries

5.6.1 Key issues

a) Trade and trafficking in tiger and other wildlife products is often associated with the trade in drugs and arms

b) In Myanmar the trade is concentrated in areas with weak enforcement, especially along the border with China and Thailand. The trade is fuelled by the disparity in economies between neighbour countries, creating an underground economy and a drain on Myanmar's wildlife

c) Local government officials in border areas are unaware of the Wildlife Law or the importance of wildlife, and sometimes supplement their incomes from wildlife trade.

d) Law enforcement in border areas is effected by local militias but National laws are only weakly enforced or not enforced at all.

5.6.2 Key actions

a) Conduct wildlife conservation and awareness training for 100 government personnel, including military, customs, police, immigration and local administrative staff, stationed near or on country borders. This would include basic training in identifying IUCN and CITES protected wildlife species. Completion date: December 2003.

b) Hold internal 2 workshops involving local government officials to discuss transborder issues including trade, trafficking and wildlife, and develop plans to suppress the trade. Completion date: December 2003.

c) Recruit local government officials on both sides of the Thailand border to suppress transborder wildlife trade at Mawdaung-Prachuap Kiri Khan, Kaleinaung-Ban I Tong, Kawthaung-Ranong (especially Tha Htay Island), Myawaddy-Mae Sot, Three Pagoda Pass, and Tachileik-Mae Sai, and prevent access by professional poachers from Thailand. Completion date: December 2004.

d) Create a tiger reserve in Tanintharyi Division opposite Thailand protected areas that support large populations of tigers; Western Forest Complex and Kaeng Krachan National Park. Completion date: December 2004.

e) If possible expand the reserve or create new reserves to form a corridor between these two Thai reserves. Completion date: December 2007.

f) Develop a spatially explicit tiger conservation database for the Huai Kha Khaeng – Thung Yai Naresuan TCU (Level I TCU 73). Completion date: December 2005.

g) Where possible mount annual joint antipoaching patrol/wildlife surveys along the Thailand-Myanmar border involving security personnel from both countries. Completion date: December 2005.

5.7 Monitoring the status of the tiger and prey population to assess the effectiveness of conservation efforts

5.7.1 Key issues

a) The success of the Plan will need to be assessed by monitoring tiger and prey populations

b) The Hukaung Valley landscape will be a target for an extensive monitoring program

c) Landscapes not yet protected but containing tigers e.g. Tanintharyi Division, should be targets for medium intensity monitoring

d) Sites where tigers were not found but are suspected to occur (Table 3) should be targets for low intensity monitoring

e) Specific methods used for monitoring will depend on the level of knowledge available for tigers (Table 5).

5.7.2 Key actions

For Hukaung Valley;

a) Identify critical habitats and core areas for tigers and prey across the landscape. Completion date: June 2003.

b) Estimate numbers of female tigers within the landscape and ascertain that there is a reproductively viable population of tigers. Completion date: December 2003.

c) Document the current threats, demographics, and range of human activities that must be taken into account if the proposed landscape is to be successful and sustainable in the long term. Completion date: June 2003.

d) Create a GIS map and database to show current land use patterns, possible future land use trends, and tiger and prey source areas. Completion date: December 2003.

For forest reserves in Tanintharyi Division;

e) Train local foresters how to identify tiger and prey via sign surveys, in use of camera-traps for wildlife survey, and methods for making observations and recording data. Completion date: December 2004.

f) Determine occupancy of habitats in accessible sites across the landscape, including Myintmoletkat and Lenya River areas, which away from sites where tigers are known. Completion date: December 2005.

g) Determine prey abundance using line transect sampling. Completion date: December 2005.

h) Determine tiger abundance using double-sided camera-trap sampling. Completion date: December 2005.

For sites in N. Rakhine and S. Chin State, Sumprabum, Khaunglanphu, Paunglaung, Momeik-Mobain, Bago Yoma, S. Rakhine Elephant Range, Shan Yoma (Kayah-Kayin), S. Kachin, Saramati Taung area;

i) Train local foresters how to identify tiger and prey via sign surveys. Completion date: June 2003.

j) Determine occupancy of habitats at the sites using sign surveys. Completion date: December 2003.

k) Establish a logbook to record observations of tiger and prey, and encourage use of the logbook. Completion date: December 2003.

5.8 Improving public awareness of the importance of tiger conservation to increase support from local people

5.8.1 Key issues

a) Local government officials encourage local people to hunt tigers and split profits from the sale of wildlife products.

b) Professional hunters and hilltribal people (Kachin, Lisu, Naga, Khantisham) who consume wildlife live in villages adjacent to the Hukaung Valley, and pose a threat to wildlife.

c) Little public information exists about wildlife in Myanmar

d) Wildlife education essentially does not exist in schools

5.8.2 Key actions

a) Develop wildlife education programs to discourage hunting by local people in and near tiger reserves. Where possible recruit local people, especially ex-hunters to help implement these programs. Completion date: December 2004.

b) Involve 50 local people in wildlife survey and research activities to make positive use of their local or indigenous knowledge. Completion date: December 2003.

c) Collaborate with authorities in charge of development projects to include wildlife conservation as a component of those projects and resolve any

potential conflicts between the needs of people and wildlife. Completion date: December 2003.

d) Produce a documentary about tiger conservation in Myanmar and broadcast it on National television. Completion date: June 2004.

e) Dub existing wildlife documentaries about Myanmar into Burmese and broadcast. Completion date: June 2003.

f) Adapt WCS education materials about tigers in Burmese and implement a special training program for schoolchildren at selected high schools in Yangon, and adjacent to tiger reserves. Completion date: June 2004.

5.9 Defining roles and responsibilities of personnel responsible for tiger conservation

5.9.1 Key issues

a) Wildlife conservation is hampered by a lack of understanding of roles and responsibilities of government staff.

b) The efficiency of protected area management can be improved by defining tasks and expectations for staff.

c) Park managers need leadership training to be able to perform their jobs successfully, and to direct human resources to effect conservation.

5.9.2 Key actions

a) Provide special training for managers of tiger reserves in management techniques, including leadership skills, decision making, planning, protection, use of information and technology, and personnel management. Completion date: December 2003.

b) Invite managers of tiger reserves to observe the day-to-day operations in selected tiger reserves in India and Thailand. Completion date: June 2004.

c) Define roles for junior staff in Hukaung Valley and Htamanthi Wildlife Sanctuaries, and for Tanintharyi Division junior forestry staff, and staff and in other areas in conducting field monitoring of tigers and prey. Completion date: December 2003.

Table 5. A guide to research methods for tiger conservation*

Knowledge base	Goal	Technique
No information	Determine occupancy	Sign surveys for tigers[1]
	Determine occupancy but sign survey inappropriate	Camera trap surveys for tigers
	Potential carrying capacity (K) for tigers	Line transect for prey Dung surveys for prey
Tigers present	Determine occupancy	Sign surveys for tigers
		Camera trap survey for tigers using single camera sets
	Determine tiger and prey abundance	Camera trap survey using single camera sets
		Line transect sampling for prey/dung
	Determine abundance of tigers	Camera trap survey for tigers using double camera sets
		DNA population estimation
	Determine K for tigers	Line transect sampling for prey/dung
Abundance/distribution data available	Habitat analysis	GIS to extend results of intensive habitat surveys
	Monitoring	Camera trap monitoring of tigers
		Calibrated sign surveys
	Ecological Studies	Radio telemetry
		Diet studies
		Demographic studies
		GIS

[1] 'for tigers' implies that sampling is designed to maximize the probability of encountering tigers

* Based on consensus from a workshop held at Khao Yai, Thailand, June 2001

PART 6. Historical data, field survey methods and data analysis.

This section is optional reading for researchers and others interested in the historical distributions of tigers, specific field methods used to collect information on current distributions, and data analysis techniques. All of this material provided the background for developing the Action Plan described in the previous section.

6.1 Past distributions of Tiger in Myanmar. In order to provide a framework for understanding the current situation for tigers, information on where tigers used to occur and the factors that brought about their decline were considered. For the purposes of this report, historical records were considered as those pre-1999, when this study began. A number of sources were used to reconstruct former distributions of tigers in Myanmar:

1. *Published scientific papers.* Prior to 1999, few biological surveys had been attempted in the country. The first dedicated surveys were done in the early 1960's by Milton and Estes (1963). They identified declining wildlife populations in areas such as Pidaung Wildlife Sanctuary. Then during the 1980's a series of wildlife assessments were done in the context of assessing areas for forest protection by UNDP/FAO (1985). These reports prescribed the formation of new protected areas as critical for the future conservation of wildlife. In the 1990's WCS made efforts to document and define new areas for inclusion in the protected area system.
2. *Hunter records.* The majority of historical records come from published reports and books written by hunters. Game hunting was popular during the period of occupation by the British (pre-1948). These publications describe in detail the circumstances in which tigers were shot, trapped, snared or otherwise encountered by humans.
3. *Survey reports.* A number of reports by foresters and surveyors attest to the former occurrence of tigers.

6.2 Quality and reliability of information. A gazetteer was assembled from historical tiger records. The information was categorized as follows;

(a) Confirmed presence - where there was no reasonable doubt the observation was of tiger. These observations were from direct sightings, tigers killed, or reports of attacks by tigers on humans or livestock;

(b) *Provisional presence* - where there was a possibility that leopard or other species was in fact observed but was mistaken for tiger. These were observations of tracks and sign, or reports from other sources e.g. villager reports

(c) *Provisional absence* - where a lack of evidence of tigers was reported. True absence in a given place can only be confirmed through monitoring over a period of time but except for recent efforts at Alaungdaw Kathapa (U Ye Htut, pers.comm. 2000) this has yet to be done in Myanmar.

Verbal reports were not considered as historical records due to the persistent problems with identifying large cats from track and sign (Duckworth & Hedges 1998; Lynam 1999) and because reports not written down at the time of observation invariably change in content and accuracy and become unreliable.

6.3 Characteristics of past distribution. A total of fifty-eight observations provided an historical record of tigers for the period 1903-1999 (see Fig. 2.; Appendix IV). Tigers were historically recorded from all areas but gaps in information exist for the delta area, the central east (Shan State) and the far north. The absence of records probably reflects that tiger was not reported rather than it never existed in these places. Tigers can survive in mangrove forests although the habitat is suboptimal (U. Karanth, pers.comm. 2002). Similarly, the absence of documented records from Shan State is due to the inaccessibility of the area rather than lack of tigers. (Rabinowitz 1998) reported tigers had disappeared from the far north but evidence from hunters suggests their existence there in the past.

6.4 Potential tiger areas. During the early 1990's with the advent of new techniques for assessing population viability through consideration of genetics, the focus on conserving tigers shifted towards a small population paradigm (*sensu* Caughley and Gunn, 1996). The idea was that tigers were fast being driven towards extinction in the wild so that captive breeding and genetic management would be necessary to save them (Tilson et al. 1995). There is no doubt that for some critically endangered species such as Guam rail, Black footed ferret and Arabian oryx, and the subpopulation of tigers in southern China, species survival depended primarily on successful management in zoos. However, this approach ignored the fact that

potentially viable populations of tigers still existed across most of their range in the wild but that their status remained unknown (Rabinowitz 1999), so that effective conservation planning could not happen. In an attempt to refocus attention on the plight of wild tigers, WWF and WCS attempted a geographic assessment of the extent and availability of habitat, and potential prey resources (Dinerstein 1997). This analysis identified a series of potential areas – Tiger Conservation Units (TCU's) - in which tigers could conceivably occur. For example, it was considered that tigers might occur across large expanses of potential habitat.

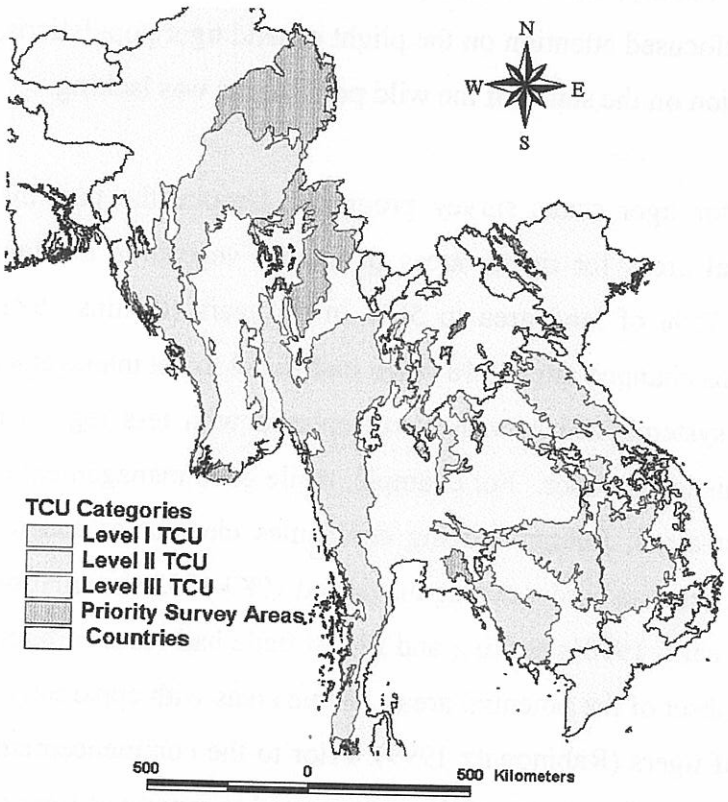

Fig. 10. Tiger Conservation Units (TCU's) for Myanmar and neighbour countries.

In Myanmar, four areas with the greatest potential for tigers (Level I TCU's) are large and relatively intact forest transboundary forests in the west along the Myanmar-Bangladesh and Myanmar-India frontier, Upper Chindwin and Upper Ayeyarwaddy, and along the Thai-Myanmar frontier, and forests in central Bago Yoma (Fig. 10). A series of much smaller, highly fragmented forest areas provide lower potential for tigers. These are termed Level II and III areas. According to the analysis, forests in the far north, central east and delta areas had unknown occupancy for tigers. These

areas were considered priorities for immediate survey reflecting large gaps in historical information on tiger occurrence.

Several characteristics of the potential tiger habitats are worthy of mention. Firstly, despite the relative intactness and contiguity of forests in the Level I category, tigers may not be uniformly found across available habitat (Prater 1940; Rabinowitz 1995). Secondly, the Level I TCU's include areas of degraded or completely cleared habitats. Tigers if occurring there would likely be non-breeding transient individuals (G. Schaller pers. comm., 2002), a small percentage of the population that are prepared to risk movement across hostile areas in the landscape to cross between forest patches. Finally, the TCU analysis was a very useful exercise because it did two things; it refocused attention on the plight of wild tiger populations, defined areas where information on the status of the wild populations was lacking.

6.5 Rationale for tiger status survey program. Despite the past distributions and current potential areas for tigers, areas of natural vegetation available for wildlife declined from 75% of land area to 50% in 50 years (Collins 1991; FAO 2000). Landuse patterns changed after 1948 when traditional forest management regimes that regulated and systematized harvest were replaced with less regulated and in some cases opportunistic clearance. For example, while good management of natural forest occurs in most areas, foreign logging companies clearcut or felled timber outside concessions in near the border during the period 1989-1993 (International 1999).

By the early 1990's hunting and illegal trade had reduced tiger populations to an unknown subset of the potential areas. Some areas with apparently suitable habitat were devoid of tigers (Rabinowitz 1999). Prior to the commencement of this project in 1999, the state of knowledge of tigers amounted to reports of tiger occurrence from a limited number of areas (Rabinowitz 1999). Hunting of tigers has been going on for a very long time (Pollok & Thom 1900). More recently with reduced supply of tigers and tiger parts in the marketplace, demand has increased (Hemley & Mills 1999) with unmeasured effects on wild tiger populations.

In order for effective conservation planning to take place, there was an urgent need to know where tigers existed across the vast landscapes of Myanmar, and what was the condition of tiger subpopulations. A field program was mounted to satisfy the following objectives:

1. to train government field staff in tiger assessment methods

2. using information on potential tiger areas from historical records and local knowledge to determine tiger presence-absence across these areas, and limits of tiger distributions
3. to define threats to tigers and their habitats
4. to redefine priority areas for future tiger conservation

6.6 Training and selection of Tiger Team members. The capacity of field staff to conduct independent wildlife survey and research is generally poor in Asia and this has led to problems with interpreting basic information on species occurrence and abundance for protected areas (Duckworth & Hedges 1998). Park staff are generally unfamiliar with animal track and sign thus making reports of tiger occurrence unreliable. As an example of this, at Alaungdaw Kathapa National Park, historically one of the better known tiger areas (UNDP/FAO 1982), park staff reported tigers as common in 1998 but plaster casts of tracks purported to be of tiger were on inspection found to be of Asiatic leopard and Golden cat (Lynam et al. 1999). Part of the problem in Myanmar is a general one across Asia in that training of government staff has traditionally focused on production forest management and silviculture. Protected area conservation is a relatively new task for foresters and wildlife training is generally unavailable at the college or university level.

Wildlife training for Myanmar foresters began with a WCS program in 1995. The training, based on a standard curriculum (Rabinowitz 1993b), provides instruction in techniques for observing and recording wildlife, and basic survey and analytical techniques. Since 1995, 270 protected area field staff, and local NGO staff have received the WCS basic training. Other specialist training in wildlife monitoring techniques was provided to Forest Department staff by Smithsonian Institution, and the California Academy of Sciences.

As a starting point for the National Tiger Action Plan project, The Wildlife Conservation Society - Myanmar Programme in collaboration with the Myanmar Forestry Department provided a training course in tiger survey techniques and conservation at Alaungdaw Kathapa National Park, from December 7-21st, 1998. The objectives of this training were;

1. to train junior forestry staff in basic techniques of map and compass, wildlife observation and data recording

2. to provide specialized training in describing tiger habitats, conservation and census techniques for tigers and tiger prey species
3. to identify talented Forest Department staff for inclusion in a National Tiger Survey Team (NTST)

The training was conducted by WCS staff from New York, Thailand and Myanmar. Dr Alan Rabinowitz, Director of Science, Asia Programs, an expert on large carnivore conservation ecology, and the author, lectured to the trainees and directed a variety of classroom based and field based training activities. They were supported by WCS Myanmar Country Programme Coordinator U Saw Tun Khaing and Research and Training Coordinator U Than Myint. This was the first time this kind of training had been done in Myanmar, and the first time anywhere in Southeast Asia.

Twenty trainees and three observers attended the 14-day training (Fig. 8.). These staff came from twelve national parks and sanctuaries, the Institute of Forestry, and the Forest Resources and Environment Development Association (FREDA). The trainees were assessed on their participation in group assignments and a 4 day field project, and on their individual performance in class and practical assignments, a comprehensive exam, and overall level of participation in the training.

From the training a group of six talented young forestry professionals were selected to form the first roving tiger field survey team to participate in field assessments for tigers at selected forest sites across Myanmar.

6.7 Methodology. The surveys were intended to determine presence-absence for tigers, and relative abundance for prey species, so as to permit the evaluation of study areas for their potential for tigers. The surveys were not intended to determine numbers of tigers in the reserves.

Tigers, like other tropical mammals, are generally difficult to observe directly due to their rarity, cryptic behaviour, partial nocturnality and avoidance of humans (Griffiths & van Schaik 1993; Schaller 1967). A combination of indirect and direct survey methods were used to detect tigers and other large mammals; potential prey species.

Field observations of tigers can be categorized so as to facilitate interpretation of their ecological status. Four types of observations are given in Table 6. Tigers

may be detected or not detected by a given survey technique. The detection of tigers confirms presence but may or may not indicate a reproductive population. Where tigers are not recorded, this could indicate problems with sampling, for example where tigers are missed due to extreme rarity, or true absence.

Where tigers occur at densities under 0.38 tigers/100 square kilometer, very large amounts of sampling with camera-traps (>1,000 trapnights) needs to be done in order to detect them (Carbone et al. 2001). In this study sampling of >1,000 trapnights was not feasible so that tigers might not be recorded at some low density sites even though they were present.

Table 6. Interpretation of tiger population status from field observations.

	Observation	Population status	Interpretation
1a	Tigers recorded	Reproductive population	Indicated by observations of pregnant females, juveniles and/or cubs
1b	Tigers recorded	Present but not necessarily reproductive	Indicated by observations of adult male or non-pregnant adult female individuals
2a	Tigers not recorded	Low density, ecological effective absence	Tigers may be present at low density but are not recorded due to sampling errors e.g. tigers not present in survey area. A tiger population may be disrupted, sex ratios skewed, or individuals have difficulty finding mates so that reproduction is not possible (Allee effect)
2b	Tigers not recorded	True absence	Tigers are not recorded over a period of monitoring at a site

6.7.1 *Choice of study areas*– Given the time frame of the project (3 years) it was not possible to investigate tiger occurrence in all forest areas. Using information from historical records and potential tiger areas, 17 sites with the highest probability of

supporting tigers were chosen for survey (Fig. 9.). These areas represented a non-random subset of available landscape and habitat options for tigers spanning the geographic extent of the country from approximately 11°-27°N, and 93°-99°30'E.

1. Alaungdaw Kathapa National Park (AKNP)
2. Htamanthi Wildlife Sanctuary (HTM)
3. Thaungdut Reserve Forest (TD)
4. Mahamyaing Reserve Forest (MHM)
5. Nankamu Reserve Forest (NKM)
6. Saramati Taung (SRMT)
7. Paunglaung Catchment (PGL)
8. Panlaung Pyadalin Cave Wildlife Sanctuary (PPDL)
9. Bago Yoma (BGY)
10. N. Rakhine (RN)
11. S. Rakhine Elephant Range (RER)
12. Hukaung Valley (HKV)
13. Khaunglanphu (KLP)
14. Sumprabum (SBP)
15. Momeik-Mabein (MB)
16. Myintmoletkat (MMLK)
17. S. Tanintharyi (TNTY)

Descriptions of each site are given in Appendix II.

6.7.2. *Interview surveys* - Interviews of people living in suspected tiger areas are potentially useful because they draw upon local knowledge of wildlife accumulated over long periods of time, and may help determine the status and identify threats to tigers and other mammals (Rabinowitz 1993b). However, the reliability of information to be gained depends upon a number of factors, especially the correct interpretation of local information by the interviewer (Duckworth 1999), the manner and disposition of the interviewer, and how this is perceived by the interviewee. An interview protocol (Appendix IV) was designed during the tiger training course (Lynam et al. 1999) and this was used by Burmese-speaking interviewers to gain indirect evidence on tiger occurrence in the 17 potential areas. Direct survey was

done in and around locations of the most recent reliable reports of tigers from interviewees.

6.7.3 *Track and sign* - Large mammals produce tracks, feces, scrapes, scratches, kills and other sign so that under certain circumstances the substrates on wildlife trails, streambeds, and ridges may indicate their recent presence (Wilson 1996). However, there is significant variation in the size, shape and appearance of tracks and sign of some groups; including large cats (Duckworth & Hedges 1998; Kanchanasakha et al. 1998) so that tiger may be confused with other species (Lynam et al. 1999). For these reasons sign was considered not sufficient for the identification to species level for cats, dogs, civets, deer, muntjac, wild cattle, and otters. However, the abundance of sign was generally indicative of the level of mammal traffic in an area. Ungulate sign was additionally used to indicate possible areas of carnivore activity, and as such to help guide the placement of camera-traps for detecting the latter (below).

Standardized datasheets were used to record date, time of day, weather, location (latitude/longitude) type of sign, dimensions of track/sign, probable species/genus identity, age, substrate, and habitat type (Appendix V). Locations where mammal sign was encountered were recorded with a Global Positioning System (GPS) device capable of resolving position information beneath tree canopies, accurate to ± 100 m* (Garmin 12XL, Garmin Corporation, Kansas USA). Feline tracks with total length ≥120mm or pad width ≥7cm, and scat ≥3.5cm in diameter were considered to be indicative of tigers (A.J. Lynam, A. Rabinowitz & R.K. Laidlaw unpublished data; Cutter 1999; Duckworth & Hedges 1998). Where the size of a feline track was ambiguous because of the substrate or age of a track, the track was identified only as "large cat" meaning either tiger or leopard. Other species were identified using a field guide to Thai mammal tracks (Green World Foundation 1999). An index of abundance "Encounter Rate (CR)" was estimated from sign surveys as ER = no. sign detected/hr.

6.7.4. *Camera-trapping* - Remote camera methods have been used successfully to photographically record wildlife in tropical Asian forests (Chapman 1927; Griffiths &

* As of 1 May 2000 the United States Department of Defence, that agency that controls GPS satellites, turned off Selective Availability (SA) or "scrambling" of GPS satellite signal information. Prior to this date the accuracy of GPS position fixes was limited to ±100 m. Most recreational GPS devices are now capable of real time position fixes accurate to ±20 - 25m.

van Schaik 1993). Although these devices are relatively expensive they offer a reliable method for inventory of species that are cryptic nocturnal or rare, including tigers (Lynam et al. 2001). Passive infrared-based camera-traps (Camtrak South Inc., Georgia USA)(Fig. 11.) were used in all surveys.

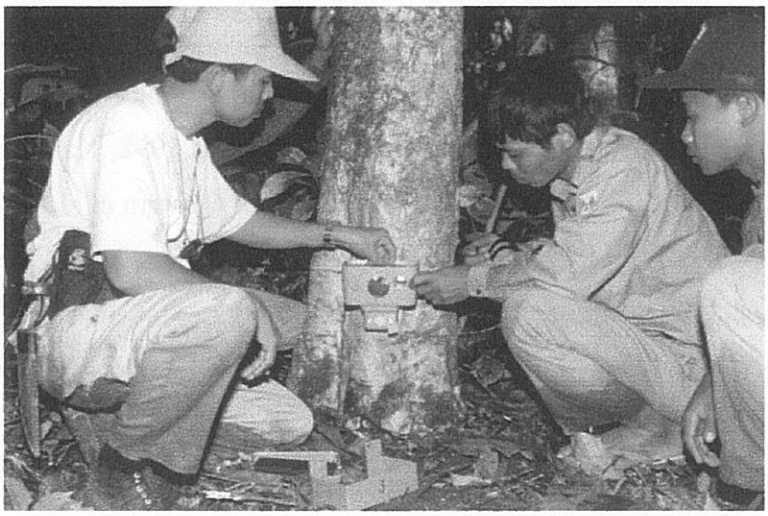

Fig. 11. Infrared-based camera-traps were used to detect tigers and prey species.

To achieve the best possible resolution of species identity from photographs, camera-traps were secured to trees 0.4m above the ground, 3-5 m from a wildlife trail. All camera-traps were set to allow continuous recording of wildlife movements day and night. Traps were left in place for at least 24 days to allow for adequate sampling of large mammal species richness (A.J. Lynam unpublished data) and at least 1,000 trapnights to correctly determine tiger presence or absence (Carbone et al. 2001). For example, tigers were considered absent from a site if they were not recorded in any trap, with absence referring to the particular area effectively sampled for the particular sampling period. The sampling effective area at a site was estimated by placing a buffer around the outermost locations of camera-traps with the length of the buffer equivalent to half the mean distance between camera-traps. A time delay of 3 or 6 minutes prevented entire rolls of film being taken by groups of animals lingering in front of the camera-trap. An index of abundance "Capture Rate" (CR) was estimated from camera-trapping as CR = no. photorecords/100 camera-trap nights.

6.7.5. *Survey design* - Two survey designs were employed for tigers (Fig. 12.). In both cases, the primary intention was to gain information on (1) tiger presence-absence, (2) tiger and prey microdistribution and activity in each study area.

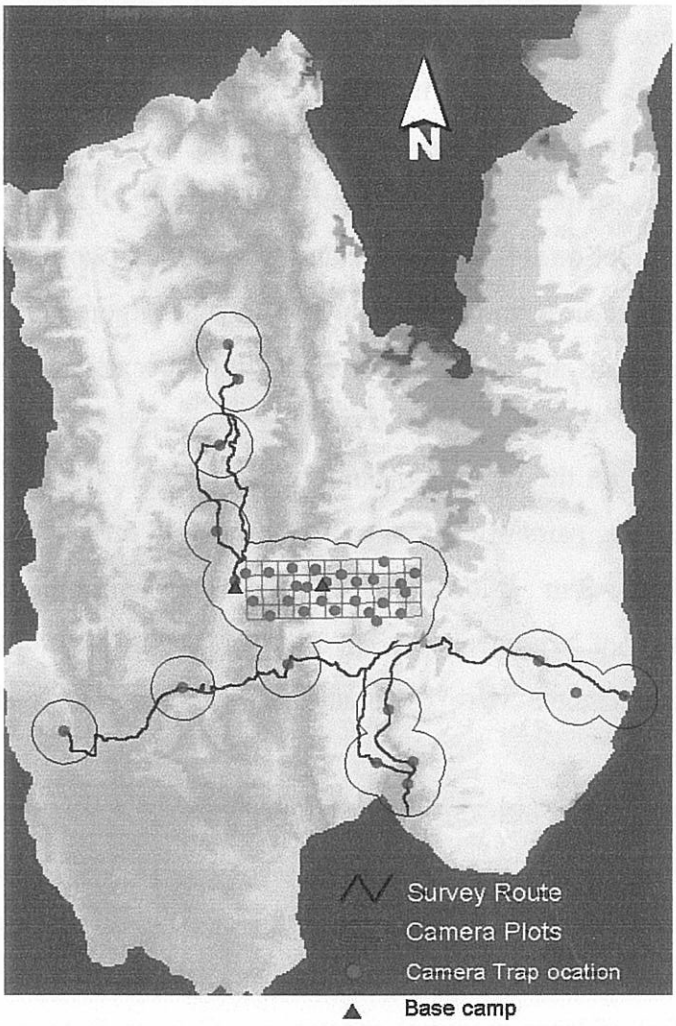

Fig. 12. Tiger survey design (see text for details).

First, camera-traps were placed at random locations within 10 x 4km sampling grids, in alternative 1km^2 grid blocks. This was termed the *plot-based* survey design (Lynam et al. 2001). The random locations were reached using Global Position System (GPS) receivers (Garmin 12XL, Garmin Corp. Kansas USA). Traps were established on trails or other suitable positions within 100m of random locations. Grids were located in areas where interviews suggested tigers occurred, or where tiger occurrence could not be determined, in the part of a study area least disturbed by humans. Tigers require a core area of undisturbed habitat for their survival (Schaller 1967) although this may be a small part of their entire home range (Miquelle et al. 1999). If tigers are present in an area they are likely to at least frequent a core undisturbed area and should be detectable there.

In the second design, camera-traps were deliberately placed along trails and roads where sign of tigers, large cats or their prey species were recorded. This was termed the *trail-based* survey design (Lynam et al. 2001). Sampling locations where capture probabilities for tigers are highest (Karanth and Nichols 1998) increases the likelihood of their detection at a site.

Because the stripe patterns of tigers are unique to an individual (Schaller 1967) but are different on left and right sides, camera-trap photographs of both sides of an animal must be used to distinguish it from other tigers (Franklin et al. 1999) While specific methods are available for estimating tiger density from double-sided camera-trap designs (Karanth 1995) this was not the purpose of this study. However, to gain information on the minimum number of tigers known to be alive (MNKA) inside the survey area, pairs of camera-traps were placed on opposite sides of animal trails, staggered by 2 - 3 m at locations where field staff considered tigers were likely using e.g. because of presence of sign of tiger and/or large ungulates These "checkpoint" arrangements were established to gain double-sided photographs of tigers.

In summary, the surveys obtained four types of indices: i) tiger presence-absence, (ii) minimum numbers of tigers known alive (MNKA); (iii) minimum ranges of individual tigers from linking outermost points of locations where tigers were captured in camera-traps or identifiable from tracks and sign; (iv) an index of abundance (traffic) of large mammal species, i.e. Capture Rate = no. captures/ 100 trapnights

6.7.6 *Survey personnel.* At all sites surveys were done by Myanmar Forest Department staff in collaboration with WCS personnel (except in Tanintharyi Division), and local forestry or other government staff. Local people were hired as porters to carry equipment and assist with field logistics. In security areas teams of military personnel joined the survey team. The size of the field survey teams was 3 - 7 key staff with 10 – 40 support staff. The average cost of each survey was US$3,600.

6.7.7. *Survey effort, constraints and coverage.* In most cases, the survey areas were remote and difficult to access, and surveys required special permissions and clearances. Surveys were constrained by a number of factors including extremes of

weather, topography, and security considerations. The particular sites where camera-trap surveys were done at MMLK and TNTY were *not* optimal sites, and were in fact selected by security personnel assisting the team. At each site, field staff attempted to obtain the maximum coverage of the area suspected in tiger survey. All surveys were conducted on foot and consumed 26 ± 5 days (range: 15 – 100) to reach the survey area, and 86 ± 12 days (range: 10 – 207) to complete a survey from start to finish. Total survey coverage was 3,432 sq. mi (5,491 km2), or 202 ± 29 sq.mi (range: 91 – 525 sq. mi). At Alaungdaw Kathapa and Htamanthi the areas covered by survey (244 and 329 sq. mi, respectively) were each one-quarter the size of the protected areas. Interviews of a total of 990 people, or 58 ± 17 interviews (range: 5 – 276) per site were done to determine areas for direct survey. A total of 1,382 hrs, or 81 ± 9 hrs (range: 32 – 171) per site were spent searching for track and sign of tigers. Camera-traps were established in a total of 430 locations, or 25 ± 3 locations per site (range: 0 – 45) to detect tigers.

6.7.8. *Data recording and storage* - Standardized data recording forms were employed to record all field data from surveys (Appendices V-VIII). In the field, staff recorded information on camera-trap operation, measured a suite of microhabitat characteristics at survey locations, and records of track and sign taken along survey routes. All records of wildlife were spatially referenced in UTM grid format using GPS. Following camera-trap retrieval, films were developed at a laboratory in Yangon, and slides catalogued and scored, with records entered into a spreadsheet. Slides were scanned at low resolution and archived.

In order to manage the volume of information arising from the field program, to facilitate analyses of data, and to develop a clearing house of baseline information on tiger and other wildlife for the 17 survey areas for use in future management efforts, an electronic database was developed for the project. This database, written in Microsoft Access by U Myint Thann, contains 15,021 records including all results of track and sign and camera-trap surveys, as well as measurements of microhabitat structure.

In addition to the Access database, a spatial database was developed using Arcview 3.1 software (ESRI Systems, Inc., Redlands, USA) with the assistance of the Myanmar Forest Department (FD) GIS Facility. The database includes information