# Assessing the status of tigers in the Western Forest Complex of Thailand and developing a landscape scale management plan

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## EXECUTIVE SUMMARY

** Note: Numbered maps referred to in the text can be found at the back of this report.*

Over a four year period from 1997 to 2000, we surveyed a large portion of the Western Forest Complex--an expansive landscape (~10000 km2) of contiguous, mostly forested protected areas in western Thailand (Map 1) to assess the status of tigers, their prey base, and other factors potentially affecting the tiger population in this area. In particular, we sought to answer the following questions:

1. What proportion of the core area of the Western Forest Complex is occupied by tigers?
2. What are the landscape-scale patterns of tiger prey distribution and quality in this area?
3. What are the landscape-scale patterns of human impact in this area?
4. Are patterns of tiger distribution, tiger prey distribution, and human impacts related?

In their macro-scale tiger conservation priority setting exercise, Wikramanayake et al. (1998) identified the Western Forest Complex and surrounding areas as the largest high priority Tiger Conservation Unit (TCU) in Asia and it is likely that this TCU is home to the largest population of tigers in Southeast Asia (Smith et al. 1999b). The area is mostly rugged, mountainous terrain with 2 major river systems and 2 mountain ranges bisecting it. The vegetation is a complex mosaic tropical seasonal forest including dry or semi-evergreen forest, tropical mixed deciduous forest, bamboo forest, and dry dipterocarp forest. Within the survey area, there are approximately 4000 people living in about 35 village sites.

Our initial efforts focused on selecting methodologies appropriate to the geographic scale of the investigation and the questions being asked. In most cases, field methods that could be learned quickly, employed consistently, and that were not technology-dependent were selected so as to involve a greater number of people in the process and in so doing, foster greater long-term capacity building. Additionally, a Geographic Information System (GIS) was established at the outset of the project to store, analyze, and display data collected.

On over 50 field trips during the course of the project, a core survey team would visit protected areas within the larger study area on a rotating basis to carry out training with protected area personnel and to supervise fieldwork. All of these efforts were focused on both completing the specific goals of the project and building the local capacity and baseline data necessary to continue the work after the completion of the project. Approximately 50 Royal Forest Department (RFD) rangers (4-6 from each of the 5 protected areas surveyed plus several replacements during the course of the project) took part in an intensive 2-3 day practical training course prior to assisting with fieldwork. The training covered wildlife and wildlife sign recognition, basic sampling concepts, forest navigation skills (including the use of handheld GPS units), and other methods specific to this investigation. An original training manual was created to supplement the training.

To assess tiger distribution, irregular transect or “recce” style tiger sign surveys (Walsh and White 1999) were conducted on approximately 1880 km of roads, trails, streams, and ridges (Map 4). To assess relative prey abundance, pellet/dung count plots were carried out on 57 km of transects at 114 discrete locations (Map 4). Methods followed those used extensively throughout the Terai area of Nepal (Smith 1984, 1999) allowing for a comparison of relative densities between these two areas.

During the course of the study, 150 interviews were carried out at 29 villages and 47 Thai Royal Forest Department (RFD) stations in and around the study area (Map 5). These guided discussions provided additional information on the distribution of tigers (Map 7) and other wildlife (Map 9) as well as valuable insights into patterns of human use and impacts (Map 3).

Visits to captive facilities during the course of the investigation resulted in a database of track measurements of tigers of known age and sex and the establishment of objective criteria for estimating the age and sex of tigers whose tracks were measured in the field. Applying these criteria to the pooled "unknown" sign collected during the investigation provides a snapshot of tiger demographics during the survey period (Map 7). An evaluation of these data using very conservative assumptions yields an estimated minimum adult tiger population of 6 males and 21 females within the area surveyed which is roughly 30% of the entire Western Forest Complex.

A preliminary assessment of tiger distribution, tiger prey distribution, and human impacts indicates that there is a significant relationship between both tiger distribution and tiger prey distribution and between tiger distribution and human impact patterns.

The data collected to date are currently being used to create predictive models of tiger and tiger prey distribution beyond the bounds of the study area with the ultimate goal being a predictive map of tiger distribution in western Thailand and eastern Burma.

## STUDY AREA

The area selected for analysis encompasses five contiguous protected areas near the Thai / Myanmar border. At approximately 10,000 km2, the study area represents the core of a mostly forested landscape known as "the Western Forest Complex" comprised of 17 separately managed protected areas (Map 1). Together with a large area of contiguous forest on the Myanmar side of the border, the area represents the largest TCU (Tiger Conservation Unit) identified by Wikramanayake et al. (1998) in their range-wide tiger conservation priority-setting exercise. Armed conflict and travel restrictions have meant systematic fieldwork has not been carried out on the Myanmar side of the border in recent years.

At the southeastern end of the extensive Tenasserim and smaller Dawna mountain ranges, the area is mostly rugged, mountainous terrain interspersed with some wide valleys and plateaus (Map 2). Elevations range from below 100 meters to just over 2200 meters. Most watersheds in the area are part of the large Maeklong River system that flows south into the Gulf of Thailand; a few drain west into the Salween river system which in turn empties into the Andaman Sea.

Weather patterns in the study area are driven by a seasonal monsoon system with prevailing weather coming from the Indian Ocean during the wet season (May through October) and from the Pacific rim in the dry months (November through April). Annual temperature and rainfall patterns are summarized in Figure 1. Several high mountain ranges intercept monsoon rains during the wet season resulting in a marked difference in precipitation patterns from the southwest to the northeast.

The vegetation pattern within the study area is a complex mosaic of evergreen and deciduous types. Although stands can differ dramatically in terms of both species composition and structure, few areas exhibit sharp edges and much of the forest is part of a continuum between the idealized descriptions found in many texts. Interspersed with forested areas are smaller patches of natural grassland, savannah woodland, and cultivated areas. Bangkurdpol (1979) separates evergreen forests in the region into semi-evergreen (or seasonal evergreen) and hill evergreen types and deciduous forests into tropical mixed deciduous and dry deciduous (or dry dipterocarp) types.

Zoogeographically, the area falls within Indochinese subregion of the larger Oriental region. The tiger is the largest carnivore in the region and occurs sympatrically with leopards (*Panthera pardus*) in many parts of the study area. Other large carnivores include the Asiatic wild dog (*Cuon alpinus*), Asiatic jackal (*Canis aureus*), Asiatic black bear (*Ursus thibetanus*), and Malayan sun bear (*Ursus malayanus*). Larger herbivores include gaur (*Bos gaurus*), banteng (*Bos javanicus*), sambar deer (*Cervus unicolor*), barking deer (*Muntiacus spp.*), and wild pig (*Sus scrofa*). Elephants are present in relatively large numbers and are responsible for maintaining some of the area's vegetation patterns (Lekagul & McNeely 1977).

Ethnic Karen and Hmong populations have lived in the area for at least 200 years. Although some villages have been relocated over the last 30 years as part of protected area management efforts, approximately 4000 people (mostly Karen) still live at about 35 village sites—most near the Thai/Myanmar border. Additionally, over 70 Royal Forest Department stations in and around the area house over 300 people. Most villages practice a rotating crop system with dry-farmed rice as their staple food although an increasing number of villages are moving to paddy rice cultivation with sometimes elaborate, semi-permanent irrigation systems. Outside of protected area boundaries, human population densities increase immediately. Although officially restricted, activities such as the

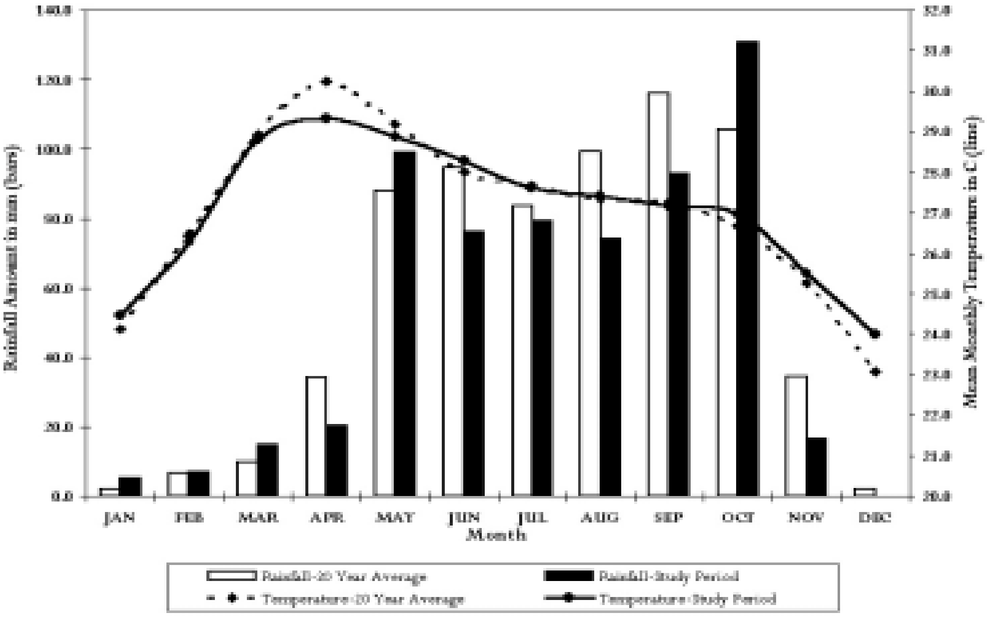


*Figure 1. Temperature and rainfall patterns. Data averaged from 11 weather stations surrounding the study area.*

collection of forest products, hunting, fishing and logging take place to some degree throughout much of the area (Map 3).

Of the five protected areas that make up the study area, 4 are Wildlife Sanctuaries (Umphang, Huai Kha Khaeng, Thung Yai Naresuan East and Thung Yai Naresuan West) and 1 is a National Park (Mae Wong). Although official regulations and management guidelines differ dramatically between these two designations, in practice, superintendents have significant latitude to set policy within the protected area they administer. Both designations have in place a system of substations scattered throughout the area. Official responsibilities include patrolling and the enforcement of the laws governing protected areas and wildlife. Wildlife research, natural history interpretation for visitors, and other conservation-oriented activities have become more common in recent years.

## CAPACITY BUILDING

Training of both Royal Forest Department staff and other local residents in general field skills and, in particular, tiger and tiger habitat assessment techniques was an explicit goal of this project. To accomplish this, teams of RFD staff and local residents were selected, took part in 2 days of intensive training, and then accompanied the survey teams during each visit to a given protected area. A detailed training manual was created (in both English and Thai) (Cutter et al. 1998) to serve as a reference to methods and other supporting information. In addition to its immediate value to this project, elements of the manual have also been translated for use in tiger conservation projects in Nepal, Cambodia, and Southern China.

## METHODS

### Tiger Surveys

Initially, a photo-trapping survey approach was contemplated as a means of documenting the presence of tigers in a given area (Smith et al. 1999a). To evaluate this approach, Trailmaster passive infrared photo-trap kits were set up in six locations to generate a total of 53 trap nights over a 2 week period. The area selected for this trial is widely considered to have one of the highest densities of tigers in Thailand and traps were located at sites determined to be tiger travel routes through the presence of tracks. Although the overall capture rate for large mammals was promising (11 photo-captures including leopard, Asiatic wild dog, large Indian civet, common palm civet, sambar deer, barking deer, banteng, and tapir), no tigers were photographed. In contrast, walking surveys of trails and dirt roads transecting the same area during the photo-trapping period resulted in several detections of unambiguous tiger sign (including tracks, scrapes, and scat) with enough variation in some of the track sizes to conclude that at least 3 tigers were utilizing the area. Given that the primary goal of the investigation was to establish the presence/absence of tigers in large catchment areas over a very large (~10000 km$^2$) area, these findings indicated that a track-based detection method would more effectively serve this effort.

To facilitate logistical planning and reporting of data, the study area was subdivided into smaller survey units of from 100-300 km$^2$. Within this framework, over 1800 km of roads, trails, ridges, streams, and other linear features were walked to note the occurrence of tiger and tiger prey species and their sign. Additionally, observations of broad vegetation classes made at intervals along these routes were used to assess the accuracy of existing vegetation maps that had been manually interpreted from satellite images. Each day's survey route was carefully mapped to provide for calculation of survey effort and coverage. Survey effort in terms of linear kilometers walked per square kilometer is summarized by survey unit in Map 4.

### Pellet/dung transects

Pellet/dung plots were carried out to determine the relative density of various tiger prey species throughout the study area (Map 4). Along straight line transects 500 meters in length, 25 evenly spaced 10 $m^2$ circular plots were carefully searched for animal pellets/dung as well as tracks and other sign. In addition to the within-plot data, animal signs observed at any point in the length of a transect were noted to establish the presence of various species at the transect site. Although, much of the sign encountered could be unambiguously assigned to an individual species, tracks and pellets of two barking deer species known to occur in the area (*Muntiacus muntjak* and *Muntiacus feai*) were grouped as were the dung and tracks of two wild cattle species (*Bos javanicus* and *Bos gaurus*). Map 8 summarizes the findings for sambar deer (*Cervus unicolor*), barking deer (*Muntiacus* spp.), wild pig (*Sus scro*fa), and wild cattle (*Bos* spp.).

### Interviews

Semi-structured interviews were carried out in 29 villages and 43 Thai Royal Forest Department (RFD) stations in and around the study area (Map 5). We employed an interview approach comprising both individual interviews and focus groups, having found that this two-pronged approach provided a more consistent and complete picture of wildlife distribution and human impacts within the study area. All interviews were conducted as a guided discussion using a written set of questions for reference. It was made clear that interviewers were independent of the Royal Forest Department and that the data collected were for use in producing a public report on wildlife distribution and human impacts in the area.

Individual interviews focused on the informant's individual experiences (such as tiger sightings, sign encounters or a favorite hunting spot). For this effort, we tried to enlist representatives of at least 10% of the households in a village to provide a nominal level of representation and an opportunity for cross-checking informant reports.

Focus group interviews (where information collected were attributable to a group of people rather than a specific individual) were conducted to capture more general information pertaining to the village community and its interactions with wildlife and wildlife habitat. We found that in such a setting, a group was more likely to share otherwise "protected" information (e.g. general hunting and trade patterns), as the reports will not be traced to a single informant. Additionally, we found the group format better suited to the production of detailed maps that could subsequently be transcribed into the GIS. We used 1:50000 scale topographic map sheets issued by the Thai Royal Survey Department for this purpose. At the beginning of interviews, landmarks would be added to the maps for orientation and reference.

Questions asked of villagers and rangers differed to reflect the different roles and activities of the informants. For example, some questions asked in ranger focus group interviews covered patrol routes and risks while on patrol while some of the villager-focused questions pertained to crop raiding by various wildlife species.

Although the written interview guidelines changed in some ways during the course of the interview effort, the following information was sought during each interview:

- Any information on tiger sightings or occurrences of tiger sign within the last 3 years.
- All reports of attacks or predation on livestock by tigers over the last 3 years
- What species have been seen within the patrol/knowledge area of the station/village in the last 3 years.

Interviews generated valuable information on encounters with tigers and tiger sign (Map 7) as well as prey assemblages (Map 9) and human impact patterns (Maps 3).

### Captive Sign Study

Track measurements have been used to determine the species (Smith 1984, Karanth 2002, Lynam et al. 2001), sex, and in some cases, the individual identity of large felids in Asia (Smith 1999, McDougal 1999). Although guidelines for such determinations exist for Bengal tigers, a comparison of track measurements from field investigations in Nepal (C. McDougal pers. comm.) with those from this study showed that track measurements of the Thai (*P. t. corbetti*) tigers were consistently smaller than those of Nepal (*P. t. tigris*) tigers. To provide an objective reference for the interpretation of sign measured in the field in western Thailand, a controlled study of tiger sign made by tigers of known age and/or sex was carried out during the course of the investigation.

Most reference sign was measured at zoos and other captive situations in both Thailand and Cambodia. To minimize observer bias, all measurements used in the analysis were taken by a single investigator (Cutter). In some cases, field circumstances (for example, the clear occurrence of large and small tiger tracks deposited at the same time at a single location indicating a female with cubs) allowed for high confidence interpretation and were also included in the reference data set. To estimate observer bias (a source of variance in most field investigations), many of the measurements were additionally taken by a second observer allowing for an analysis of paired measurements taken from the same tracks. A controlled environment further allowed for the explicit analysis of variance due to differing substrates.

Track reference data used to categorize track measurements from unknown individuals are summarized in Figure 2.

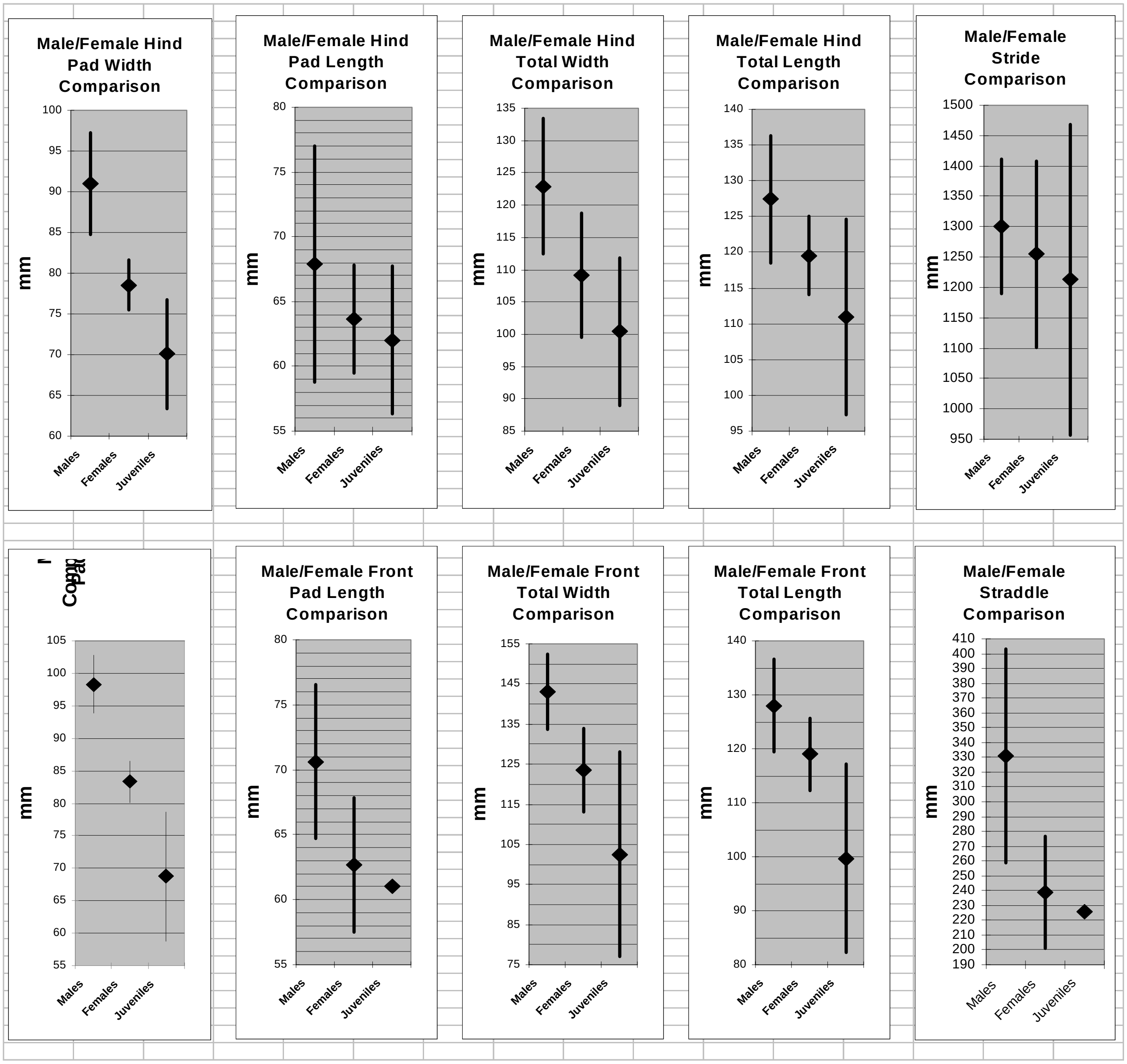


*Figure 2. Values of adult male, adult female and juvenile tiger sign data in terms of 10 track dimensions evaluated for their power to distinguish between these demographic classes. Data were obtained from 5 males, 9 females, and 14 juveniles (< 2 years of age) of known age. Only tigers reported by handlers to be of Indochinese subspecies (P.t. corbetti) were included in the analysis. Diamonds represent average values; bars represent 99.9% confidence intervals.*

# RESULTS

## Geographic Information System (GIS) Database

The GIS that we have created includes both data collected during the course of the project as well as numerous other themes that provide a detailed context for those data. In most cases, preexisting data were corrected, enhanced, or processed to serve the modeling process that is now taking place. Among these background themes is a high resolution (50x50m pixels) digital elevation model (DEM) created from 28 high quality 1:50000 topographical maps of the area. An automated hydrology algorithm (Hydrologic Modeling Environment; Environmental Systems Research Institute) was applied to this DEM to delineate the 59 survey units that have served both the logistical and analytical objectives of the investigation. All between 100 and 300 km$^2$ in size, the survey units allow for sample data to be aggregated and evaluated at a resolution that we feel is appropriate from both ecological and management perspectives.

A summary of all of these themes can be found in below (Table 1). The GIS that we have created includes both data collected during the course of the project as well as numerous other themes that provide a detailed context for those data. In most cases, preexisting data were corrected, enhanced, or processed to serve the modeling process that is now underway.

*Table 1. Summary of GIS Information collected and compiled during the course of the project.*

| Name of Theme | Type [a] | Data Attributes | Extent [b] | Notes (Precision, resolution, geographic accuracy, base data, processing) |
|---|---|---|---|---|
| ***International boundaries*** | *polygon* | • | *Asia* | |
| ***Thailand Protected Areas*** | *polygon* | • Name of protected area<br>• Presence/absence of large mammal spp. Based on previous studies | *Thailand* | |
| ***Thailand administrative units*** | *polygon* | • Name of administrative region<br>• Name of province<br>• Name of district | *Thailand* | |
| ***Survey Units*** | *polygon* | • Survey effort (km of survey/km$^2$<br>• Landcover diversity<br>• Ruggedness<br>• Prey quality index<br>• Tiger Presence/absence | *Study area* | • *Attributes based on aggregated data based on other raster and vector data themes described here*<br>• *Automated delineation based on DEM + procedure described in text* |
| ***Survey routes*** | *line* | • Date of survey<br>• Distance | *Study area* | • *Acquired using handheld GPS* [d]<br>• *Waypoints recorded at least every 200 meters* |
| ***Transect locations*** | *point* | • Date<br>• Dung/pellet group amounts by species<br>• Vegetation class | *Study area* | • *Acquired using handheld GPS* |
| ***Hunting routes*** | *line* | • Intensity of use | *Buffered study area* | • *Mapped in consultation with local hunters and other residents (see Methods)* |
| ***Human activity zones*** | *polygon* | • Intensity of use | *Buffered study area* | • *Mapped in consultation with local hunters and other residents (see Methods)* |
| ***Contours*** | *line* | • Elevation | *Western Forest Complex* | • *From 1:50,000 scale maps with 20m between contours* |
| ***Elevation model*** | *TIN* | • Elevation | *Western Forest Complex* | • *From contours, peak points, and streams as breaklines* |

| | | | | |
|---|---|---|---|---|
| ***Elevation model*** | *DEM* | • Elevation | *Western Forest Complex* | • *50 m cells*<br>• *derived from triangular integrated network based on contour maps described above*<br>• |
| ***Slope*** | *grid* | • Degree slope<br>• Percent slope | *Western Forest Complex* | • |
| ***Ruggedness*** | *grid* | • Ruggedness index (250 m, 500 m circular neighborhoods | *Western Forest Complex* | • *Ruggedness index is standard deviation (in meters) of grid centroids within a circular neighborhood of each cell*<br>• *Edge effects within 500 meters of DEM surface used to generate grid* |
| ***Rainfall*** | *grid* | • Avg. annual amt. (20 year mean)<br>• Avg. annual amt. (study period mean) | *Buffered study area* | • *20 years of monthly amouts*<br>• *Interpolated from 9 point locations surrounding and within the study area* |
| ***Temperature*** | *point* | • | *Buffered study area* | • *20 years of monthly amouts*<br>• *Interpolated from 9 point locations surrounding and within the study area* |
| ***Villages*** | *point* | • Male/female population<br>• Education rate | *Western Forest Complex* | • *Not all data attributed*<br>• *Attribute data from ~1996* |
| ***Travel Routes*** | *line* | • Type of route | *Buffered study area* | • |
| ***Streams*** | *line* | • Class<br>• Seasonality | *Study area* | • *Evidence that seasonality (i.e.permanent vs. ephemeral) is not accurate* |
| ***Forest cover*** | *polygon* | • Forest cover | *Asia* | • *History of data not known*<br>• *Low precision (inaccuracies up to at least 10 km)* |
| ***Landcover*** | *polygon* | • Landcover class | *Study Area* | • *Based on visual interpretation of satellite and aerial photograph images.*<br>• *Accuracy of landcover class attribute questionable (see discussion in text)* |

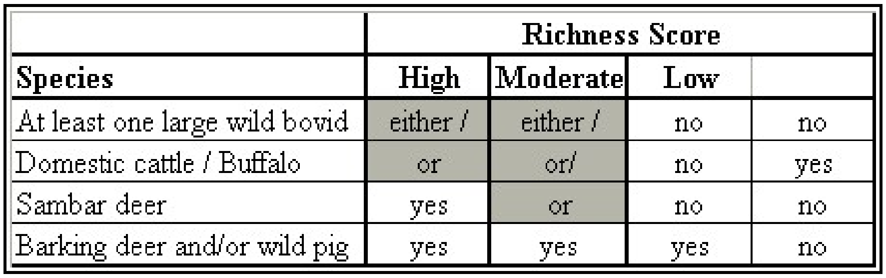
## Human Impact Patterns

The extent and nature of human impact patterns mapped in the course of interviews and field surveys are shown in Map 3.

## Prey Base Assessment

Data from 112 pellet/dung count transects are summarized in Table 3 and Map 8.

Interview data on the occurrence of prey were summarized in terms of prey assemblage quality in a procedure similar to those used in Smith (1999b) and Hean (2000). Three relative prey assemblage quality levels were assigned based on the following table:

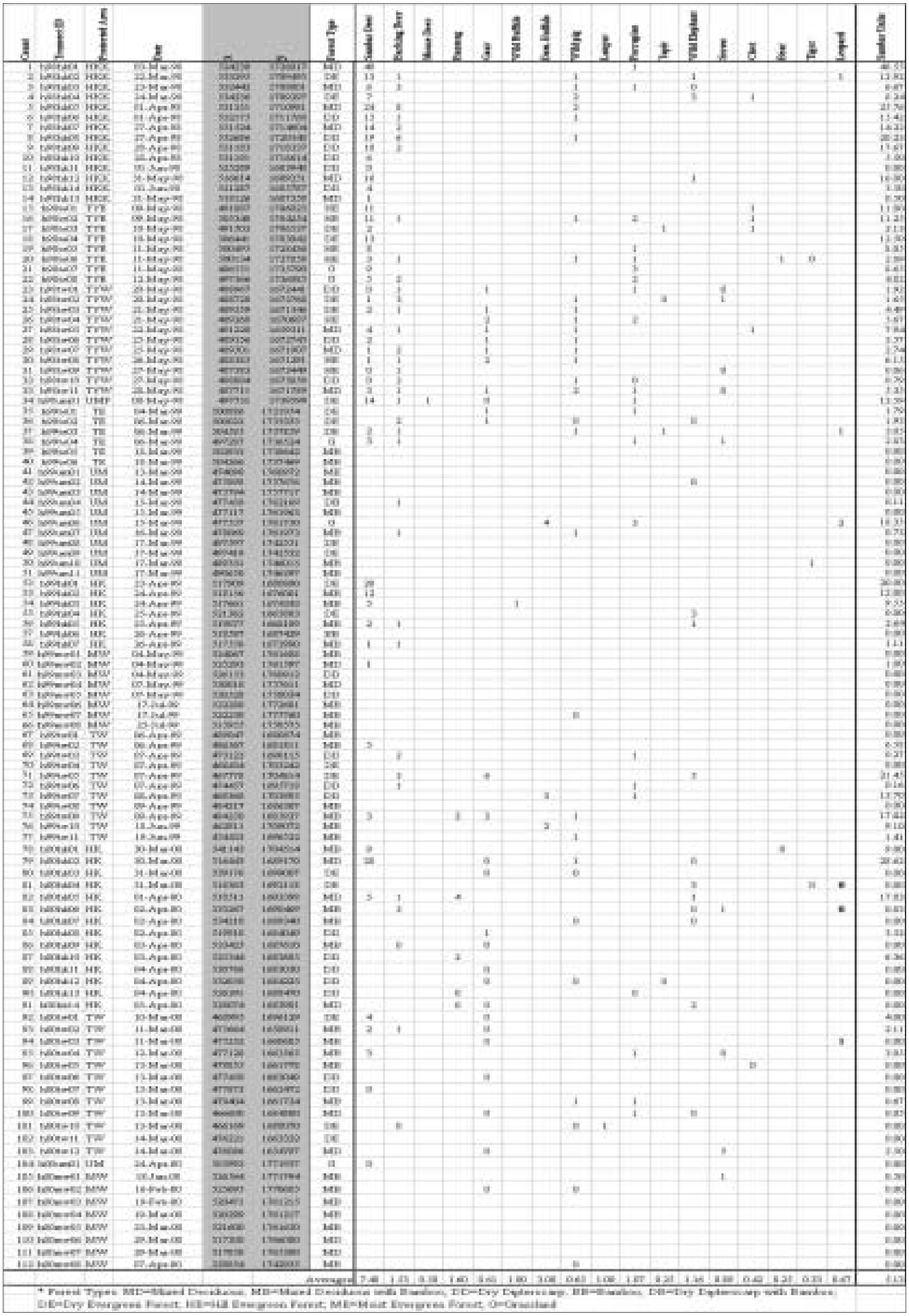


| | Richness Score | | | |
|---|---|---|---|---|
| **Species** | **High** | **Moderate** | **Low** | |
| At least one large wild bovid | either / | either / | no | no |
| Domestic cattle / Buffalo | or | or/ | no | yes |
| Sambar deer | yes | or | no | no |
| Barking deer and/or wild pig | yes | yes | yes | no |

*Table 2. Tiger prey assemblage quality scores.*

These data are summarized in Map 9.

*Table 3.  Summary of pellet/dung transects.*



## Tiger - Habitat Relationships

A preliminary evaluation of the data has indicated a significant correlation between tiger presence/absence patterns and both relative prey abundance and human activity patterns. These relationships provide an objective basis for extrapolation of data beyond the area directly surveyed.

We are currently using multiple regression techniques to model relationships between tiger presence/absence and several landscape scale environmental variables. By incorporating values identified in the regression analysis with data themes for which we have developed continuous data, we have begun the process of building explicit predictive models of tiger distribution.

## Tiger Distribution and Estimated Minimum Breeding Population

The locations of tiger sign survey routes and locations where unambiguous tiger signs were encountered are shown in Map 7. We used an area representing a 6 kilometer buffer around all routes surveyed (7233 $km^2$) as an estimate of effective area surveyed. From a total of 289 signs encountered, 86 provided high-quality track impressions that could be measured confidently. Using the results of the captive sign investigation (see above), these occurrences were assigned a demographic class based on the available track dimensions. Where more than one dimension was available, each dimension was assigned to a demographic class. To assign final demographic classes, priority was given to the dimensions with the boldest separation between demographic classes.

To estimate the minimum breeding population within the study area, we first buffered locations where tigers had been detected with a 6 km radius. Each buffer area represented an area of 113 $km^2$—slightly larger than the 100 $km^2$ male tiger home range size estimated by Rabinowitz (1991). Any buffered occurrence or group of occurrences that did not intersect with another buffered occurrence or group was assessed as a distinct cluster. If track measurement data were available for any of the individual occurrences within a cluster, male occurrences were compared with each other and females with females. If the available measurements were within 0.5 cm of each other for any given dimension, the occurrences were ascribed to the same individual. If they differed by more than 0.5 cm, they were considered distinct individuals. Juveniles were not included in this assessment. Using this procedure, we estimate that there is a minimum of 6 males, 21 females, and 4 individuals of indeterminate sex (= 31 total) within the area surveyed.

Finally, we estimated tiger numbers throughout the study area by calculating the density of tigers in surveyed areas (~72% of the total area) and extrapolating this density into unsurveyed areas. Because many of these unsurveyed areas were shown through interviews to have a relatively high degree of human activity, the extrapolated population was discounted by half. Based on this procedure and rounding to whole numbers, we estimate a minimum population of 37 breeding tigers within the entire study area. It is important to note that this estimate is 1) based on very conservative assumptions, and 2) does not extend into contiguous areas known to be occupied by tigers and therefore part of the same population.

## Monitoring

A practical use of the catchment survey unit (CSU) approach used in our project is a consistent platform on which to evaluate tiger survey data from year to year. By providing a basis for the explicit definition of survey effort over a period of time (in terms of days spent surveying or distance covered within each unit, CSUs allow for diverse investigations and methods to meaningfully contribute to single, consistent framework that can address several landscape scale questions. With a minimum of additional work, CSUs can also be used in a retrospective way to summarize data collected during past surveys.

## CONCLUSIONS

This project has documented that the Western Forest Complex is likely home to the largest tiger population in Thailand and provides further evidence that this is the second largest breeding population of tigers in the world.

We have demonstrated that field surveys relying on simple, locally available equipment and easy to learn methodologies can be applied on a landscape level to document tiger distribution patterns at a resolution of immediate interest to resource managers seeking practical information on which to base their policies. By utilizing explicit and tangible survey units as a means of planning, executing, and reporting data, survey effort targets can be defined and tracked and reliable presence/absence data generated.

The value of track-based surveys has been questioned in recent years (Karanth & Nichols 1998). Our approach demonstrates a way in which track-based data can be used to map tiger distribution as well as provide estimates of minimum breeding populations and demographic makeup of those populations. We are confident that as we expand the reference dataset of tiger sign, we will be able to provide more accurate (and perhaps more precise) estimates.

## ACKNOWLEDGEMENTS

We wish to thank the many people who made important contributions throughout the course of this investigation.

Mark Graham provided enthusiasm, a pragmatic working style, and indispensable guidance during the early part of the investigation. His memory was a constant source of inspiration to the project team even after his tragic death in 1999.

Ms. Passanan Boontua contributed a unique and invaluable set of skills and an unflinchingly positive attitude in her role as research assistant and interview coordinator. Mr. Chachawan Pitdamkham, Chair of the Royal Forest Department's Western Forest Complex Management Committee (WEFCOM) was supportive in many ways—from providing transportation in a pinch to introducing the project to many of the protected area leadership and staff with whom we worked. Several members of the WEFCOM staff including Dr. Anuk Patanawiboon, Dr. Theerapat Prayurasiddhi and others provided invaluable logistical support and important background information.

Local residents living in and around the study area were, without exception, gracious hosts during our field surveys and selflessly contributed everything from a comfortable place to spend the night to unparalleled knowledge and appreciation of a wilderness that most find mystifying if not intimidating. Most of the fieldwork would have been impossible without the enthusiastic assistance of numerous

Royal Forest Department rangers who were quick to pick up new skills and eager to apply them in the field.

Mr. Sompon Tanhan and his very capable staff at the Royal Forest Department's Forest Boundary Survey Division contributed their time and expertise in many ways to help create and process much of the GIS data used during the course of the project.

Many other contributors, too numerous to list here, made the project possible and we would like to thank them all for their dedication and interest in establishing an important foundation for future surveys and monitoring efforts in the area.

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## **Appendix 1. Maps**

Map 1. Study area reference map.

Map 2. Topography, hydrology, and location of tiger sign detections.

Map 3. Human impact patterns.

Map 4. Effort tracking.

Map 5. Interview coverage.

Map 6. Tiger sign surveys by year.

Map 7. Tiger distribution: Field surveys and interviews.

Map 8. Tiger prey status: Pellet / dung transects.

Map 9. Prey assemblage quality – interviews.

## Appendix 2. Photos