A Framework for Identifying High Priority Areas and Actions for the Conservation of Tigers in the Wild

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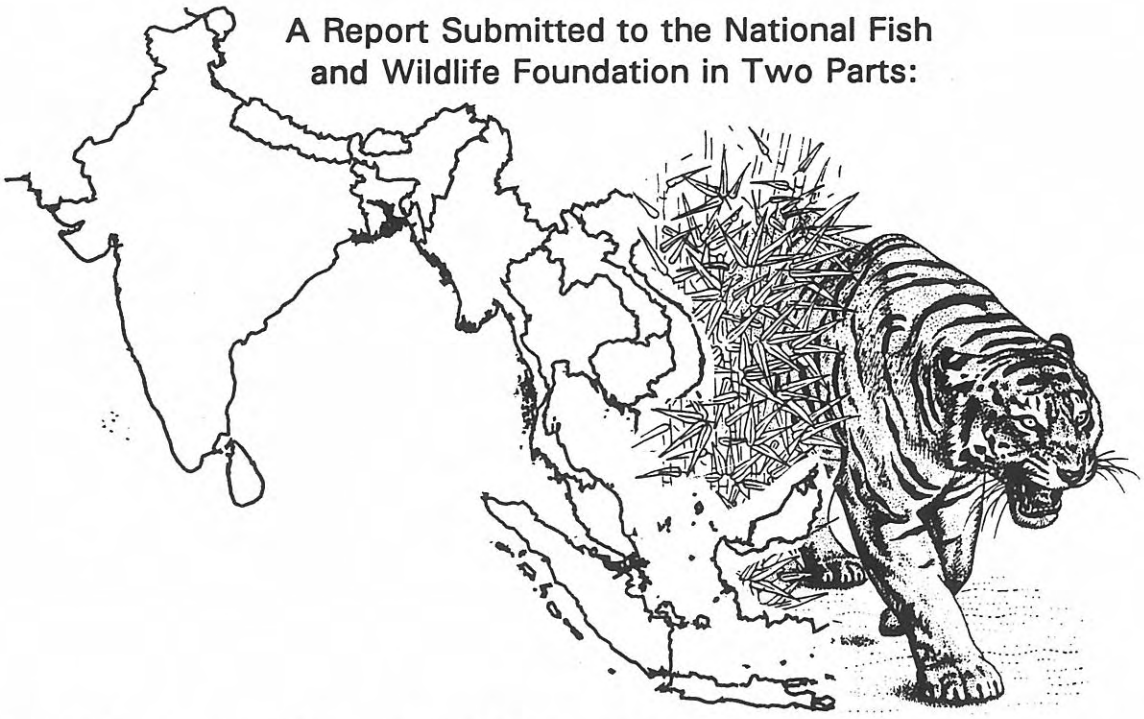

Part I: A Framework for Identifying High Priority Areas for the Conservation of Free-ranging Tigers (*Panthera tigris*)

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Part II: Controlling the Trade and Reducing Demand for Tiger Products: A Preliminary Assessment of Priority Needs

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Part I: A Framework for Identifying High Priority Areas for the Conservation of Tigers (*Panthera tigris*) in the Wild

Executive Summary

Tigers are threatened with extinction in the wild. The combination of rampant poaching of tigers and their prey–the former largely spurred by the Chinese medicinal trade–and unabated habitat loss due to fragmentation, degradation, and conversion has intensified the long-term threats to the survival of healthy wild populations. Responding to this crisis, conservation groups, donors, and national government agencies have distributed funds to halt the decline of tiger populations, but in an *ad hoc* manner. Most of the funding has been earmarked for a few protected areas, and in some cases, for activities that will do little to rectify the current crisis. Many important sites and activities have been overlooked for funding, largely because there has been no method of systematically identifying priorities. This project provides that method.

The ideal conservation strategy would be to protect all blocks of natural habitat containing tigers and to stop all illicit trade of tiger products. But due to limited financial and human resources, conservation activities must be prioritized for the next few years. Also, these priorities must also be set in a rational, transparent manner based upon the best data available.

To address these problems, we created an objective priority-setting framework to address four goals. First, we identified areas across the tiger range where conservation action and funds would have the greatest impact on conserving tigers over the long term. Second, we identify general approaches appropriate for high priority areas. Third, for the first time, we mapped tiger areas across the Indian Subcontinent, Indochina, Southeast Asia at a scale suitable for regional conservation planning. Fourth, we have identified priority countries and activities for building enforcement and trade control capacity and for reducing the demand for tiger products (see Part II of this document).

Our approach is *ecology-based*, rather than *taxonomy-based*, meaning that instead of seeking to conserve putative subspecies of tigers *per se*, we seek to conserve a suite of wild areas that represent the range of ecological conditions in which tigers occur. This approach recognizes that tigers are uniquely defined by the ecological conditions in which they live. A tiger population living in the boreal taiga of Russia will have different demographic, genetic, and behavioural characteristics than a population living in the subtropical alluvial grasslands of Nepal. By conserving examples of tiger populations in distinct bioregions, ecosystems, and habitat types, we meet a fundamental goal of conservation biology–*maintaining*

representation–while also conserving the range of communities in which tigers occur. The tiger "representation" approach has the favorable consequence that conservation efforts directed at tigers also protect many other species found in the same habitats, thus emphasizing the important role of tigers as "umbrella" species. To achieve representation, we first divided Asia into five distinct bioregions–the Indian Subcontinent, Indochina, Southeast Asia, Central and Southern China, and the Russian Far East (Amur-Sakhalin bioregion). We further divided bioregions into a total of 8 Tiger Habitat Types (THTs), in which approximately 159 Tiger Conservation Units (TCUs) occur. We relied upon local experts to evaluate the boundaries of the TCUs we delineated. Using GIS, we overlaid remaining habitat data, with data on roads, railroads, urban centers, villages, and agricultural land–features that restrict movement of tigers between habitat blocks. We formally defined TCUs as *a block or cluster of blocks of existing habitat that contains, or has the potential to contain, interacting populations of tigers.*

We evaluated TCUs on the premise that the decline of tigers across their range is caused by: 1) the fragmentation, degradation, and loss of habitat, and 2) intensive poaching pressure on tigers and their prey. These threats affect the integrity of the habitat, impoverish the biological communities in which tigers live, and reduce tiger populations. To index these changes, we created three variables: a) habitat integrity, which includes the size, degree of degradation, fragmentation, and connectivity of tiger habitat blocks; b) poaching pressure, which indexes the intensity of illegal hunting and potential for its control; and c) tiger population status, which indexes tiger abundance and recent trends in numbers within each THT.

For each TCU, a score was assigned for each of these three variables. We relied on regional and local experts to generate scores; these evaluations were augmented by published accounts and unpublished reports reviewed during this study. We then combined these scores in a weighted fashion, reflecting the reversibility of threats to tiger conservation. We considered a loss of habitat integrity to be the most difficult to reverse, and thus weighted this variable twice as high as poaching pressure, which can be turned around more easily. Poaching pressure, in its turn, was weighted twice as high as population status, reflecting the observation that tiger populations can rebound quickly if they and their habitat and prey are protected over sufficiently large areas. For each TCU therefore, we assigned a score for each of these three variables, and weighted these scores in a 4:2:1 fashion. Each TCU thus has a unique score, which reflects the probability of persistence of the resident tiger population over the long term.

TCUs were thus categorized into the following three levels:

Level I TCU: A TCU offering the highest probability of persistence of tiger populations over the long term. They are essential for a global tiger conservation strategy. Level I TCUs share the following attributes: large blocks of habitat suitable for tigers and prey with adequate core areas and low to moderate poaching pressure on tigers and prey species either as a result of remoteness or vigilant protection.

Level II TCU: A TCU offering medium probability of persistence of tiger populations over the long term. They contribute best to a bioregional tiger conservation strategy. Level II TCUs share the following attributes: moderate to large sized blocks of habitat suitable for tigers with adequate core areas and moderate to high poaching pressure on tigers and prey species, but with potential for implementing effective anti-poaching measures in the near future.

Level III TCU: A TCU offering low probability of persistence of tiger populations over the long term due to its small size, isolation from other habitat blocks containing tigers, and fragmentation within its respective THT. With intensive management and protection, Level III TCUs can harbor small populations of tigers. Level III TCUs share the following attributes: small blocks of habitat suitable for tigers with little or no core area and high poaching pressure on tigers and prey species that endangers conservation efforts.

TCUs requiring immediate surveys: Any TCU that potentially contains extensive blocks of appropriate tiger habitat with or without protected core areas, but data on habitat quality, poaching pressure, or population status for the most important habitats within the TCU are lacking.

During the process, scores for each TCU were compared only with other TCUs that *shared the same Tiger Habitat Type (THT) within the same bioregion*. Thus, we did not compare TCU scores from the Indian Subcontinent bioregion with TCUs from the Southeast Asia bioregion, nor, *within the Indian Subcontinent bioregion*, did we compare TCUs from the Alluvial Grasslands THT with TCUs from the Tropical Dry Forest THT. This approach ensures better representation of predator-prey dynamics and regional patterns of biodiversity across the range of the tiger.

In all, we identified 24 TCUs as Level I (15% of all TCUs), 22 as Level II (14%), and 101 as Level III (63%). The Level I TCUs are recommended as highest priority areas and should be the target for soliciting proposals to conserve tigers. Although we stress a biogeographic rather than a country approach to setting

priorities, we point out that all tiger range states contain at least one Level I TCU. We also identified 13 TCUs (8%) that require Immediate Surveys. We urge the financing of surveys in these TCUs immediately to better rank these TCUs and determine their contribution to a regional tiger conservation strategy.

We also discuss the prospects for tiger conservation in the two other bioregions, the Russian Far East (RFE)and Southern China. Based on extensive conservation planning already completed in the RFE and the major gaps in knowledge about tigers in Southern China, we recommend appropriate conservation activities to determine the current status of tigers (Southern China) and better protect tigers and their habitats (RFE).

The results of this study give important new knowledge about tiger conservation (illustrated in accompanying maps, graphs, and databases). We found that:

1) Virtually all of the Level I TCUs straddle or lie near international boundaries. The exceptions are a few units in central and southern India and Sumatra. This result will be essential for venues like the Global Tiger Forum to ensure that trans-boundary conservation activities are given high priority. It will also support the rationale for the trans-boundary initiatives already underway in Asia.

2) Strict protected areas typically cover only a fraction of a TCU. This spatial relationship has particular relevance in India which contains more tigers than any other country. Half of all tigers in India live outside official Project Tiger reserves, but much of the remaining half are restricted to other protected areas that are not official Project Tiger reserves. While tigers do exist outside sanctuaries and reserves, reproduction of tigers in these exterior habitats is low or may be nonexistent. This study points toward the need to upgrade management for biodiversity in many of the larger TCUs to maintain the long-term health of tiger populations and their habitats. This goal will likely require increased cooperation among multiple sectors of national and state governments.

3) Several Level I and II TCUs are very large, and we recognize that they will not receive complete protection. Since tiger habitat is being rapidly lost, this study can serve as leverage for more "conservation-friendly" land use and improved landscape management within these high-priority TCUs. If proper use is planned and enforced, habitat linkage zones, effective core areas, and buffer zones can be better maintained.

4) The habitat integrity index used in this study provides only a snapshot in time as to habitat quality within each TCU. The length of this study was too short to assess the trajectory of tiger habitats over the next 10-20 years. However, we point out that some of the most intensive, large-scale logging in the Indochina

bioregion is occurring or slated for many of the Level I TCUs, and many of these same areas suffer from intense poaching of tigers and tiger prey. We urge finer-scale studies focusing on Level I and Level II TCUs to assess trajectories.

5) The only prime example of a TCU that conserves a representative unit of tigers living in mangrove ecosystems is the Sundarbans TCU on the border of India and Bangladesh. Other TCUs containing mangroves in Indochina or Southeast Asia are mere remnants of mangrove habitat and tiger populations are severely depleted. Thus, the Sundarbans TCU emerges as a global priority for tiger conservation.

6) There was no significant relationship between the size of a TCU and its score (i.e., value as a high priority TCU). Thus, the largest blocks of remaining habitat may not always be the best areas to conserve tigers. Some large blocks are quite degraded across most of the TCU or are not considered prime habitat. In other words, one cannot simply select the largest blocks of habitat and assume to have identified the most important units.

In sum, this analysis should help guide international donors to those areas requiring immediate attention while simultaneously allowing them to make a more cost-effective investment in tiger conservation. From a possible list of 159 TCUs, we strongly recommend a portfolio of sites that, at a minimum, include some portion of the TCUs classified as Level I, II, or targets for surveys. These TCUs best capture the intrinsic biodiversity value of tigers, the ecological value of tigers as top predators in ecosystems, and the importance of tigers as "umbrella species" for conservation.

Part II: Controlling the Trade and Reducing Demand for Tiger Products: A Preliminary Assessment of Priority Needs

Executive Summary

The most immediate threat to tigers is poaching, particularly for the trade in tiger parts for use in Asian medicinal products. Until very recently, however, conservation efforts have focused almost exclusively in protected areas and reserves that contain tigers and have not addressed the increasing illegal trade in tiger parts that drives much of the poaching. It has become critical to focus on controlling trade as one element of a comprehensive strategy to conserve the tiger in the wild. In 1994, over 100 countries, including key consumer and tiger range states, supported a specific CITES tiger resolution which addresses the needs associated with trade control, enforcement, and reducing demand for tiger products.

The needs associated with trade control fall into two principal categories: strengthening capacity to control the trade and reducing demand for tiger products. This preliminary assessment identifies immediate needs and offers specific actions for addressing them.

Strengthening the capacity of countries to control the illicit trade in tiger parts and products requires law enforcement infrastructure, including specific laws with meaningful penalties, government agencies with clearly defined responsibilities, trained manpower, and intelligence-gathering networks. Our assessment identified eleven priority tiger range countries and four priority consumer nations for targeting efforts to improve trade control capabilities. We recommend five specific activities to address training and technical needs: holding workshops to address enforcement communication, information, and collaborative training issues, particularly in cross-border areas; undertaking detailed reviews of capacity-building needs as a basis for developing enforcement and trade control plans; establishing tiger trade monitoring networks to collect and disseminate information; developing identification guides on tiger parts and products to improve enforcement; and conducting independent market surveys to determine levels of trade, monitor trends, and assist in trade control efforts.

Effective legislation is essential to controlling trade in tiger parts and products but is lacking in almost every tiger range state and major consumer nation. In response to international pressure, several consumer nations have recently enacted specific domestic measures to control the tiger trade, but it is too early to determine the longterm effectiveness of these. We therefore recommend conducting detailed reviews of tiger trade control laws and regulations and making

recommendations for strengthening provisions. We further recommend that appropriate assistance be provided to Bhutan, Cambodia, Laos, and Myanmar to encourage formal participation in CITES.

Reducing demand for tiger products is also critical to successful long-term conservation of tigers in the wild. Currently little is known of the demographics of tiger product users, the possible alternatives that might be advocated as replacements for tiger products, and associated market dynamics. Efforts that target these issues should focus primarily on the East Asian markets of China, Hong Kong, Taiwan, Singapore, South Korea, and Japan, as well as the large Asian communities in the United States, Canada, and Europe. In addition, it is critical to build general public support for conserving tigers and an understanding of the links between tiger product consumption and the decline of the species in the wild.

We recommend specific activities that target three different audiences in the priority consumer countries: traditional Chinese medicine (TCM) practitioners, users of tiger products, and the general public. It is essential to design and implement these activities within the cultural context of the different target audiences. The recent international symposium on traditional Chinese medicine and wildlife conservation sponsored by TRAFFIC, WWF, and the Hong Kong government, underscored that working with the TCM community is a top priority. Efforts with the TCM community need to focus on disseminating information on the relationship between the decline of the tiger and use of tiger medicinal products, exploring possible substitute products, enlisting the support of the TCM community in trade control efforts, and collaborating on consumer education efforts.

Broad public awareness efforts are also needed to target the general public and should be linked with specific efforts targeting the TCM communities and tiger user groups. Four specific activities we recommend are: using tiger public awareness coordinators to develop a suite of outreach and educational efforts, enlisting corporate and international advertising and marketing support to disseminate tiger conservation messages, designing school curricula on tigers accompanied with training teachers, and designing a general educational kit that addresses the range of tiger conservation issues for use with a wide variety of audiences. These same activities are also recommended to build public support for conserving tigers in range countries.

I. Introduction

All areas across Asia containing tigers are worthy of conservation effort and support. However, funds and personnel are insufficient to adequately protect all remaining tiger populations. Thus, we need to prioritize among remaining populations to ensure that sufficient resources are allocated to those populations with the highest probabilities of persistence.

Threats to free-ranging tigers have intensified over the past three years due to rampant poaching of tigers and their prey. The extensive loss and degradation of tiger habitats over certain parts of their range has also been devastating. Intensive logging in valuable tiger habitat and rapidly growing human populations around the periphery of other areas suggest a grim future for tigers unless we act now.

Because of the lack of an objective, global tiger conservation strategy, most efforts to conserve tigers in the wild have been largely *ad hoc* in place, time, and type of activity. Lack of a strategy has also hampered the cost-effectiveness of conservation funding. Much recent funding has concentrated on anti-poaching activities in a few well-known protected areas, several short-term surveys, and policy and enforcement initiatives to attain better compliance with CITES regulations. But this is only a piecemeal approach to conserve tigers in the wild.

Determining the appropriate places, timing, sequence, and level of effort required to save wild tiger populations across Asia is an essential part of endangered species management. We must act now to identify the most cost-effective projects, basing them on sound science and, more specifically, on the principles of conservation biology and landscape ecology. Several important fora have already initiated the task of identifying priorities for tiger conservation, including the Species Survival Commission's Cat Specialist Group of the IUCN and the Global Tiger Forum.

To accelerate the process of setting priorities, the National Fish and Wildlife Foundation, through its Tiger Council, requested World Wildlife Fund-US and the Wildlife Conservation Society to provide a framework for evaluating funding proposals for conserving free-ranging tigers. Both organizations have a long history of financing basic research, reserve establishment, anti-poaching efforts, habitat protection, and innovative approaches to tiger conservation across Asia. Most importantly, WWF and WCS maintain close links with tiger experts or actually employ field staff who are monitoring tiger populations and habitats across the range.

In accepting the task from the Tiger Council, WWF and WCS agreed to serve as honest brokers in evaluating the relative importance of tiger habitats and the

populations they contain without the influence of existing tiger or related programs in either organization. Thus, this framework excludes proposals from either organization to finance conservation in any priority area. Instead, we encourage donors to entertain or actively solicit proposals from tiger range states that contain the highest priority units identified by this assessment. An outline of an appropriate suite of conservation activities in the highest priority areas is included here for the Indian Subcontinent, Indochina, and Southeast Asia to guide donors evaluating the completeness of proposals to conserve tigers.

This assessment was conducted rapidly, but benefited from our review panel's long experience working in tiger habitats. It also benefited greatly from the most recent remaining habitat data made available to us by Dr. John MacKinnon and the World Conservation Monitoring Centre, and all of the Asian conservationists who contributed to updating the maps of remaining habitats. Without their timely contribution, this rapid assessment would not have been possible. For the first time, areas that contain tigers across the Indian Subcontinent, Indochina, and Southeast Asia are mapped at a scale suitable for regional conservation planning. To make this assessment as transparent as possible for planners, we include the complete databases on which Tiger Conservation Unit (TCU) scores were based. Others may wish to use these databases to delineate new TCUs or to update our scores. We welcome responses from our colleagues across the range states in this regard.

The products of this rapid assessment will be fine-tuned through regional workshops and field surveys, which will involve in-country NGOs and government officials. We urge the continuation of this aspect of the project under a Phase II to achieve better local support for initiatives and to refine the list of Level I and II priority areas even further. Many of the areas selected as highest priority also contain core habitats for other endangered large mammals and habitats. Thus, there is great opportunity for complementary efforts to conserve other threatened large mammal populations.

The intended audience for this framework is: 1) international conservation donors, particularly bilateral and multi-lateral agencies 2) conservation organizations and individuals interested in tiger conservation and 3) conservation biologists who may find the approach we designed for tigers applicable to other endangered species with wide geographic ranges. The results of this current analysis are not meant to supplant detailed conservation planning at the national level already being conducted in some range states. Rather, it is our goal to bring to the attention of foreign donors the areas in which their investments can yield the biggest dividends in conserving tigers and their habitats. We hope that by more carefully and scientifically directing new funds, the most important tiger populations will be protected and allowed to flourish.

II. Approach.

Our approach is *ecology-based*, rather than *taxonomy-based* in that instead of seeking to conserve putative subspecies of tigers *per se*, we seek to conserve a suite of wild areas that represent the range of ecological conditions in which tigers occur. This approach recognizes that tigers are uniquely defined by the ecological conditions in which they live. A tiger population living in the boreal taiga of Russia will have different demographic, genetic, and behavioral characteristics than a population living in the subtropical alluvial grasslands of Nepal. By conserving examples of tiger populations in distinct bioregions, ecosystems, and habitat types, we meet a fundamental goal of conservation biology—*maintaining representation*—while also conserving the range of communities in which tigers occur.

Within this framework, this approach ultimately aims to identify those populations with the highest probability of long-term persistence. The probability of long-term persistence is determined by factors extrinsic to the population itself (e.g., short and long-term trends in habitat fragmentation, human impact, local development, and commitment to conservation) and in part by factors intrinsic to the population (e.g., population size, demographic structure).

A. Underlying Principles of the Approach

Several basic principles underlie our approach to this priority-setting initiative:

1. The root causes of the decline of tigers across their range is caused by: a) fragmentation, degradation, and loss of habitat, and b) intensive poaching pressure on tigers and their prey. These threats affect the integrity of the habitat, impoverish the biological communities in which tigers live, and reduce tiger populations.

2. The reclamation or restoration of large tracts of tiger habitat in many areas of its previous range is unlikely in the near future so that the immediate response to ward off local extinctions is to reduce poaching pressure on both tigers and their prey and protect remaining habitats. This is often best achieved by a combination of protection measures, including the financing of anti-poaching information networks, and adequate staffing and training needs for managing protected areas and reserved forests.

3. The historical demography of many tiger populations—particularly in India, Nepal, and the Russian Far East—has shown that reducing or eliminating poaching pressure and protecting relatively large tracts of prime habitat can lead to a

relatively rapid increase in tiger numbers. We should not assume that tiger populations currently at very low levels or well below carrying capacity are in long-term demographic jeopardy, or "doomed."

4. Most existing protected areas containing tigers are relatively small, necessitating conservation areas that extend over larger landscape units, involving lands not currently managed strictly for biodiversity protection. In some instances, restoration of buffer zones, dispersal corridors, and protection of core areas and seasonal refugia may be essential for protected areas to maintain tiger populations with a high chance of persistence.

B. An Ecology-based Framework for Tiger Conservation

We developed a hierarchical framework for conserving tiger populations that represent a) the full spectrum of habitat types found across Asia and the Russian Far East (hereafter RFE) and b) the distinct species assemblages, predator-prey dynamics, and ecological processes associated with these diverse populations.

Our approach departs from the traditional approach of following a strict taxonomy that focuses on populations of threatened subspecies. For tigers, the focus has been on the five extant subspecies. Subspecies are recognized by genetic variability across their range; their differences warrant the subclassification of the species. But, a genetic approach only recognizes some of the variation inherent in tigers—we must also account for the behavioral, demographic, and ecological variation present among populations. Thus, we propose a more ecologically based approach that still manages to encompass the ranges of all five purported subspecies and to ensure that the genetic and ecological differences are represented in the portfolio of prioritized conservation units.

To adequately capture the variation of tigers throughout their range, we divided Asia and the RFE into 5 bioregions—Indian Subcontinent, Indochina, Southeast Asia, RFE, and South China. The priority-setting analysis is first stratified by bioregion, so that tiger populations from different bioregions will not be ranked together.

The geographic boundaries of the five bioregions are as follows (see Maps 1 and 2):

I. **The Indian Subcontinent**, ranging from South India to the Indian and Nepalese Himalaya and foothills and east to the Burmese transition zone.

II. **Indochina**, ranging from the Burmese transition zone into southern China and south to the Isthmus of Kra.

III. **Southeast Asia,** ranging from south of the Isthmus of Kra to the southern tip of Sumatra.

IV. **Northern Temperate and Taiga Zone,** including Manchurian China, North Korea, northward into Khabarovsk Krai of the RFE.

V. **South China,** including the low-lying areas where tigers still persist.

(note: if Javan and Bali tigers, and Caspian tigers were still alive, they would form separate bioregions, i.e. Java and Bali, Caspian).

As a second layer of stratification, we identified eight Tiger Habitat Types (THTs)—Alluvial Grassland / Moist Deciduous Forests, Tropical Dry Forests, Tropical Moist Deciduous Forests, Tropical Moist Evergreen Forests, Mangroves, Subtropical and Temperate Upland Forests, Boreal Taiga, and Temperate Mixed Conifer and Broadleaf Forest. These THTs reflect habitat types where tigers are considered to play different ecological roles, but they do not represent biological diversity *per se*.

Tiger populations are in part characterized by the habitat in which they live; for instance the morphology, behavior, and population demography of tigers differ among tropical dry forests, monsoonal forests, boreal forests, and mangrove ecosystems.

This hierarchical stratification (Fig. 1) allows us to: a) capture the genetic variability represented in the tiger populations across their range; b) capture the full spectrum of ecological roles of tigers by including all THTs, and associated ecological processes, across Asia and the RFE.

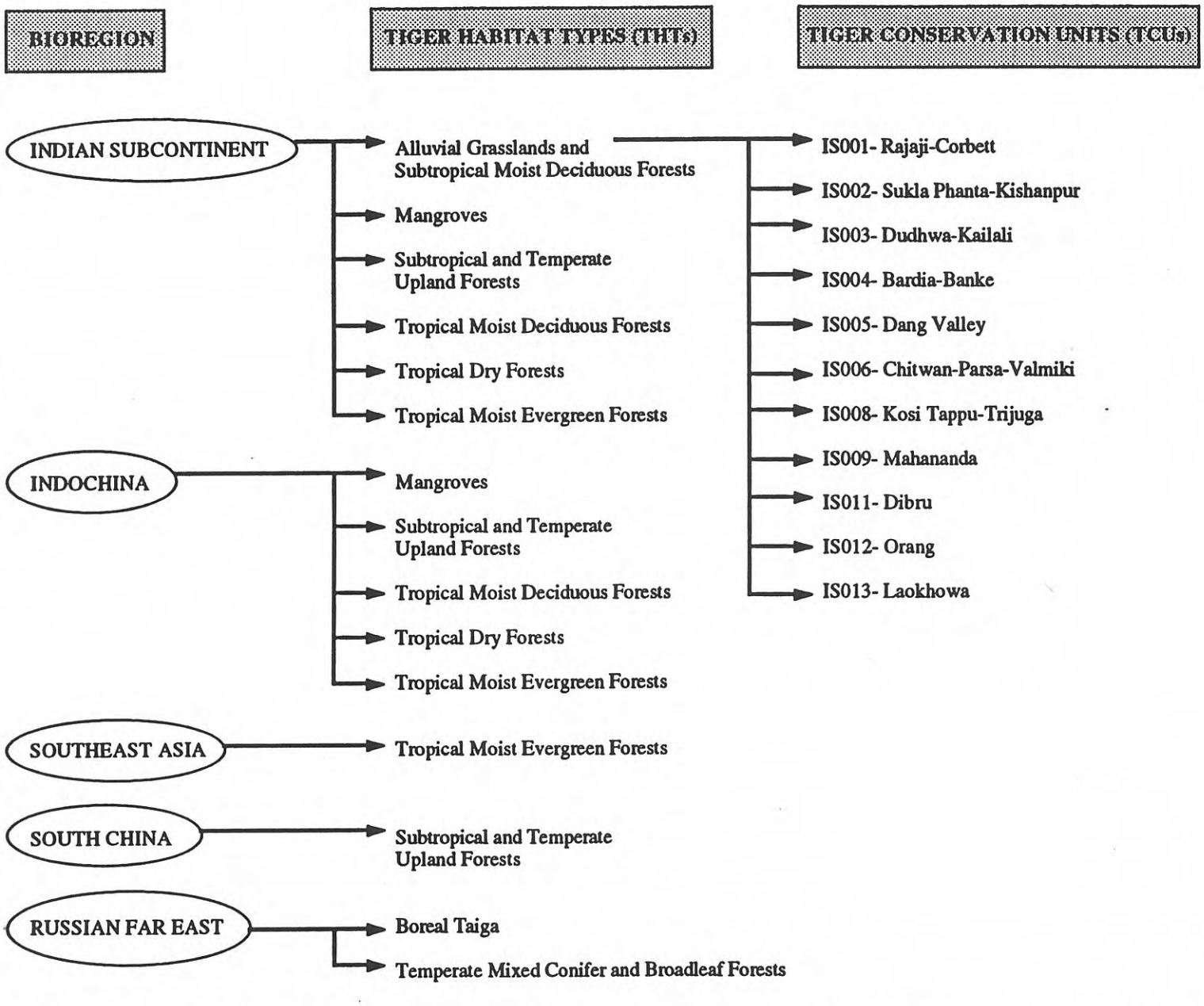


Figure 1. Hierarchy for maintaining representation of tiger-dominated ecosystems across Asia. Bioregions are stratified by Tiger Habitat Types containing one or more Tiger Conservation Units (only a partial list of TCUs, those identified within the Alluvial Grasslands THT, are shown). For setting priorities, we compared only those TCUs sharing the same THT and Bioregion. For example, only the TCUs that belong to the Alluvial Grasslands/Subtropical Moist Deciduous Forests were compared with one another.

We also depart from other approaches that base priorities largely on the perceived viability of a population. Controversy surrounds the "population viability analyses" (PVAs) currently being conducted for tiger subspecies and other endangered taxa. First much of the essential life history data required to properly conduct a PVA is lacking (e.g., lifetime reproductive success), requiring "guesstimates" to calculate a population's probability of persistence up to a given time period. PVAs typically assume a certain minimum population size based upon maintenance of a certain number of breeding adults, even though how this number will vary by species remains unknown. Finally, PVAs typically make the assumption that populations remaining below a certain critical threshold size for a given length of time may be doomed. It remains unclear how this phenomenon relates to large carnivores that have evolved to live at low densities and have evolved behaviors to avoid inbreeding. Our approach does not automatically assume that tiger populations currently below a certain number are no longer viable or that there is even a clearly established number that serves as a defining indicator of the long-term viability of tiger populations across their range.

A convenient and biologically sound alternative to the PVA process is to assess over the previous decade the population status of tigers as a demographic trend, rather than attempting to determine viability from absolute numbers. This approach takes on added ecological importance because tigers, as top predators in natural systems, potentially play a major role in structuring biological communities. Estimates of trends we used were based on the best available local knowledge (see Appendix II for sources).

Thus, in this approach we:

- consider even small tiger populations to be important. Past experience has shown that when given adequate ecological resources (habitat, water, prey) and protection, small populations can recover.

- consider all suitable tracts of habitats within a tiger range as potentially containing tigers until proven otherwise by available information or future surveys. Habitats lacking reliable information on tiger presence/absence will be flagged for ground surveys rather than being disregarded during the initial assessment stage.

- emphasize the intrinsic biodiversity value of tigers, the ecological value of tigers as top predators in ecosystems, and the importance of tigers as "umbrella species" for conservation.

C. Delineating Tiger Conservation Units (TCUs)

Within each THT, we identified Tiger Conservation Units (TCUs). A TCU is defined as *'a block or a cluster of blocks of existing habitats that contain, or has the potential to contain, interacting populations of tigers'*. A TCU need not be restricted to protected areas, but instead includes the entire landscape of natural habitats over which tigers may disperse and become established.

TCUs were delineated by identifying contiguous and adjacent blocks of habitats using vegetation maps provided by the Asian Bureau for Conservation (ABC) and the World Conservation Monitoring Centre. The ABC dataset provides the most up-to-date digital maps of remaining habitat across the range of the tiger in the Indo-Malayan realm. For the RFE, we used one kilometer (km) resolution AVHRR data classified for us at Woods Hole by Dr. Thomas Stone.

As the definition implies, TCUs may consist of several adjacent blocks of habitat. We considered adjacent habitat blocks as part of one contiguous TCU if linked by degraded scrub forests, tall crops (e.g. sugar cane), plantations with dense growth or canopy cover (coffee), or river or stream courses. We assumed that tigers would disperse across these altered habitats or along river courses. Based on field studies in India (by Dr. Ullas Karanth) we considered a threshold of five km of cleared/open land as the maximum distance that a tiger may cross. Thus, areas separated by more than five km were delineated as distinct TCUs for all THTs in this assessment. We also point out that blocks of tiger habitat separated by less than five km by intensive agriculture still have the potential to be linked relatively cheaply, based upon restoration efforts using one km wide by five km long strips around Royal Chitwan National Park, Nepal (E. Dinerstein, pers. obs.).

Other man-made features besides croplands can restrict the movement of tigers. Using work-station ARC/INFO, we overlaid remaining habitat data with data layers available from the Digital Chart of the World to assess the spatial relationship between habitat blocks and potential dispersal barriers, such as roads and settlements. If habitat blocks were completely separated by roads, railroads, settlements, or villages, the habitats were placed in different TCUs. Although TCUs are shown on 1:3,000,000 (Maps 1-4) scale maps, the actual delineation was done at smaller scales, ranging from 1:1,000,000 to 1:50,000, using other available maps (see large format maps 1 and 2). To calculate the total intact area of a TCU, we subtracted the polygons of altered habitat within TCUs from the total area, all calculated using ARC/INFO.

Some of the TCUs are extremely large in size (e.g., Indochina Map 2 TCU no. IC014). Extensive ground-truthing surveys may break up these big units into smaller TCUs. However, using our criteria for habitat integrity (see Annex I), any

fragment of good habitat larger than 5,000 km^2 would automatically receive the same score as the existing, much larger, TCU. We reiterate our definition of a TCU: *a block or cluster of blocks of suitable habitat that contains, or has the potential to contain, interacting populations of tigers*. The key phrase in this definition is *has the potential to contain*. In essence, this means that areas that are only narrowly connected should still be considered as a single TCU if at least one tiger per generation successfully disperses to and breeds in an adjacent block of habitat.

D. Scoring Tiger Conservation Units

We evaluated TCUs on the premise that the decline of tigers across their range is caused by: 1) fragmentation, degradation, and loss of habitat , and 2) intensive poaching pressure on tigers and their prey. These threats affect the integrity of the habitat, impoverish the biological communities in which tigers live, and reduce tiger populations. To index these changes, we created three variables: a) habitat integrity, which includes the size, degree of degradation, fragmentation, and connectivity of tiger habitat blocks; b) poaching pressure, which indexes the intensity of illegal hunting and potential for its control; and c) tiger population status, which indexes tiger abundance and recent trends in numbers within each THT.

For each TCU, a score was assigned for each of these three variables (see Annex I for criteria used to index TCUs). We relied on regional and local experts to generate scores; these evaluations were augmented by published accounts and unpublished reports reviewed during this study. We then combined these scores in a weighted fashion, reflecting the reversibility of threats to tiger conservation. We considered a loss of habitat integrity to be the most difficult to reverse, and thus weighted this variable twice as high as poaching pressure, which can be turned around more easily. Poaching pressure, in its turn, was weighted twice as high as population status, reflecting the observation that tiger populations can rebound quickly if they and their habitat and prey are protected over sufficiently large areas.

For each TCU we assigned a score for each of these three variables and weighted these scores 4:2:1 (Annex I). Each TCU thus has a unique score which reflects the probability of persistence of the resident tiger population over the long term. While many factors contributed to the decline of tigers across their range, we suggest using these three variables as the most powerful predictors of the long-term persistence of tiger populations.

The three indices were used to score each TCU and rank them by the sum of the index scores. During the ranking process, the TCUs were nested by THTs, which were, in turn, nested within bioregions (Fig. 1).

When scoring TCUs for habitat integrity, we took into account the following:

- If a habitat block included extensive roads, railroads, settlements, etc., (as indicated by the Digital Chart of the World overlays), we considered it to be degraded, and scored it in the appropriate category (i.e., 5a, 6a see Annex I).
- The shape of the TCU was also considered in the scoring process: long, narrow shaped TCUs which would not offer adequate core protection were considered to be suboptimal habitat.

Wherever and whenever possible we relied on regional experts to help score the TCUs.

We also created the following decision guidelines to help score TCUs:

- If information was insufficient to score a TCU, it was flagged for surveys and/or information verification.

- TCUs were assigned to the dominant THT represented in the TCU.

- If more than one THT was included in a TCU, the THT which consisted of >50% of the TCU area was considered to be the primary THT and the THT represented by <50%, but >30%, was considered a secondary THT. (If a second THT was represented by <30% it was not considered). In cases of 50:50 representation, the TCU was evaluated under both THTs.

- If less than 3 TCUs were categorized as Level I, II or Immediate Surveys, Level III TCUs in the same THT were elevated to Level II to achieve adequate representation of tigers in different THTs and bioregions. We elevated the Level III TCU with the highest score.

- Level I, II and Immediate Survey TCUs were named after significant protected areas. If there were no protected areas within the TCUs, they were given a name to signify regional distribution (e.g., IS043 Orissa Dry Forests). If the TCU did contain one or more protected areas, it was named according to the largest/most significant protected area. Similarly, TCUs that straddled one or more international boundaries were listed first under the country that contained the largest or best quality block of habitat within the TCU.

Next we categorized the TCUs according to the probability of persistence of tigers (Box 1).

Box 1. Classification of Tiger Conservation Units

Level I TCU: A TCU offering the highest probability of persistence of tiger populations over the long term. They are essential for a global tiger conservation strategy. Level I TCUs share the following attributes: large blocks of habitat suitable for tigers and prey with adequate core areas; low to moderate poaching pressure on tigers and prey species either as a result of remoteness or vigilant protection. (45-70 points)

Level II TCU: A TCU offering medium probability of persistence of tiger populations over the long term. They contribute to Bioregional tiger conservation strategy. These TCUs share the following attributes: moderate to large-sized blocks of habitat suitable for tigers with adequate core areas; moderate to high poaching pressure on tigers and prey species but with potential for implementing effective anti-poaching measures in the near future. (32-44 points)

Level III TCU: A TCU offering low probability of persistence of tiger populations over the long term due to its small size, isolation from other habitat blocks containing tigers, and fragmentation within its respective Major Habitat Type. With intensive management and protection, Level III TCUs can harbor small populations of tigers. They are most important to national tiger conservation strategies. Level III TCUs share the following attributes: small blocks of habitat suitable for tigers with small or no core area; high poaching pressure on tigers and prey species that endangers conservation efforts (<32 points)

TCUs requiring immediate surveys: Any TCU that potentially contains extensive blocks of appropriate tiger habitat with or without protected core areas, but data on habitat quality, poaching pressure, or population status for the most important habitats within the TCU are lacking.

Scores for each TCU were compared only with other TCUs that shared the same THT within the same bioregion. Thus, we did not compare TCU scores from the Indian Subcontinent bioregion with TCUs from the Southeast Asia bioregion, nor did we, within the Indian Subcontinent bioregion, compare TCUs from the Alluvial Grasslands THT with TCUs from the Tropical Dry Forest THT. This approach ensures better representation of predator-prey dynamics and regional patterns of biodiversity across the tiger's range.

III. Assessment of Priority Tiger Conservation Units across Asia

A. Introduction and Caveats

Because natural habitat for tigers is limited throughout the entire tiger range, the ideal conservation strategy is to protect all blocks of natural habitat containing tigers. However, the limited financial and human resources available force us to prioritize activities over the tiger's range for the next few years. A few caveats:

1) Our goal is to direct resources to important places for tiger conservation where international donors need to turn their attention. We reiterate that this priority-setting exercise is not meant to supplant national tiger conservation plans, which may give different weight to conservation efforts in some of the TCUs delineated in this study. Priorities emerging from this study focus more on where to invest rather than what should be done specifically at any given site. We do, however, outline an appropriate suite of conservation activities in the highest priority TCUs for the Indian Subcontinent, Indochina, and Southeast Asia as a means for donors to better evaluate the completeness of proposals aimed at conserving tigers. These activities, although diverse, address the threats of loss of habitat integrity and poaching pressure. The relative magnitude of the scores generated by the indexes we used can help to determine appropriate activities at each site.

2) *Our goal is not to advocate that only those blocks of habitat that still contain tigers are the only units worthy of conservation*. Over the past few decades, tigers have disappeared or become severely depleted over large tracts of habitat across Asia. Some of these larger blocks and fragments are still very important for biodiversity, even though the role that tigers might play as "umbrella species" for conservation of these units is greatly reduced or lost. Even areas with severely depleted tiger populations in poor tiger habitat may still be important sites for conservation of other forms of biodiversity (e.g., peat swamp forests of Sumatra). *Biodiversity is important to conserve everywhere in Asia*.

3) TCUs contain many other endangered and charismatic species or rare habitats that are worthy of protection in their own right, regardless of the size of the tiger population. An essential future analysis is to determine how investment in tiger conservation measures in various TCUs provides dividends in conserving populations of other species or rare habitats subject to intensive conservation management.

4) Two important activities go beyond site-specific recommendations and are essential for tiger conservation over the long term: 1) policy changes at the national level to create mechanisms to allow recycling of ecotourism revenues to local development initiatives; and 2) the creation of a Trust Fund for tiger conservation to address the difficult challenge of meeting recurrent costs of protection of TCUs. We discuss these two initiatives in more detail at the end of this chapter.

5) Identifying high priority areas is not enough; donors must help meet the recurrent costs of tiger conservation, particularly in countries where tiger conservation has low priority. These recurrent costs, such as paying for better protection of tigers and their habitats, conservation and development projects, etc., often swamp national budgets for conservation. At some point, the need for a conservation trust fund to maintain tiger conservation activities is paramount if we are to conserve tigers over the long term (see Chapter III section 3).

6) A number of areas containing tigers have enormous potential to generate revenues from ecotourism, if properly managed. Ultimately, legal mechanisms must be created to channel some portion of these revenues back to local development around tiger conservation areas if local residents are to be swayed by arguments for the long-term value of tiger conservation (see Chapter III section 3).

B. Priority Sites for Tiger Conservation

The results of our rapid assessment appear in a series of accompanying maps, and we urge the reader to refer to these maps (Maps 1-5) while reading the text.

Among the three bioregions and six THTs portrayed on the maps, we identified 24 TCUs as Level I (15% of all TCUs), 22 as Level II (14%), and 101 as Level III (63%). Although we stress a biogeographic rather than a country approach to setting priorities, we point out that all tiger range states contain at least one Level I TCU. The Level I TCUs are recommended as highest priority areas and should be the target for soliciting conservation proposals. We have greatest confidence in our ability to designate TCUs as Level I and II. Even after extensive field reviews of the TCUs, we suspect that few, if any, Level III TCUs will be elevated to Level I or II.

We also identified 13 TCUs (8%) as Immediate Surveys whose potential for long-term tiger conservation may be on par with some Level I or II TCUs, but for which data are lacking. We also list several Level I and II TCUs, that although were scored, are so large that more information on the distributions of tigers is essential for good management. These TCUs are indicated as such in the list below. We urge the financing of surveys in these TCUs immediately to better rank these TCUs and to better determine their contribution to a regional tiger conservation strategy.

Below, we present the results of our assessments, stratified by bioregion and THT.

1. Indian Subcontinent Bioregion

We identified 11 Level I TCUs and seven Level II TCUs among the six THTs (Table 1, Map 3) in the Indian Subcontinent. Three of the six THTs have adequate replication of a combination of three Level I or II TCUs: Alluvial Grasslands; Tropical Moist Deciduous Forests, and Tropical Dry Forests. We elevated to Level II a Level III TCU in Tropical Moist Evergreen Forests (Parambikulum IS058). There was only one TCU in the Mangroves; thus, increased representation was not possible.

Table 1. Classification of Tiger Conservation Units for the Indian Subcontinent Bioregion

Level of TCU	Alluvial Grasslands / Moist Deciduous Forests	Mangroves	Subtropical and Temperate Upland Forests	Tropical Dry Forests	Tropical Moist Deciduous Forests	Tropical Moist Evergreen Forest
1	IS006 - Chitwan-Parsa-Valmiki (Nepal,India) IS004 - Bardia-Banke (Nepal) IS001 - Rajaji-Corbet (India)	IS018 - Sundarbans (Bangladesh, India)	IS010 - Manas-Namdapha (India, Bhutan)	IS027 - Bagdara-Hazaribagh (India) IS052 - Nagarajunarsagar (India)	IS031- Kanha-Pench (India) IS039 - Simlipal (India)	IS059 - Periyar-Kalakad (India) IS055 - Dandali-Bandipur (India)
2	IS003 - Dudwa-Kailali (India, Nepal) IS002 - Sukla Phanta-Kishanpur (Nepal,India)			IS040 - Kanha-Indravati Corridor (India) IS043 - Orrisa Dry Forests (India) IS047 - Sitapani-Udanti (India)	IS046 -Indravati-Navegaon (India) IS051 - Papikonda (India)	
3	IS011, IS005 IS009, IS008 IS012, IS013		IS007	IS056, IS044 IS054, IS053 IS020, IS042 IS022, IS021 IS036, IS057 IS023, IS038 IS026, IS025 IS019	IS045, IS048 IS037, IS014 IS015, IS041 IS032, IS050 IS034, IS033 IS049, IS035 IS030	IS058, IS017
Survey				IS029 - Ratapani-Singhori (India) IS028 - Melghat (India) IS024 - Panna-Son Gharial (India)	IS016 - Kaziranga-Meghalaya (India)	

Table 2. Classification of Tiger Conservation Units for the Indochina Bioregion

Level of TCU	Mangroves	Subtropical and Temperate Upland Forests	Tropical Dry Forests	Tropical Moist Deciduous Forests .	Tropical Moist Evergreen Forests
1			IC055 - Virachay-Xe Piane-Yok Don (Cambodia, Laos,Vietnam) IC064 - Kulen Promtep-Thap Lan (Cambodia) IC042 - Phu Khieo-Nam Nao (Thailand,Laos)	IC002 - Chin Hills (Myanmar) IC013 - Pegu Yoma (Myanmar)	IC014 - Huay Kha Khaeng-Thung Yai Naresuan (Thailand) IC003 - Arakan Yomas (Myanmar) IC063 - Khao Yai (Thailand) IC067 - Phnom Bokor-Aural (Cambodia) IC040 - Nam Theun Nakai-Vu Quang (Laos, Vietnam)
2		IC005 - Maymo (Myanmar) IC036 - Bu Huong-Nam Xam (Vietnam, Laos)	IC043 - Phu Phan (Thailand) IC041 - Phu Kao-Phu Kham (Thailand)	IC022 - Thung Salaeng - Nam Poui (Thailand,Laos)	IC049 - Bach Ma-Nui Thanh (Vietnam) IC034 - Song Da forest (Vietnam) IC045 - Xe Bang Nouane (Laos)
3	IC068	IC016, IC033 IC021, IC038 IC007, IC006 IC025, IC029 IC010, IC032 IC008, IC009	IC020, IC069 IC062, IC044 IC019, IC017 IC018, IC051 IC060	IC035, IC058 IC037, IC059 IC011	IC039, IC056 IC066, IC052 IC050, IC047 IC053, IC015 IC030, IC046 IC054, IC061 IC027, IC026 IC028, IC057
Survey	IC012 - Irawaddy Delta (Myanmar) IC070 - Hat Chao Mai (Thailand)	IC001 - Northern Triangle (Myanmar) IC004 - Shan Plateau (Myanmar) IC031 - Nui Hoang Lien (Vietnam)		IC024 - MuangXaignabouri (Laos) IC023 - Louangphrabang (Laos)	IC065 - Khao Ang Ru Nai-Khao Soi Dao (Thailand)

Table 3. Classification of Tiger Conservation Units for the Southeast Asia Bioregion

Level of TCU	Tropical Moist Evergreen Forest
1	SA017 - Gunung Leuser-Lingga Isaq (Sumatra) SA020 - Kerinci Seblat-Seberida (Sumatra) SA001 - Taman Negara-Belum-Halabala (Malaysia-Thailand) SA031 - Bukit Barisan Selatan-Bukit Hitam (Sumatra)
2	SA002 - Selama (Malaysia) SA022 - Kerumutan-Istana Sultan Siak (Sumatra) SA019 - Siak Kecil-Padang Lawas (Sumatra) SA024 - Berbak-Sembilang (Sumatra) SA032 - Way Kambas (Sumatra) SA011 - Endau (Malaysia)
3	SA012, SA005 SA014, SA025 SA028, SA015 SA021, SA029 SA008, SA006 SA007, SA016 SA009, SA013 SA015, SA003 SA004, SA010
Survey	SA023 - Air Sawan (Sumatra) SA018 - Sibolga-Dolok Surungan (Sumatra) SA027 - Padang Sugihan (Sumatra) SA026 - Dangku (Sumatra)

Brief descriptions of THTs, Level I TCUs, and an outline of an appropriate suite of conservation activities for each Level I TCU are provided below. Specific recommendations are based in part on the scores of our three variables (habitat integrity, poaching pressure, population status). Important TCUs for surveys are discussed in the following chapter. Please refer to Map 3 to locate TCUs.

1a. Alluvial Grasslands / Tropical Moist Deciduous Forests

Description and Important Features:

The Alluvial Grasslands / Tropical Moist Deciduous Forests THT once covered a huge swath of grasslands and riverine and moist semi-deciduous forests along the major river systems of the Gangetic and Brahamaputra plains (Map 1 inset). Today the best examples of this MHT are limited to a few blocks of habitat at the base of the outer foothills of the Himalayas known as the Siwaliks (Map 1). This MHT contains TCUs that support the highest recorded densities of tigers in Asia. High densities of tigers are in part a response to the extraordinary biomass of ungulates that constitute the tiger's prey base. Also, the deposition of heavy annual silt loads in alluvial grasslands during monsoon floods recharges nutrient levels and maintains the world's tallest grasslands. Some grassland associations are dominated by species that exceed seven meters by the end of the monsoon.

Besides having high densities of tigers, Chitwan (IS006) contains the second largest population of greater one-horned rhinoceros in Asia (@450). Bardia (IS004) has at least 40 rhinos, all translocated from Chitwan, and Dudhwa (IS003) has at least 10 including 4 founders from Chitwan and the rest from Kaziranga (IS016). Both Sukla Phanta (IS002) and Dudhwa are important because both contain large populations of endangered swamp deer which have disappeared from Chitwan and are rare in Bardia.

A burgeoning ecotourism industry has emerged in two of the Level I TCUs; Chitwan is the most widely visited wildlife-viewing destination in Asia. Recent legislation ratified in February 1996 by the Nepalese Parliament paves the way for between 30 and 50 percent of tourism dollars to be recycled into local development projects in the buffer zone. This policy initiative has tremendous potential for replication in other TCUs across Asia that have the infrastructure to support ecotourism (see last section of this chapter).

Some important conservation activities that should be addressed or included in proposals for Level I TCUs:

IS001 Rajaji-Corbett (India)

- Improve and maintain connectivity between western and eastern sections of TCU by improving management and restoration of degraded habitats.
- Improve management of buffer zone of Corbett to reduce pressures on park.
- Increase effectiveness of anti-poaching programs.

IS004 Bardia-Banke (Nepal)

- Monitor impact of ecotourism and begin tracking recycling of revenues from tourism back to local development.
- Maintain vigilant effort to fight financing and construction of a major hydroelectric dam along the last undammed, prime tiger-dominated flood plain in the bioregion.
- Continue successful anti-poaching efforts.

IS006 Chitwan-Parsa-Valmiki (Nepal, India)

- Continue successful program to restore degraded forests in buffer zone.
- Accelerate efforts to enact land transfer of villages in an isolated enclave (Padampur Panchayat) to area across the Rapti River. This action will increase prime tiger habitat within Royal Chitwan National Park by at least 10 percent and fulfill requests of 14,000 villagers who want to be transferred to an area closer to the nearest town and markets.
- Monitor impact of ecotourism and begin tracking recycling of revenues from tourism back to local development.
- Continue successful anti-poaching efforts.

1b. Mangroves

Description and Important Features:

Mangroves are limited to the interface between land and the marine environment in deltas and fringing parts of the coastline. The best example in this bioregion (and one of the best in the world) is the Sundarbans TCU, reported to have the largest population of tigers in Asia.

Although not often thought of as typical tiger habitat, tigers survive in this area, swimming between islands in the delta to hunt prey. The Sundarbans are under increasing pressure from wood cutters. Because extensive tracts of mangroves have largely disappeared or tigers disappeared from them across tropical Asia, the Sundarbans TCU stands as the last best chance to conserve mangrove ecosystems containing tigers. The Sundarbans TCU plays other important ecological roles,

such as a major buffer from cyclone damage for densely populated South Bengal and as a nursery for a globally important fishery. The Sundarbans has been recognized as a MAB Biosphere Reserve and a World Heritage Site.

Some important conservation activities that should be addressed or included in proposals for Level I TCU:

IS018 Sundarbans (Bangladesh, India)

- Create plantations of mangroves along the park periphery to meet local fuel wood demand and reduce the pressure on the core area.
- Intensify other integrated conservation and development activities in the buffer zone areas.
- Assess the impact of fisheries in the TCU and better regulate against overharvesting.

1c. Subtropical and Temperate Upland Forests

Description and Important Features:

Tigers are not naturally restricted to flat terrain. Rather, the loss, fragmentation, and degradation of upland forests in the Himalayas has truncated the distributions of tigers and limited them to low-lying habitats in Western India and Nepal. The one major exception to this trend is the sprawling Manas-Namdapha TCU. Tigers have been recorded above 3000 m in Bhutan; the areas stretching from the Black Mountains of Bhutan to Namdapha represents the last chance to conserve the movements of tigers from alluvial grasslands into forests bordering on alpine areas. The conservation of these altitudinal corridors are also vital to many other species of vertebrates that move seasonally along elevational zones.

This TCU offers the last opportunity to conserve an intact example of temperate Himalayan forests. The steep terrain and heavy precipitation over much of the TCU precludes large-scale development of core areas. The most critical areas to protect are the slivers of land that contain alluvial grasslands on the lowland edges of the TCU. Namdapha and the surrounding forests of Arunachal Pradesh contain some of the most biologically interesting habitats of all the TCUs in Asia. We chose not to elevate IS007 to Level II to improve replication of TCUs because this TCU was assessed as too degraded.

Some important conservation activities that should be addressed or included in proposals for Level I TCU:

IS010 Manas-Namdapha (India, Bhutan)

- Bring poaching of tigers and other endangered species under control in Manas.
- Reduce illegal extraction of timber in Buxa area.
- Promote conservation and development projects in buffer zone along low-lying section of this TCU.
- Conduct surveys in important areas for tiger conservation and better determine connectivity of habitat blocks within the TCU.

1d. Tropical Dry Forests

Description and Important Features:

Tropical dry forests and thorn scrub (here treated as one THT) once covered large tracts of Central and Western India. Today, much of it is reduced. Tigers are distributed across the extreme edges of the dry forests and thorn scrub, from Sariska and Ranthambore in Rajasthan, across to Bihar, and south to the Nagarjunasagar TCU.

These forests are more open than the moist deciduous forests to the north and east. Harsh, long dry periods force tigers to concentrate near perennial sources of water. Tropical dry forest TCUs are not as productive for tigers as some of the more mesic habitats, but do include some of the largest blocks of remaining habitats left in India. Some reports indicate that tigers are largely restricted to the protected areas within the TCUs. The distribution and reproduction of tigers outside protected areas requires immediate survey in some of the TCUs in this THT.

Some important conservation activities that should be addressed or included in proposals for Level I TCUs:

Level I TCUs:

IS027 Bagdara-Hazaribagh (India)

- Improve management of key reserves and core areas within this TCU.
- Maintain linkages among reserves.
- Provide communities with alternatives for meeting forest product needs and reduce livestock grazing inside core areas.

- Survey extent of TCU to determine important sites for conservation action and validate integrity (connectivity within TCU).

IS052 Nagarajunasagar (India)
- Improve basic management of Project Tiger Reserve which is affected by instability in the surrounding area.
- Provide communities with alternatives for meeting forest product needs and avert further loss and degradation of forests.

1e. Tropical Moist Deciduous Forests

Description and Important Features:

Tropical moist deciduous forests are probably some of the most productive habitats for tiger and their prey in the subcontinent. The extensive loss of this habitat type across India calls for vigilant protection of the remaining blocks. The forests of this THT and the species assemblages they support are similar to subtropical moist semi-deciduous forests but are not driven by the dynamics of flooding as are the subtropical forests to the north. They often have dense undergrowth of bamboos in some areas, a feature not seen in the subtropical moist deciduous forests to the north. This THT contains some of the most famous tiger reserves in Asia, most notably Kanha National Park.

We placed the Meghalaya-Kaziranga TCU in this category even though Kaziranga is certainly an alluvial grassland. The rationale for this decision was that most of the TCU and, consequently, the largest population of tigers within the TCU is far from the river course.

Some important conservation activities that should be addressed or included in proposals for Level I TCUs:

IS031 Kanha-Pench (India)
- Develop participatory approaches to meeting basic human needs in buffer zone.
- Determine possibility for buffer zone to be put under local management and for recycling of ecotourism revenues similar to Royal Chitwan National Park.
- Maintain linkages and corridors in this TCU which is becoming more fragmented.

IS039 Simlipal (India)
- Reduce pressures from illegal timber felling, extensive cattle grazing, and habitat destruction.

We also suggest elevation of the Meghalaya-Kaziranga TCU (IS016) to high priority in this THT if surveys warrant such a decision.

1f. Tropical Moist Evergreen Forests

Description and Important Features:

Tropical moist evergreen forests represent one of the less common THTs in the Indian Subcontinent, being largely limited to the upland areas and wetter parts of the Western Ghats. Tigers once ranged along the entire range of the Western Ghats, but recent reports suggest that fragments of moist evergreen forests north of 16° no longer contain tigers. Tropical moist evergreen forests support a different prey base than moist deciduous forests, and thus they support lower densities of tigers. Alternatively, tigers in moist evergreen forests serve as umbrella species for an area of the Subcontinent with high endemism of plants and invertebrates. Only three TCUs remain, all relatively large.

Some important conservation activities that should be addressed or included in proposals for Level I TCUs:

IS055 Dandeli-Bandipur (India)
- Maintain connectivity among tropical moist evergreen fragments.
- Investigate opportunities for recycling some fraction of ecotourism revenues back to local development to improve condition of buffer zone areas.
- Develop conservation plan for Western Ghats of which tiger conservation will play a major part.

IS059 Periyar-Kalakad (India)
- Improve park management of Periyar, particularly that related to tourism.
- Halt poaching pressure on tigers and other wildlife throughout TCU.

Other considerations:
Elevate TCU IS058 Perimbikulum to achieve better representation of TCUs within the THT.

2. Indochina Bioregion

We identified 10 Level I and 8 Level II TCUs among the five THTs in this Bioregion (Table 2, Map 4). Three THTs —Tropical Dry Forests, Tropical Moist Deciduous Forests, and Tropical Moist Evergreen Forests—have the minimum number of TCUs required to achieve adequate representation, as dictated by our decision rules.

Of the other two THTs, the Subtropical and Temperate Upland Forests THT is represented by two Level II TCUs, whereas, the Mangrove THT does not have any at Levels I and II. We therefore urge that IC070, IC012, IC001, IC004, and IC031 be surveyed immediately, so that these TCUs can be assessed for suitability as Level I and Level II TCUs in these THTs.

2a. Tropical Dry Forests

Description and Important Features:

The Tropical Dry Forests that once covered much of central and eastern Thailand and parts of central Myanmar have now been degraded or cleared (see map 2). But, fairly extensive areas of Tropical Dry Forest still exist in Cambodia—although with the granting of extensive logging concessions to foreign corporations these forests are now threatened—with the two large, Level I TCUs covering much of this country. IC055, is particularly significant as it extends over Cambodia, Laos, and Vietnam. It will be of special concern to the recent transboundary conservation and protected areas management initiatives underway in the region.

Although tigers have been confirmed from the forests included within the TCUs, very little is known about their populations. Poaching pressure on tigers and prey is heavy in Cambodia, Laos, and Vietnam.

Some important conservation activities that should be included in proposals for Level I TCUs:

IC055 Virachay-Xe Piane-Yok Don (Cambodia, Laos,Vietnam).

- Although the protected areas in this TCU are relatively large by Asian standards, they lack on-the-ground protection and management. Park staff should be trained and deployed in all parks.
- Laos, Vietnam, and Cambodia should cooperate in conservation efforts in this area. Since logs harvested illegally from Cambodia are being transported to Thailand via southern Laos, cooperation from Thai authorities should be solicited.
- Anti-poaching efforts should be instituted to curtail the heavy poaching in this area.

IC064 Kulen Promtep-Thap Lan (Cambodia)

- Although this is a Level I TCU, Khmer Rouge activity in the area precludes immediate conservation efforts. However, as soon as a window of opportunity arises, basic surveys for tigers, prey, and habitat integrity should be conducted, and anti-poaching efforts should be instituted.

IC042 Phu Khieo-Nam Nao (Thailand, Laos)

- Part of this TCU was impacted by heavy poaching pressures. Immediate actions should be implemented in these areas to alleviate these impacts.
- Habitat connectivity should be maintained whenever possible through appropriate land-use planning.
- Tiger surveys should be conducted to determine quality of habitat outside reserves.

2b. Tropical Moist Deciduous Forests

Description and Important Features:

Tropical moist deciduous forests once covered much of central Myanmar, with smaller tracts of forests in northern Thailand and Laos (see inset on Map 2). Today, only fragments of these forests remain. We have identified two Level I TCUs (Myanmar) and one Level II TCU in this THT (northern Thailand and Laos).

Some important conservation activities that should be included in proposals for Level I TCUs:

IC013 Pegu Yomas (Myanmar)

- Train field staff in survey techniques and anti-poaching/enforcement activities.
- Evaluate potential ecotourism options to promote conservation.

IC002 Chin Hills (Myanmar)

- Train field staff in survey techniques and anti-poaching/enforcement activities.
- Identify dispersal corridors and protect potential core areas against future land-use options.
- Evaluate potential ecotourism options to promote conservation.

2c. Tropical Moist Evergreen Forests

Description and Important Features:

Several longitudinal bands of these forests once extended throughout the Indochina bioregion (see inset on Map 2). Although now fragmented, relatively large extents of this THT still exist, especially along the Arakan Yomas in western Myanmar, the Myanmar-Thailand border, the Lao-Vietnamese border, and in southwestern Cambodia. We have identified five Level I TCUs and three Level II TCUs from this THT. One TCU has been identified for immediate survey.

Some important conservation activities that should be included in proposals for Level I TCUs:

IC063 Khao Yai (Thailand)
IC067 Phnom Bokor-Aural (Cambodia)
IC014 Huay Kha Khaeng-Thung Yai Naresuan (Thailand)
IC003 Arakan Yomas (Myanmar)
IC040 Nam Theun Nakai-Vu Quang (Laos, Vietnam)

- Many of these TCUs are impacted by heavy poaching pressures. Immediate actions should be implemented in these areas to alleviate these impacts.
- Habitat connectivity should be maintained whenever possible in the larger TCUs during land-use planning.
- Tiger surveys should be conducted within portions of these TCUs for which good information is missing.

2d. Subtropical and Temperate Upland Forests

Description and Important Features:

These forests along the southern slopes of the Himalayas are not prime habitat for tigers compared with the lowland forests; nevertheless, because of the different ecological role of tigers in these montane ecosystems and the different prey assemblages, these habitats are represented as a distinct THT. Because tigers occur less densely in upland montane habitats, larger areas are needed to support tigers. Since only two TCUs are represented in this THT, those identified for immediate surveys should be evaluated so that they can be assigned to Level I or II if warranted.

Level I TCUs: None

Level II TCUs.

IC036 Bu Huong-Nam Xam (Vietnam, Laos)
IC005 Maymo (Myanmar)

TCUs Identified for Immediate Surveys:

IC001 Northern Triangle (Myanmar)
IC004 Shan Plateau (Myanmar)
IC031 Nui Hoang Lien (Vietnam)

2e. Mangroves

Description and Important Features:

Little of the once extensive mangroves of the Irrawady and Mekong deltas remains. Thus, it may be impossible to achieve good representation of tiger populations in the mangrove THT in the Indochina bioregion. We have identified 3 Mangrove TCUs (Table 3). Even though none achieve a Level I or II, we encourage immediate surveys for two—IC012 and IC070—to determine if they can be classified as a Level I or II TCU.

Level I TCUs: None

Level II TCUs: None

TCUs Identified for Immediate Surveys:

IC012 Irrawady Delta (Myanmar)
IC070 Hat Chao Mai (Thailand)

3. Southeast Asia Bioregion

Southeast Asia covers a much larger region than Peninsular Malaysia and Sumatra, but with the loss of tiger populations in Java and Bali, these are the only two geographic areas that still contain tigers (Map 2). Much of the lowlands throughout Peninsular Malaysia and Sumatra that was once prime tiger habitat have been lost. What remains is often peat swamp forest, which harbors interesting biodiversity, but is poor tiger habitat. Tigers are now more or less restricted to upland areas consisting of Tropical Moist Evergreen Forests. Because other forest types (Mangroves, Tropical Moist Deciduous Forests) are so limited, we classified all remaining habitat as Tropical Moist Evergreen Forests. Some of the TCUs are quite extensive in this bioregion, but, in general, Tropical Moist Evergreen Forests tend to be poorer quality habitat for tigers than other forest types.

3a. Tropical Moist Evergreen Forests

SA017 - Gunung Leuser-Lingga Isaq (Sumatra)

- Develop anti-poaching information network
- Ensure continuation of corridors linking more isolated parts of TCU
- Survey the more remote areas of TCU for tigers.

SA020 - Kerinci Seblat-Seberida (Sumatra)

- Reduce pressure in lowland forests from conversion to cinnamon plantations.
- Increase efforts to mitigate ecological impacts of enclave area.
- Develop anti-poaching information network.
- Assure continuation of corridors linking more isolated parts of TCU.
- Survey more remote areas of TCU for tigers.

SA001 - Taman Negara-Belum-Halabala (Malaysia-Thailand)

- Maintain connectivity among blocks within TCU.
- Protect large core areas for tigers as the last refuge for tigers in this area.

SA031 - Bukit Barisan Selatan-Bukit Hitam (Sumatra)

- Maintain connectivity within protected area.
- Protect limited core areas within this elongated reserve.

TCUs benefiting most from surveys are:

SA023 - Air Sawan (Sumatra)
SA018 - Sibolga-Dolok Surungan (Sumatra)
SA027 - Padang Sugihan (Sumatra)
SA026 - Dangku (Sumatra)

4. Russian Far East Bioregion

We chose not to apply the same methodology used to assess TCUs in the other bioregions for the RFE for the following reasons:

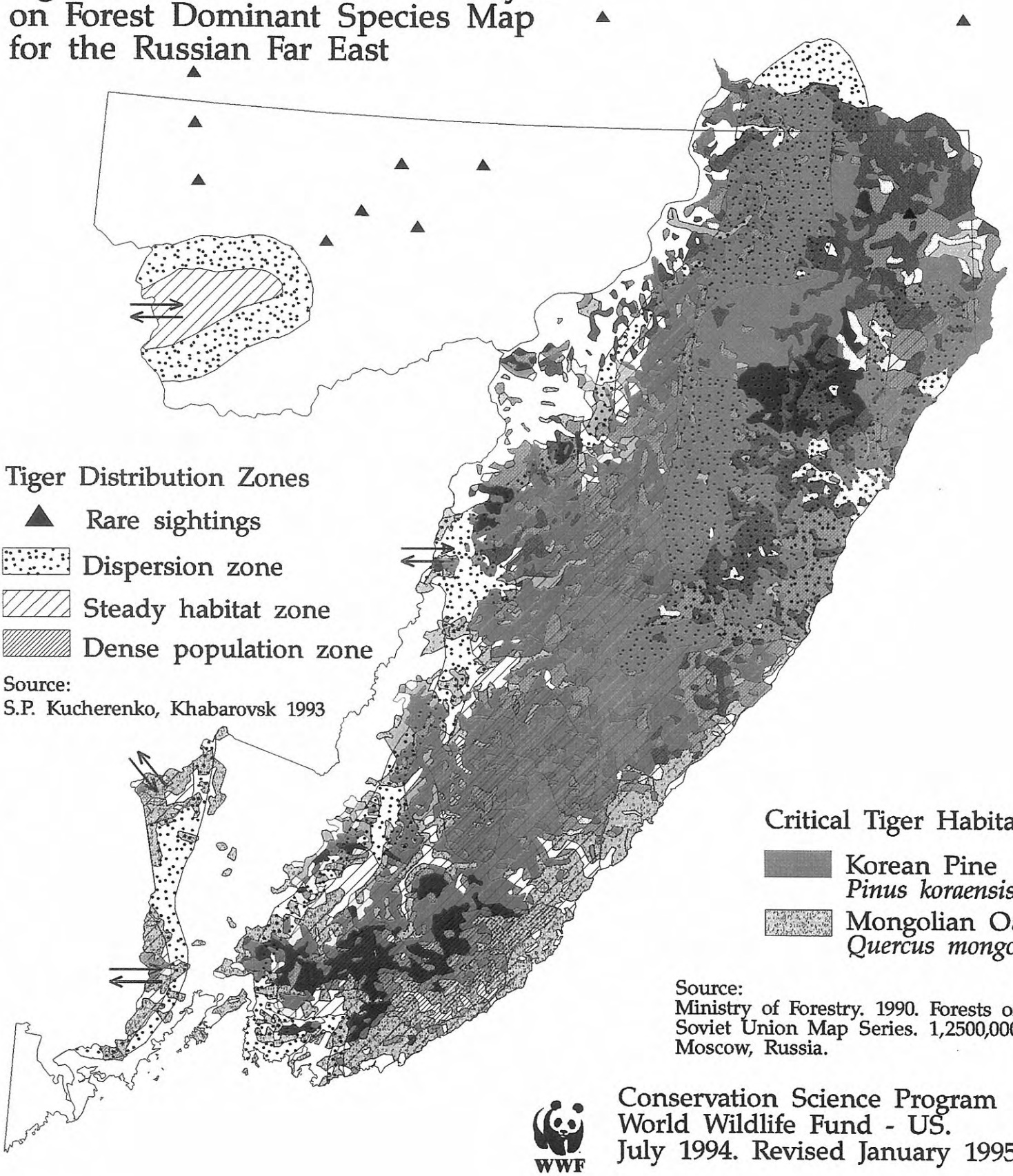
1) With the exception of two smaller blocks of habitat on the Russian-Chinese border, the RFE remains a single TCU (Map 5). It is the only area containing tigers where the connectivity still exists for tigers to move across a large landscape. Emphasizing conservation in the single large TCU versus the two smaller fragments is obvious.

2) Detailed planning for tiger conservation among the five bioregions is furthest along in the RFE. Broad generalizations about what to do within the TCU are therefore superfluous.

Instead, we submit for review a detailed workplan over the next two years for conservation activities in Primorksy and Khabarovsk Krai (States). The investments described in this plan, designed by leading Russian conservationists in collaboration with international partners, are meant to: 1) achieve the goal of

Map 5

Tiger Distribution Zones Overlayed on Forest Dominant Species Map for the Russian Far East



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representation of tiger habitats from the Boreal Taiga THT in the north to the Temperate Mixed Conifer and Broadleaf Forests THT in the south; 2) finance surveys to better determine the status of tigers and their prey; 3) finance better protection of tigers in reserves and refuges; 4) maintain the habitat integrity of tigers; and 5) raise awareness of the plight of the tiger and generate greater public support for its conservation (Annex 3).

We recommend that, at present, foreign donors would best support the RFE by helping to finance a Trust Fund for Tiger Conservation and by trying to leverage other major corporations to contribute to this fund. USAID has already pledged US$1,000,000. The Trust Fund would continue current conservation efforts that support a wide range of Russian conservation groups and international partners.

5. South China Bioregion

The lack of knowledge regarding the status of free-ranging tigers in the Central and Southern China Bioregion hinders conservation efforts. Formulation of detailed conservation plans awaits more intensive surveys. We recommend that surveys begin immediately.

C. National and Regional Activities Important for Tiger Conservation

Two national scale efforts stand out for consideration as priority funding activities: 1) Policy change to allow recycling of revenues generated from ecotourism to local conservation and development activities and 2) Conservation Trust Funds to meet the recurrent costs of field conservation efforts.

Perhaps the single most positive development in tiger conservation in the past few years is the recent (February 1996) ratification of new conservation by-laws by the Nepalese Parliament. For the first time and twelve years after the idea was first raised, the recycling of 30-50% of all tourism revenues collected in National Parks are to be invested in buffer zone conservation and development projects. The recycled revenues law allows village groups who live adjacent to tiger habitat to profit from this living arrangement, rather than only experience penalties, as in the past. Under the leadership of park wardens, steering committees are to be established which evaluate proposals submitted by Village Development Committees (VDCs), the local administrative unit, to access the recycled revenue fund. Grants will be made to village groups rather than individuals, to ensure that funds will be used for the betterment of the community. Typical investments will be used to meet basic needs, such as fuelwood, fodder, and timber plantations, and to improve roads, health care, and livestock.

TCUs have the potential to earn large sums of money from ecotourism, if properly managed. Areas containing tigers typically contain other charismatic species and are major destinations for foreign tourists and— in some tiger range states with emerging middle classes—local tourists as well. The problem with ecotourism to date is that the profits rarely remain in the immediate area. Studies in IS006 Chitwan-Parsa-Valmiki show that, prior to the ratification of the by-laws, local villagers had received virtually none of the profits from tourism, despite Chitwan National Park being the most visited wildlife tourist park in Asia (>60,000 tourists/year). Most of the money is earned by a small handful of tour operators and owners based elsewhere. Unless, locals reap some of these profits, they will never support wildlife conservation efforts.

We urge that the model in Nepal be carefully studied, and where appropriate, be adapted to provide locals with greater financial incentives to conserve endangered wildlife.

Project Tiger Reserves began with a flourish and high expectations for the long-term conservation of tigers. With the exception of a few areas, most have fallen on hard times, without sufficient personnel, equipment, or funds for enforcement to protect tigers and their habitats. While staff have remained committed to their objectives, annual budgets have become inadequate to deal with severe threats. On top of that, the ability to implement other alternatives to strict enforcement, such as integrated conservation and development projects, requires considerable annual expenditures in their own right. Clearly, the only long-term solution to addressing the needs for tiger conservation is the establishment of a conservation trust funds in each of the range states to meet recurrent costs for protecting populations and habitats, conduct monitoring, and implement participatory village development projects in appropriate areas. Such a fund is already being developed in the RFE. Once it is implemented, its effectiveness should be monitored to determine how best to adapt it to other countries included within the tiger's range. To this end, we offer a description of the Tiger Conservation Fund in Annex 3.

IV. Priority TCUs for Immediate Surveys

A. Indian Subcontinent

Thirteen TCUs in the Indian Subcontinent require immediate surveys to obtain more up-to-date information on the status of tiger habitats, their degree of connectivity (i.e., validity as a single TCU), or population status. Note that many of these TCUs were scored in the analysis as there was sufficient data to make coarse-level assessments by local experts. Some of these are so large in area that data are lacking across the range of the TCU. They are, in order of priority:

Priority:	ID no.	TCU Name
1	IS010	Manas-Namdapha
2	IS031	Kanha-Pench
3	IS055	Dandeli-Bandipur
4	IS006	Valmiki (part of Chitwan-Parsa-Valmiki)
5	IS052	Nagarjunasagar
6	IS048	Kotgarh
7	IS059	Periyar-Kalakad
8	IS028	Melghat
9	IS027	Bagdara-Hazaribagh
10	IS058	Parambikulum
11	IS024	Panna-Son Gharial
12	IS016	Meghalaya-Kaziranga
13	IS018	Sundarbans

B. Indochina

Virtually all of the larger TCUs in Myanmar, parts of Thailand, and Cambodia require more detailed surveys to assess habitat quality and population status. In order of priority, they are:

Priority:	ID no.	TCU Name
1	IC001	Northern Triangle
2	IC002	Aragon Yomas
3	IC014	Huay-Kha-Khaeng-Tennaserim
4	IC004	Shan Plateau
5	IC015	Virachai

C. Southeast Asia

Loss of habitat in Sumatra clearly defines where tigers will be conserved over the long term.

Several survey sites need evaluation:

Priority:	ID no.	TCU Name
1	SA023	Air Sawan
2	SA018	- Sibolga-Dolok Surungan
3	SA027	- Padang Sugihan
4	SA026	- Dangku

Recommendations:

1: Among the bioregions, we urge that Indochina TCUs be given highest priority for surveys. Relatively speaking, data on habitat integrity, poaching pressure, and population status is much better for Indian Subcontinent TCUs than for Indochina. The restricted nature of TCUs in Sumatra requires less effort (other than those few TCUs listed above).

2: Based on the results of the surveys, we urge that a member of the WWF/WCS team serve as an emissary to assist government agencies in Indochina to: 1) update information and clarify delineation of the large TCUs in Indochina and 2) assist in formulation of conservation plans for a cluster of Level I TCUs. These plans should be the basis for the development of several funding proposals per year for the Tiger Council and other donors for the next three years. The greatest needs for this effort would be in Laos, Cambodia, Myanmar, and Vietnam.

V. Summary of Important Findings

The results of this study give new knowledge about tiger conservation:

1) Virtually all of the Level I TCUs straddle or lie near international boundaries. The exceptions are a few units in central and southern India and Sumatra. This result will be essential for venues like the Global Tiger Forum to ensure that trans-boundary conservation activities are given high priority. It will also support the rationale for the trans-boundary initiatives already underway in Asia.

2) Strict protected areas typically cover only a fraction of a TCU. This spatial relationship has particular relevance in India, which contains more tigers than any other country. Half of all tigers in India live outside official Project Tiger reserves, much of the remaining half occur in other protected areas that are not official Project Tiger reserves. While tigers do exist outside sanctuaries and reserves, reproduction of tigers in these exterior habitats may be low or nonexistent. This study points toward upgrading management for biodiversity in many of the larger TCUs to maintain the long-term health of tiger populations and the ecosystem of which they are a part. This goal will likely require increased cooperation among multiple sectors of national and state governments.

3) Several Level I and II TCUs are very large, and we recognize that they will not receive complete protection. Since tiger habitat is being rapidly lost, this study can serve as leverage for more "conservation-friendly" land use and improved

landscape management within these high-priority TCUs. If proper use is planned and enforced, habitat linkage zones, effective core areas, and buffer zones can be better maintained.

4) The habitat integrity index used in this study provides only a snapshot in time of the habitat quality within each TCU. The length of this study was too short to assess the trajectory of tiger habitats over the next 10-20 years. However, we point out that some of the most intensive logging in the Indochina Bioregion is occurring or slated for many of the Level I TCUs, and many of these same areas suffer from intense poaching of tiger prey. We urge finer-scale studies focusing on Level I and Level II TCUs to assess trajectories.

5) The only prime example of a TCU that conserves a representative unit of tigers living in mangrove ecosystems is the Sundarbans TCU on the border of India and Bangladesh. Other TCUs containing mangroves in Indochina or Southeast Asia are mere remnants of mangrove habitat and tiger populations are severely depleted. Thus, the Sundarbans TCU emerges as a global priority for tiger conservation.

6) There was no significant relationship between the size of a TCU and its score (i.e., value as a high priority TCU). Thus, the largest blocks of remaining habitat may not always be the best areas to conserve tigers. Some large blocks are quite degraded across most of the TCU or are not considered prime habitat. In other words, one cannot simply select the largest blocks of habitat and assume to have identified the most important units.