Asiatic Golden Cat in Thailand

Population & Habitat Viability Assessment

Chonburi, Thailand

5 – 7 September 2005

FINAL REPORT

Photos courtesy of Ron Tilson, Sumatran Tiger Conservation Program (golden cat) and Kathy Traylor-Holzer, CBSG (habitat).

A contribution of the IUCN/SSC Conservation Breeding Specialist Group.

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Executive Summary

Introduction

The Asiatic golden cat, also known as Temminck's cat (*Catopuma temminckii*), ranges throughout Southeast Asia, from Nepal and parts of China to peninsular Malaysia and Sumatra. Its close relative, the African golden cat (*Profelis aurata*) is a separate species found in East and Central Africa. Once common, golden cat populations are now believed to be declining due to habitat loss and other factors. Asiatic golden cats are listed as a CITES Appendix I species, and their status in 2002 was classified as Vulnerable by the IUCN Red List.

Little else is known regarding Asiatic golden cat biology or the status of wild golden cat populations in Thailand. Current research and conservation efforts focus on other felid species, such as the tiger, clouded leopard or marbled cat. Such projects sometimes produce incidental information on golden cats, but there are no systematic or concentrated efforts on this species. Golden cats can be found in zoos throughout several Southeast Asian countries, but to date there has not been a coordinated *ex situ* management program.

The South East Asian Zoo Association (SEAZA) has targeted the Asiatic golden cat as one of its high priority species for management and conservation. To assess the conservation needs of this species, SEAZA collaborated with the Royal Forestry Department (RFD) of Thailand and the Zoological Parks Organization of Thailand (ZPO) to conduct two concurrent workshops focusing on the Asiatic golden cat: an *Ex Situ* Management Workshop to address captive population management, and a Population and Habitat Assessment Workshop to assess the wild golden cat population in Thailand.

The PHVA Process

The Conservation Breeding Specialist Group (CBSG) was invited to conduct a Population and Habitat Viability Assessment (PHVA) workshop for the Asiatic golden cat in Thailand as part of an integrated *in situ* – ex situ conservation assessment for this species. The PHVA workshop was held 5 – 7 September 2005 at Khao Kheow Open Zoo in Chonburi, Thailand and was sponsored by the Zoological Parks Organization of Thailand and the South East Asian Zoo Association. Participants included field researchers, university faculty and graduate students, zoo staff and non-governmental organization (NGO) staff (see Appendix I of this report for a complete list of workshop participants).

CBSG was invited to serve as a neutral workshop facilitator and organizer. CBSG is a part of the Species Survival Commission (SSC) of the IUCN - World Conservation Union, and for more than 15 years has been developing and applying a series of science-based tools and processes to assist species management decision-making. One tool CBSG employs is use of neutral facilitators to moderate small working groups, as the success of the workshop is based on the cooperative process of dialogue, group meetings, and detailed modeling of alternative management scenarios.

Information sharing is at the heart of the PHVA workshop process, which takes an in-depth look at the species' life history, history, status, and dynamics, and assesses the threats that may put the species at risk. One crucial by-product of a PHVA workshop is that an enormous amount of information can be gathered and considered that, to date, has not been published.

This information can be from many sources; the contributions of all people with a stake in the future of the species are considered.

To obtain the entire picture concerning a species, all of the information that can be gathered is discussed by the workshop participants with the aim of first reaching agreement on the state of current information. These data then are incorporated into computer simulation models to determine: 1) risk of population extinction under current conditions; 2) those factors that make persistence of the species problematic; and 3) which factors, if changed or manipulated, may have the greatest effect on improving the prospects for survival. In essence, these computer-modeling activities provide a neutral way to examine the current situation, identify and prioritize gaps in knowledge, and establish what needs to be changed to meet defined goals.

Complementary to the modeling process is a communication process, or deliberation, that takes place during a PHVA. Workshop participants work together to identify the data parameters to be entered into the *Vortex* model. During the PHVA process, participants work in small groups to discuss key issues. Each working group produces a report, which is included in the PHVA final report. A successful PHVA workshop depends on determining an outcome where all participants, coming to the workshop with different interests and needs, "win" in developing a model that best represents the reality for the species and is reached by consensus. The workshop report is developed by the participants and is considered advisory to the relevant management authorities for the species.

The PHVA workshop began with an introduction to the CBSG workshop process and Vortex simulation model. Workshop participants then generated a list of the primary issues affecting golden cat viability and conservation in Thailand. Habitat loss/conversion/fragmentation and the lack of accurate information regarding golden cat numbers, distribution and threats were identified as the top concerns. Two working groups were formed, one focusing on golden cat distribution and habitat and the second on human-related impacts, including habitat loss and fragmentation. A third group, composed primarily of CBSG modelers, incorporated data from the other working groups to build a golden cat simulation model and develop population projections under various potential scenarios.

Each working group discussed and analyzed the problems for this species, documented available data, and recommended actions to address the key issues. At each stage of the process each working group presented their conclusions to all workshop participants during plenary sessions to provide everyone with the opportunity to contribute to the work of the other groups and to assure that issues were carefully reviewed and consensus achieved. Sections 2 through 4 of this report contain detailed results from each of the working groups. Summaries of the results of each working group report are presented below.

Working Group and Model Results

The *Distribution and Habitat Working Group* addressed those issues related to golden cat distribution and habitat throughout Thailand and obstacles to population estimation. Four key issues were identified, described and prioritized: lack of information, habitat fragmentation/ degradation, effects of other species, and population fitness. Lack of accurate information regarding golden cats was considered the primary issue in need of resolution before effective conservation actions can be developed. The working group suggested six steps toward ameliorating the paucity of data concerning the Asiatic golden cat: 1) literature review; 2) preliminary surveys; 3) ecological data collection; 4) density estimates; 5) determination of primary threats; and 6) information exchange. As a first step, group members assembled and documented all available information at the workshop on golden cat distribution in Thailand.

Potential threats posed to golden cat populations by various human activities were discussed by the *Human Impacts Working Group*. This group lacked sufficient expertise to identify key issues specific to Thailand but classified five potential sources of human impacts on golden cats: habitat alteration/loss; human-wildlife conflict; lack of public awareness; harvesting; and disease transmission. For each of these topics, the group outlined the primary issues, existing knowledge, gaps in knowledge, goals, and suggested actions. Recommendations included research and surveys, increased law enforcement, protected area expansion, habitat restoration, corridor development, improved habitat management, improved livestock management, and public education programs.

The *Modeling Working Group* was given the difficult task of building a population model for golden cats in Thailand, a species for which almost no information was available. A baseline model was developed using life history data from similar felid species and population estimates from the *Distribution and Habitat Working Group*. Carrying capacity, initial population size, and population growth then were varied systematically to create a series of alternative models for evaluation. Fewer than 200 Asiatic golden cats were estimated to exist in 11 isolated populations across Thailand. Modeling results suggest that these populations are extremely vulnerable to extinction, and that golden cats may disappear from most or all of Thailand within 50 years. Unfortunately this situation does not apply only to the Asiatic golden cat – photo-trapping evidence suggests that much of Thailand's wildlife is in much worse shape than is generally believed.

Although there was very little available data on wild golden cat populations going into the PHVA, this workshop may facilitate conservation of the golden cat through the following two major conclusions:

1. The golden cat is not currently targeted for research or conservation efforts. There is a general lack of data on the biology of the species in the wild and, more importantly, on the status of the population, its distribution and degree of fragmentation, and threats faced by the species, including harvest rates. Research needs to address these gaps in knowledge were identified by workshop participants.

2. The scant field and antidotal data available suggest that the golden cat may be at far greater risk in Thailand than is generally assumed. Although the species may be more common than other sympatric felid species such as marbled cats and tigers, this does not mean that it is not at significant risk of extinction. The conclusions of this workshop may be viewed as a call to arms to better examine the current status of golden cats and other wildlife populations in the remaining habitat fragments in Thailand.

Once common through much of Southeast Asia, the golden cat may now face serious threats in Thailand and possibly other portions of its range. The results of this PHVA workshop suggest that urgent action is needed to save the Asiatic golden cat from extirpation from Thailand.

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SECTION 2

Distribution and Habitat Working Group Report

Distribution and Habitat Working Group Report

Members: Anon Cherpaiboon, Prateep Duengkae, Kanda Dumrongchai, Huynh Tuyet Mai, Dusit Ngoprasert, Pipat Soisook

Defining the Issues

This working group was given the task of addressing issues broadly concerned with golden cat distribution and habitat throughout Thailand. The group identified and prioritized four major issues within this topic pertaining to conservation of the Asiatic golden cat. The list of issues is listed below from most to least urgent. Each issue was then discussed further by the group.

1. The greatest problem was identified as being the lack of information on populations of Asiatic golden cats (e.g., estimates of numbers of individuals, distribution of Asiatic golden cats in Thailand and across Asia).

2. The second biggest problem is that the available habitat in Thailand is severely fragmented and heavily degraded.

3. The third biggest problem relates to heavy competition among the various carnivore species because they have been squeezed into reserves at unnatural densities combined with an insufficient prey base due to poaching and human encroachment.

4. The final issue identified by the working group is the lack of knowledge concerning reproductive rates and poaching rates impacting the viability of Asiatic golden cat populations.

Lack of Information

The lack of information on golden cat populations was attributed to several causes:

- No budget for running conservation programs.
- Lack of technical support, lack of equipment to conduct field surveys, lack of professional support.
- Lack of public awareness concerning the urgency of the problem.
- Government policy not focused on golden cat conservation.

The group discussed why such information is important and what benefits it could provide. Accurate information on golden cat populations in Thailand would make it possible to:

- Identify the level of endangerment of the species and act accordingly.
- Identify current and potential golden cat habitat to be protected.
- Increase public awareness of the status of golden cats in Thailand.
- Provide wildlife managers with information that could be used for sustainable development plans.
- Provide information that could be shared with international organizations.
- Develop conservation plans (e.g., genome bank, biodiversity).

Habitat Fragmentation/Degradation
Habitat fragmentation and degradation negatively impacts golden cat populations and occurs due to factors such as:

High density of humans within protected areas: Human activities directly impact Asiatic golden cat habitat in a negative way. Local people are dependent on forest products and also harvest animals and timber for profit.

Agriculture: Farms degrade forest habitat via the runoff of pollutants such as pesticides and fertilizers. Moreover, forest is converted to agricultural land or the forest is degraded through edge effects (e.g., loss of soil moisture) when situated near agricultural fields.

Construction: Habitat fragmentation is often a result of infrastructure build-up, such as road or reservoir construction.

Natural forces: Natural damage from forest fires, flooding, and soil erosion can lead to habitat degradation. Note that all of these can be exacerbated by habitat fragmentation.

Impact of Other Species
Due to habitat loss, unnatural densities of predators can concentrate in protected areas where predators are compressed into the few areas supporting prey. This can greatly increase competition among predators within the remaining habitat, with smaller predators often faring worse than larger predators. An even greater problem can be competition with alien species, such as domestic dogs and cats, which can reduce prey densities and spread disease to wildlife populations.

Population Fitness
It is important to determine if populations of the Asiatic golden cat are in decline and, if so, why they are in decline. One component of this assessment will be to determine harvest rates (poaching) of golden cats and possibly their prey species. An assessment of the primary threats to golden cat populations is necessary in order for effective management actions to be identified to address these threats.

Recommended Actions
These steps follow a logical progression and are presented in Table 1.

Step 1: Literature Review
The first step should be to review the current information concerning the Asiatic golden cat and deposit it in a central location. The information gathered should concentrate on the distribution of the golden cat inside and outside of Thailand and basic ecological information such as reproductive rates, variation in fecundity and mortality due to physical environmental factors and prey availability, the impacts of human presence on behavior and mortality rates, and identification of major threats to wild populations. The information should be used to define priority areas for presence-absence surveys and for more advanced surveys later. This work should be funded and carried out by the Department of National Parks, Wildlife and Plant Conservation (DNP), universities, and NGOs. It is important to train researchers in the methods for conducting these surveys.

Step 2: Preliminary Survey
Currently, we lack sufficient information on the habitat requirements of the Asiatic golden cat, so that we cannot predict the location of golden cat populations or locate suitable habitat where they might be missing for other reasons. The next step is for researchers to determine the presence or absence of Asiatic golden cats from each protected area, starting with the high priority areas identified in the literature review. Standard methods for conducting surveys of golden cat populations should be developed and conducted in all protected areas where the species has not already been confirmed to exist. Responsible parties should include DNP, universities, and NGOs.

Step 3: Ecological Data
Basic ecological and life history data for the golden cat should be collected. Such data include the interbirth interval, age at sexual maturity in the wild, litter size, home range size, diet, activity patterns, and habitat use/selection.

Step 4: Density Estimates
Once we have a good understanding of golden cat ecology, appropriate methods for conducting density estimates can be designed and workshops conducted to train field researchers in methods for estimating population size. Density estimates should be carried out every 10 years. Responsible parties include DNP, universities, and NGOs.

Step 5: Threatening Factors
Knowledge of the basic ecology of the species will allow us to examine both the direct and indirect causes of population decline of golden cats. Identifying the causes of decline is the first step in better managing the population. Particular attention should be given to identifying and ranking threats to the golden cat, including causes of habitat degradation, monitoring the presence and impacts of domestic animals, and the effects of human settlement.

Using a combination of ground surveys and remote sensing/GIS, habitat fragments suitable for being joined by the use of corridors should be identified. Research should be conducted to design corridors that will be used, and then the corridors should be created. Responsible parties include the Thailand Institute of Science and Technology Research (TISTR), DNP, universities, and NGOs.

Step 6: Information Exchange
Sometimes the needed data are not available to the decision makers. Developing ways to share these data, or to make the information easily accessible, will improve management of the species. Environmental education should be provided to local people inside and surrounding the protected areas and to tourists. This should be carried out by universities, Zoological Parks Organization of Thailand (ZPO), and local organizations.

Table 1. Steps toward improving our knowledge of the golden cat to facilitate conservation.

Rank	Issue
1	Literature review
2	Preliminary survey
3	Life history and ecological data
4	Density estimates
5	Threatening factors
6	Information exchange

Data Assembly and Analysis

The working group spent considerable time assembling and analyzing all available published and unpublished information on golden cat distribution and habitat use in Thailand. This analysis provided population structure and size estimates to the Modeling Working Group for use in assessing the viability of golden cat populations in Thailand. A summary of this information is provided below.

The current range of the Asiatic golden cat is believed to include Bhutan**,** China (some parts), India, Malaysia, Nepal, Sumatra, Thailand, Tibet, and Vietnam. Specific locations in Vietnam are the provinces of Lai Chau, Bac Can, Lang Son, Tuyen Quang, Ha Tay, Ninh Binh, Thanh Hoa, Kon Tum, Gia Lai, and Lam Dong.

In Thailand, there are reports of golden cats in the following areas: Doi Chiang Dao Wildlife Sanctuary (1996), Nam Nao National Park (1996), Thung Yai Naresaun (1995), Phu Kheow Wildlife Sanctuary (2005, two individuals), Khao Yai National Park (2005, two individuals), Tab Lan National Park (1999)**,** and Kang Krachan (2004, three individuals) (also see Tables 2 and 3 for further information). Figure 1 provides a map of many protected areas in Thailand.

Table 2. Summary of current distribution in Thailand of Asian golden cats and number of individuals from literature citations and camera trap surveys.

Location	**Location type**	**Area (km^2)**	**Data source**	**Year**	**MNKA[a]**	**Habitat type**
Chiang Dao	WS	510	Ref*	1996	1	Montane
Salawin	WS	879	Ref*	1996	1	
Nam Nao	WS	975	Ref*	1996	1	
Thung Yai Naresuan	WS	3,689	Survey	1995	1	Evergreen
Huai Kha Kaeng	WS	2,813	Ref*	1996	1	
Phu Kheow	WS	1,577	Ref**	2005	2	Evergreen
Khao Yai	NP	2,185	Survey	2005	2	Evergreen
Tab Lan	NP	2,220	Survey	1999	1	Evergreen
Kaeng Krachan	NP	3,027	Survey	2004	3	Primary & Secondary
Khao Luang	NP	575	Ref*	1996	1	-
Total					**14**	

WS = Wildlife Sanctuary; NP = National Park
[a] minimum number of individuals known alive (MNKA)
* Nowell and Jackson 1996
**Grassman *et al.* 2005

Table 3. Survey summary of each protected area.

Area	Method	No. of locations	Trap nights	No. of individ.[a]	Year of the survey
Klong Sang Wildlife Sanctuary	Camera Trap	-	1,200	3	1999 (Bussabong, DNP, researcher)
Khao Yai National Park	Camera Trap	84	2,100	4	Jan-Sep. 2005 Carnivore Conservation Project
Thung Yai Naresuan WS	Personal contact	1			
Tap Lan National Park	Camera Trap	24		1	Sep-Nov.1999 WCS-Thailand
Kaeng Krachan National Park	Camera Trap	29 72	1,030 4,493	1 2	WCS-Thailand, 2001 2003-2004 (Dusit Ngopresert)
Total				**11**	

[a] = number of individuals photographed

The following sections provide information for surveys referenced in Tables 2 and 3.

Kaeng Krachan National Park

First survey, 2001 from WCS-Thailand *(Ngoprasert and Lynam 2002)*

This survey was conducted during January-March (2001) and covered four different areas. The minimum number of individuals known alive (MNKA) during the survey was 1 individual (1 camera trap photograph).

The four study areas were:

1. Huai Mae Saliang – walked the road as far as Khao Panoem Thung and then walked 15 km of riparian habitat (Huai Mae Saliang-Khao KraTing-Bong Ta Dang).
2. Bong Pow - start at Khao Prakalang-Bong Comkit-Huai Ta Na-Bong Pow-Bong Ta dang.
3. Walked the Phetchaburi River starting from the Kasetsart University camp and traveling both upstream and downstream of the Phetchaburi River. Upstream: Start at Km 33 of road and go to Khao Panoem Thung, walk along Phetchaburi River - Km 36.
4. Downstream: Start at KU camp and raft along the Phetchaburi river to Bong Lauk.

Table 4. Summary of survey effort at four areas in Kaeng Krachan National Park.

Location	Camera-trap location	No. of trap nights	Golden cat presence
1. Huai Mae Saliang	8	294	Not recorded by camera-trap
2. Bong Pow	5	368	Not recorded by camera-trap
3. Phetchaburi River (upstream)	8	294	Presence
4. Phetchaburi River (downstream)	8	74	Not recorded by camera-trap
Total		**1,030**	

Second survey, 2003-2004 *(Ngoprasert 2004)*
Trap locations were based on reconnaissance conducted during July-December 2002. Stratified random sampling was used to choose 72 trap locations. The results from camera trapping for 266 days from February 2003 to January 2004 confirmed the presence of 2 Asiatic golden cats. The cats were photographed in two different areas. The sampling effort involved 4,493 trap-nights.

Phu Kheow Wildlife Sanctuary *(Lynam et al. 2001)*

Tap Lan National Park *(WCS-Thailand, personal communication)*
This survey was conducted during September-November 1999. A total of 24 camera-trap locations confirmed the presence of 1 Asian golden cat.

Thung Yai Naresuan Wildlife Sanctuary
Personal contact from the former head of Thung Yai Naresuan Wildlife Sanctuary, Sompoch Maneerat. He encountered an Asian golden cat near the ranger station in 1995.

Thung Yai Naresuan Wildlife Sanctuary (3,200 km^2) is located between (longitude) 14 ^{o} 55′ to 15 ^{o} 45′ north and (latitude) 98 ^{o} 25′ to 99 ^{o} 05′ east. Climate conditions range from tropical to semi-tropical. The climate is monsoonal, with a dry season from November to May, and a hot, wet season from May to October. Mean annual rainfall in the west is 2,000-2,400 mm, declining to 1,600-2,000 mm in the east with more than 80% of the rain produced by the southwest monsoons. Mean minimum and maximum temperatures ranged from 15 °C to 35 °C during the hot season, 20 °C to 33 °C during the wet season, and 10 °C to 29 °C during the cool season. Minimum and maximum night and day temperatures ranged from 7 °C to 40 °C (Faculty of Forestry, 1989).

The study areas were surveyed using 6 Camtrakker® (Winder, GA,USA) camera-traps. Surveys were conducted from June 2000 to October 2001. Twenty-three mammal species were recorded during this study. Six species (26%) were listed as threatened according to the IUCN (2003): tiger, Asian elephant, Asiatic black bear, Malayan sun bear, marbled cat, and serow. Seventeen species (73%) are protected by the Thai Wildlife Reservation and Conservation Act of 1992.

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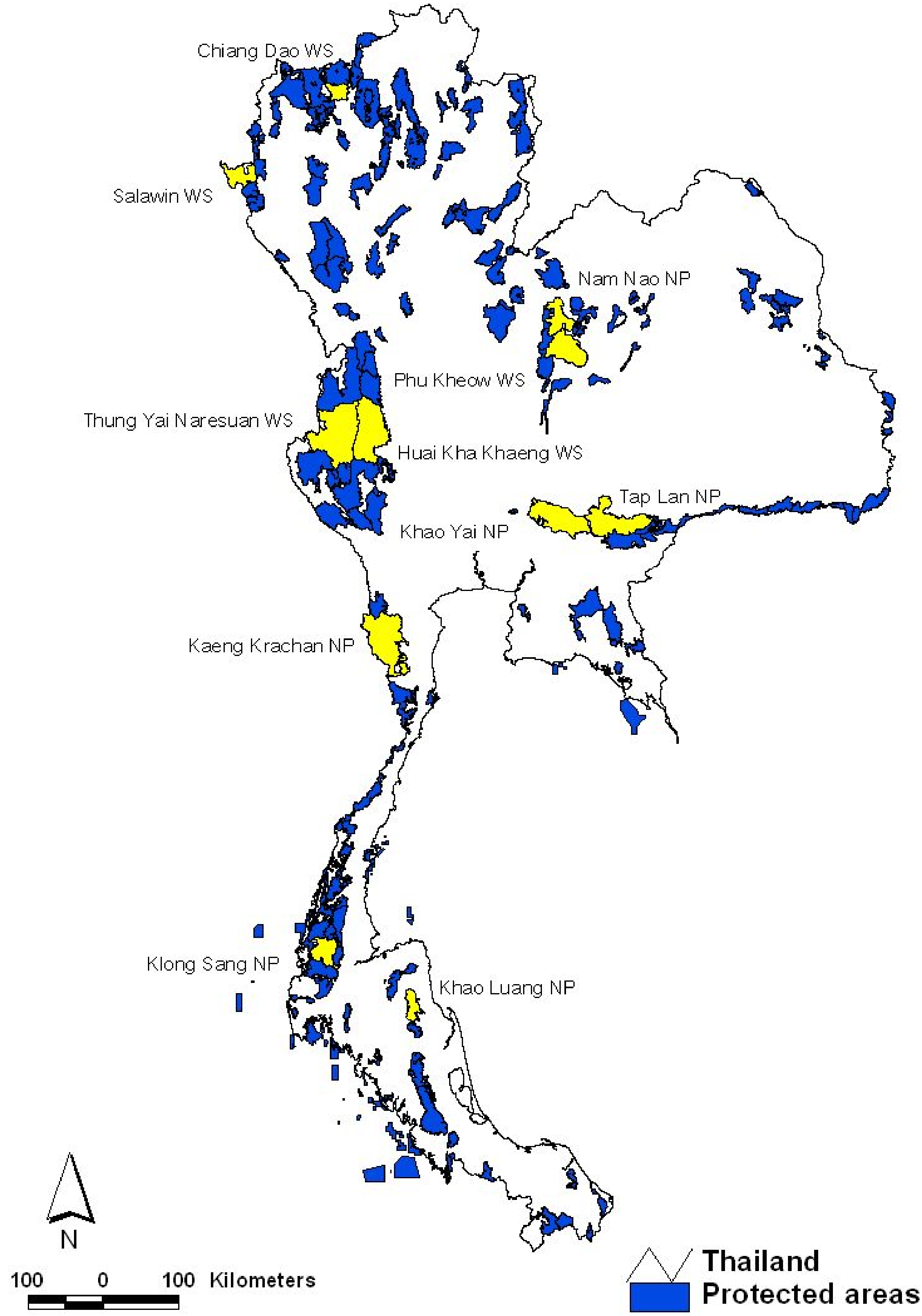

Figure 1. Map outlining protected areas in Thailand (courtesy of Dusit Ngoprasert)

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SECTION 3

Modeling Working Group Report

Modeling Working Group Report

Members: Noviar Andayani, Hang Lee, David Reed, Ligaya Tumbelaka

Model Development

This working group was given the difficult task of building an informative population model for a species for which virtually no information was available. The first step was to build a baseline model using the *Vortex* population simulation software program (v9.57). Since none of the input parameters were known for the Asiatic golden cat, the group relied on models built for other medium- to small-sized felines. Models had already been built for the bobcat (*Lynx rufus*) (Reed *et al*. 2003), clouded leopard (*Neofelis nebulosa*) (Wang *et al*. 1995), Eurasian lynx (*Lynx lynx*) (Reed *et al.* 2003), and ocelot (*Leopardus pardalis*) (Miller 2005). Furthermore, there was adult mortality data for several populations of the leopard cat (*Prionailurus bengalensis*) (Austin 2002; Rajaratnam 2002; Haines *et al*. 2004).

The parameters from these models and data sets were used to obtain weighted averages for use in the Asiatic golden cat baseline model. The models were weighted according to the quality and quantity of data (with the bobcat being the most extensively studied and the clouded leopard the least), the similarity in body size of the modeled feline to the Asiatic golden cat (the bobcat and ocelot of are very similar sizes, the clouded leopard and lynx larger and the leopard cat smaller), and the similarity in habitats (the clouded leopard and leopard cat are found in the same habitats). Parameter values used for the baseline model are given below.

Model Conditions: Each model scenario was run 1,000 times for 100 time steps (years). The choice of 100 years was thought to provide the optimal trade-off between the greater uncertainties with longer projection times and the time scale over which the threatening processes were operating.

Extinction: Defined as only one sex remaining.

Number of Populations: Extensive photo-trapping data exists from numerous protected areas in Thailand. The Distribution and Habitat Working Group and the Modeling Working Group also contained several members with extensive experience in and outside of protected areas throughout Thailand. Thus, we are reasonably confident that there are 11 isolated populations of Asiatic golden cat existing in Thailand and that no animals exist permanently outside of protected areas. These 11 populations are located at Chiang Dao, Hua Kha Kaeng, Kaeng Krachan, Khao Luong, Khao Yai, Khlong Saeng, Nam Nao, Phu Khieo, Salawin, Thap Lam, and Thung Yai.

Inbreeding Depression: We modeled 6 lethal equivalents for juvenile mortality, which has been suggested as typical for wild populations (O'Grady *et al*., unpublished).

Environmental Concordance of Reproduction and Survival: *Yes*. The working group felt that the major causes of environmental variation (disease, drought) were likely to impact both reproduction and survival similarly, producing a strong correlation between the two.

Correlation among Populations in Environmental Variation: *= 0.15*. The populations modeled are scattered throughout Thailand and, with few exceptions, are separated by several hundred kilometers. Further, the populations are genetically isolated from each other. Thus, we felt that the correlation among populations in environmental variation was low.

Catastrophes: *2.* The working group felt that the greatest non-anthropogenic threats to the Asiatic golden cat were disease and drought.

Dispersal: The habitat working group strongly felt that there was no gene flow connecting the 11 populations in Thailand. In fact, the only possible gene flow would be from individuals from Myanmar crossing the border into Thailand (Kaeng Krachan or Salawin).

Breeding System: This species is polygynous (*long-term polygyny*).

Age of First Reproduction: 2 years of age for females and 3 years of age for males.

Maximum Age of Reproduction: 13 years.

Proportion of Females Breeding: 76% (standard deviation = 8.95%).

Offspring Number: There were some indications from zoo records that Asiatic golden cats can produce up to four offspring per litter. Litter size distribution was given as:

Number of Offspring	Probability
1	0.40
2	0.35
3	0.20
4	0.05

Mortality Rates: Age-specific annual mortality rates for males and females are as follows.

	FEMALES		MALES	
Age Class	% Mortality	SD (EV)	% Mortality	SD (EV)
0 – 1	46.60	16.75	46.60	16.75
1 – 2	20.55	13.70	20.55	13.70
2 – 3	17.50	7.70	23.76	7.85
3+	17.50	7.70	17.50	7.70

Catastrophe Rate and Severity: Catastrophes were divided into minor and major catastrophes. Minor catastrophes were modeled as occurring with a 3% probability per year and reduced the proportion of females breeding by 25% (while leaving mortality rates unchanged). Major catastrophes occurred with a frequency of 0.25% per year (once every 400 years on average) and reduced the proportion of females breeding by 80% and increased mortality by 40%. Catastrophes were considered to be local and therefore catastrophes occurred independently among the subpopulations.

Initial Population Sizes: Population size estimates for Asiatic golden cat populations currently existing in Thailand was probably the most controversial parameter among the two working groups, in part because none of the participants wanted to believe what the available data suggested. However, all indications are that the Asiatic golden cat currently exists at dangerously low numbers throughout Thailand. An example follows.

Khao Yai National Park is Thailand's oldest national park, created in September 1962. In 1982 it was listed as an ASEAN heritage site due to its variety of flora and fauna. Khao Yai has also been nominated as a World Heritage Site. It is Thailand's third largest national park, covering an area of 2,166 km^2. Approximately 1,300 $km^2$of the park was camera-trapped during January-September 2005, using 84 cameras, as part of the Carnivore Conservation Project. Only four Asiatic golden cats were photographed. Some group members suspected that the park may have been too sparsely sampled to have captured all of the Asiatic golden cats on film. However, Dusit Ngopresert, a member of the Distribution and Habitat Working Group, sampled a similar sized and mostly overlapping area of Khao Yai using 128 cameras and found only 3 individuals.

A statistical analysis by D. Reed of camera trapping studies showed that the number of individuals photographed was not associated with the density of cameras or the number of trap nights, but strongly associated with the total area trapped. This suggests, within the limits of our small sample size, that areas that were camera-trapped were trapped sufficiently to find all or most of the Asiatic golden cats present, and that finding more cats would require sampling a larger area. One protected area, Khlong Saeng Wildlife Sanctuary, has been extensively camera-trapped over almost the entire region and captured only 3 individuals.

Thus, we believe that the golden cat numbers estimated for these protected areas that have been camera-trapped are reasonably accurate and that any errors are, if anything, biased toward being too optimistic. For areas that were not camera-trapped, we used the average density of other protected areas with similar quality habitat to calculate an expected population size. In some cases the number of tigers in a given area was known fairly precisely and camera-trapping data typically reveals a 2:1 ratio of Asiatic golden cats to tigers. This allowed us another independent predictor of the number of Asiatic golden cats in areas that were not sampled. These calculations resulted in the following current population sizes used in the model (Table 1).

Table 1. Estimates of current golden cat populations in Thailand.

Protected Area	Population Size	Carrying Capacity
Chiang Dao	2	15
Hua Kha Kaeng	38	90
Kaeng Krachan	55	110
Khao Luong	2	15
Khao Yai	6	55
Khlong Saeng	10	40
Nam Nao	10	30
Phu Kieo	8	45
Salawim	4	20
Thap Lam	45	90
Thung Yai	15	105
TOTAL for Thailand	**195**	**615**

Carrying Capacity: Carrying capacity is always a contentious parameter in models of population viability analysis and it is often, along with population growth rate, the major determinant of the probability of population persistence over a given period of time (Reed *et al.* 2003). Baseline carrying capacities for these simulations were determined by looking at densities of similar-sized felines in areas sparsely inhabited by humans where the populations are hunted and by using the Distribution and Habitat working group as a source of expertise on the relative quality of habitat, with respect to Asiatic golden cats, among protected areas. The resulting estimated carrying capacities for each area are given in Table 1.

Alternative Model Scenarios

Since the demographic input values used in the model were best guesses and were not based on actual data, the working group felt it was not productive to perform sensitivity analysis on demographic inputs. Instead we focused our attention on "big picture" factors that impact population persistence in multiple ways: carrying capacity, initial population size, and population growth. These three parameters were varied systematically to create a series of alternative models for evaluation.

As mentioned previously, the working groups were fairly confident in their estimates of current (initial for the model) population size or felt that these estimates were too generous. However, as an alternative scenario the modeling group created simulations in which initial population size was twice the best guess estimate from the baseline model. These estimates are labeled I_1 for the initial population size and I_2 for twice this estimate (Table 2).

While carrying capacity can never truly be known, and is not likely to be temporally constant, we can put reasonable bounds around our estimate of carrying capacity. The upper bound can be estimated by examining data on home range size of Asiatic golden cats. Grassman *et al.* (2005) provide home range sizes for one male and one female Asiatic golden cat in Phu Khieo Wildlife Sanctuary. By dividing the total available habitat in each protected area by the home range size for males and females, allowing the entire protected area to be used as golden cat habitat, and allowing female territories to totally overlap those of males – we can impose an absolute upper bound on the current carrying capacity of the 11 protected areas believed to currently harbor golden cats. Carrying capacity could change in the future by increasing the prey base through habitat improvement, managing the populations to reduce poaching, or possibly through extinction of other carnivores that compete with golden cats.

We set the lower bound for carrying capacity as twice the initial population size in the baseline model. Thus, we have three different carrying capacities that we simulate: K_1 = twice the initial population size in the baseline model, K_2 = the carrying capacity described for the baseline model, and K_3 = the maximum carrying capacity described above using the estimated home range sizes for the Asiatic golden cat (Table 2).

Table 2. Initial population sizes and carrying capacities for each subpopulation used in alternative modeling scenarios.

Protected Area	I_1	I_2	K_1	K_2	K_3
Chiang Dao	2	4	4	15	30
Hua Kha Kaeng	38	76	76	90	164
Kaeng Krachan	55	110	110	110	169
Khao Luong	2	4	4	15	33
Khao Yai	6	12	12	55	128
Khlong Saeng	10	20	20	40	55
Nam Nao	10	20	20	30	57
Phu Kieo	8	16	16	45	92
Salawim	4	8	8	20	51
Thap Lam	45	90	90	90	128
Thung Yai	15	30	30	105	215
TOTAL for Thailand	**195**	**390**	**390**	**615**	**1122**

The last parameter varied was the population growth rate. Our estimates of the demographic parameters for the Asiatic golden cat were derived from models of similar-sized felines for which there were adequate data to build a model. However, none of these populations were hunted and data were collected from pristine or only slightly degraded habitat. By most accounts, hunting pressure on the Asiatic golden cat is strong (Tungittiplakorn and Dearden 2002; Grassman *et al*. 2005) and estimates of adult mortality rates are vastly different in hunted and non-hunted populations of bobcats and leopard cats (Fuller *et al*. 1995; Chamberlain et al. 1999; Kamler and Gipson 2000; Nielsen and Woolf 2002; Haines *et al*. 2004). Thus, we modeled two alternative scenarios – the baseline model, where population growth was strong (little or no human-caused mortality), and a hunting scenario where the growth rate was weakly positive (modeled as an increase in annual adult mortality from 17.5% in the baseline model to 30.0%). This reduces the deterministic population growth rate from 0.088 (R_1) to 0.025 (R_2).

All three parameters (i.e., initial population size, carrying capacity, and population growth rate) were varied in combination with each other, so that 12 different scenarios were tested. An additional five scenarios were run with intermediate growth rates using baseline initial population size and carrying capacity values to better explore the effect of this parameter.

Results of Simulation Modeling

All scenarios were run for 1,000 iterations each. The results are summarized in Tables 3 and 4 below. Probability of extinction, median time to extinction, mean population size after 100 years, and gene diversity retained are presented for the separate golden cat populations and as well as the metapopulation as a whole (i.e., all Asiatic golden cats in Thailand).

Table 3 represents the baseline model, with strong population growth and little to no human-caused mortality. Although the species has a low risk of extinction (2%) in Thailand over 100 years, most golden cat populations are likely to go extinct, leaving only 1 to 4 isolated pockets of animals in the country. All populations except for Kaeng Krachan (the largest) have a relatively high risk of extinction. Those that do persist are reduced in number and lose significant genetic variation.

Table 3. Probability of extinction (PE), median time to extinction in years (MTE), mean population size (N), and remaining gene diversity (GD) after 100 years for the golden cat populations and metapopulation in Thailand assuming no hunting pressure.

Scenario	Initial N	PE	MTE	Mean N	GD
Chiang Dao	2	1.000	4	0	0
Hua Kha Kaeng	38	0.394	---	24	0.666
Kaeng Krachan	55	0.178	---	50	0.734
Khao Luong	2	1.000	3	0	0
Khao Yai	6	0.991	18	0	0.472
Khlong Saeng	10	0.975	35	0	0.422
Nam Nao	10	0.998	32	0	0.460
Phu Kieo	8	0.987	27	0	0.403
Salawim	4	1	9	0	0
Thap Lam	45	0.326	---	28	0.676
Thung Yai	15	0.732	59	10	0.604
Metapopulation	**195**	**0.020**	**---**	**112**	**0.840**

Table 4. Probability of extinction (PE), median time to extinction in years (MTE), mean population size (N), and remaining gene diversity (GD) after 100 years for the golden cat metapopulation in Thailand under various scenarios for initial population size (I), carrying capacity (K), and hunting pressure/growth rate (R).

Scenario	PE	MTE	Mean N	GD
$I_1K_1R_1$	0.026	---	93	0.822
$I_1K_2R_1$ (base)	0.020	---	112	0.840
$I_1K_3R_1$	0.000	---	275	0.910
$I_1K_1R_2$	1.000	45	0	---
$I_1K_2R_2$	0.998	46	0	0.664
$I_1K_3R_2$	0.996	47	0	0.545
$I_2K_1R_1$	0.016	---	104	0.837
$I_2K_2R_1$	0.007	---	147	0.879
$I_2K_3R_1$	0.000	---	413	0.944
$I_2K_1R_2$	0.999	52	0	0.406
$I_2K_2R_2$	0.999	54	0	0.408
$I_2K_3R_2$	0.982	61	0	0.595

As can be seen from the Table 4, only one parameter – population growth rate – significantly impacts the viability of the population. Additional exploration of intermediate population growth rates indicates how this parameter affects population viability (Fig. 1). If the population growth rate is similar to that of non-hunted populations in pristine habitat, the persistence of at least some Asiatic golden cats in Thailand is fairly secure for the next century. The extirpation of golden cats from Thailand becomes much more likely as human pressures decrease the species' population growth. Even in the absence of hunting, however, it should be noted that even healthy, non-fragmented populations with carrying capacities of K_1 or K_2 are not considered viable in the long-term (Reed *et al*. 2003).

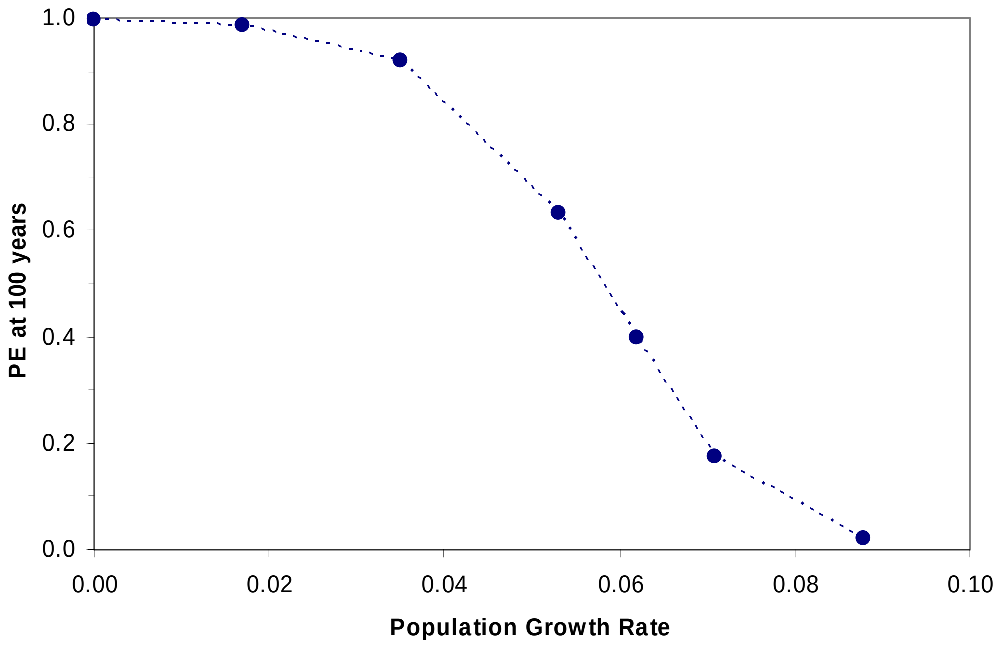

Figure 1. Probability of metapopulation extinction over 100 years for six different population growth rates.

Most of the scenarios explored by the model are not representative of the realistic current situation, but rather something that should be strived for in the future. Carrying capacities are almost certainly much smaller than what is suggested in the most optimistic scenarios. It is estimated that 15 million people are living in Thailand's protected areas (Lynch and Talbott 1995). More importantly, it is likely that population growth rates are as low, or lower, than what is presented in the more pessimistic model scenarios. There is evidence that golden cat populations are in steep decline. Lekagul and McNeely (1977) described the Asiatic golden cat as locally common in some areas of Thailand in 1977. Nobody would describe the Asiatic golden cat as common anywhere in Thailand 28 years later. Tungittiplakorn and Dearden (2002) have shown the rapid and predictable sequence of species extirpations, including the Asiatic golden cat, in areas surrounding Hmong villages even near protected areas. This suggests that hunting pressure is very strong in the vicinity of local villages and, with 15 million people living within protected areas, there will be few populations that are not near villages. Further, the Asiatic golden cat does not survive well outside of interior forest areas (Lekagul and McNeely 1977), and individual cats hunting or attempting to disperse outside of protected areas are thought to be killed by poachers or villagers protecting their farm animals (opinion of the Distribution and Habitat Working Group).

Recommendations

Analysis of the model results suggests that increasing the population growth rate of Asiatic golden cats is the most urgent and important step that can be taken toward slowing extirpation of this species in Thailand. Very little data are available regarding the reasons for its decline or quantitative measures of its rate of decline. However, there is considerable circumstantial evidence for a rapid decline in numbers, and preliminary evidence suggests that illegal poaching is the primary culprit. However, reduction in prey base or other forms of habitat degradation are potentially important or at least are likely contributing factors. This requires immediate study.

After stabilization of the existing populations, attention should be given to increasing the carrying capacity of the available Asiatic golden cat habitat. This can be accomplished by improving the habitat (stocking prey animals and/or decreasing illegal and legal hunting) or increasing the amount of available habitat. Thought should also be given to connecting habitat fragments within Thailand. A corridor between Hua Kha Kaeng and Kaeng Krachan would link two of the larger golden cat populations. Other measures might include ensuring that golden cats from Myanmar are able to disperse into Thailand and/or translocating individuals from Cambodia/Laos/Malaysia to Thailand. However, the question of subspecies designation needs to be addressed before translocation is seriously considered. Any reasonable steps to relieve inbreeding depression and increase genetic diversity in the small remnant populations of the Asiatic golden cat in Thailand will result in improved chances of the species' persistence in that country (Reed 2004).

It is not practical, ethical, economically feasible, or probably beneficial to long-term conservation efforts to relocate millions of tribal peoples out of protected areas. With millions of people living within protected areas, most of them with a long history of hunting and/or a desire to hunt for economic gain or subsistence, it will be nearly impossible to enforce laws against poaching and illegal trade by concentrating on local villages directly. The most significant gains in conservation might be made through other strategies, such as improving law enforcement aimed at middlemen purchasing and transporting illegal forest products, educating those living within protected areas, exploring possible benefits of ecotourism, and providing economic incentives for individuals to leave protected areas willingly.

Summary

Urgent action is needed to save the Asiatic golden cat from extirpation across all of Thailand. Modeling results suggest that the Asiatic golden cat exists in small isolated populations that are extremely vulnerable to extinction. It is also possible that the species is in deterministic decline due to anthropogenic causes. Modeling results suggest that if things do not change, the Asiatic golden cat will likely disappear from most or all of Thailand in approximately 50 years. Unfortunately this situation does not apply only to the Asiatic golden cat. Photo-trapping evidence suggests that much of Thailand's wildlife is in much worse shape than is generally believed and that Thailand could lose species that are emblematic and a deep part of Thai culture, if strong action is not taken immediately.

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Asiatic Golden Cat in Thailand

Population & Habitat Viability Assessment

Chonburi, Thailand

5 – 7 September 2005

FINAL REPORT

SECTION 4

Human Impacts Working Group Report

Human Impacts Working Group Report

Members: Prateep Duengkae, Hang Lee, Narayan Mahanta, Tirtha Maskey, Rattapan Pattanarangsan, Mukul Tamuly, Charlene Yeong

Identification of Issues

Due to the diverse background of the participants in this working group, discussions specific to Thailand proved to be difficult. Therefore, most or all issues discussed were of a general nature and may or may not be suitable in the context of Thailand.

As a group, we brainstormed and listed all of the issues that we thought may be affecting the Asiatic golden cat (AGC). We then proceeded to consolidate these issues into large topics and prioritize them. Definitions were drawn up for each of these major topics, followed by consolidation of existing knowledge and types of data that are lacking. Goals were drawn up for each major topic, and within each topic, these goals were prioritized. High priority goals were examined in detail and action steps were recommended for these goals.

The major issues identified by the working group (listed in terms of priority) were:

1. Habitat alteration and loss
2. Human-wildlife conflict
3. Lack of public awareness
4. Harvesting
5. Transmission of diseases

Habitat Alteration and Loss

Definition

The alteration or destruction of habitat making it less suitable or unsuitable for AGCs.

Issues

- Conversion of land for agriculture.
- Human encroachment into AGC habitat (e.g., construction of houses).
- Developmental activities and industrialization, which includes the construction of roads, bridges and dams.
- Use of forest for timber, minor forest products and other resources.
- Natural catastrophes, such as floods and fires, which may also affect natural AGC habitat or worsen the state of altered habitat.

Existing Knowledge

- The general range of the AGC is from Sumatra through southern China.
- AGCs are found in dry deciduous and tropical forests in Thailand and evergreen, semi-evergreen and moist deciduous forests in Assam.
- In Nepal, there are records of AGCs in sub-tropical regions to 3,000m in elevation. However, no specific evidence exists for this.
- AGCs have not been reported in lowland and swampy areas and therefore may not be found in these areas.
- This species was listed as threatened (IUCN, 1978) and the greatest threat was believed to be deforestation (1987).

Gaps in Knowledge

- The precise distribution and status of the AGC.
- The impacts of habitat alteration and loss on breeding and rates of survival.
- The carrying capacity for prey species and predators of different habitats and areas.

Goals/Solutions *(in order of priority)*

1. Initiate and assist in comprehensive research to investigate the density, distribution and ecology of AGCs across Thailand.
2. Create more protected areas (PAs) as well as increase enforcement in already existing protected areas.
3. Develop a strategic plan for habitat restoration.
4. Develop corridors between fragmented habitats.

Actions

1. *Conduct comprehensive research on AGCs across Thailand.*
   - This research should include, but should not be limited to, the numbers and distribution of the AGC. Satellite imagery, GIS, spotlighting, radio-tagging and a record of sightings may be employed.
   - The survey should include the entire area of Thailand and should begin as soon as possible, for a period of one year.
   - Government department can identify the organization(s), institution(s) or individual(s) who are capable of carrying out such research.
   - This will create baseline data on which future plans, such as a strategic plan for habitat restoration, can be formulated.

2. *Create more PAs and increase enforcement in already existing protected areas.*
   - After analyzing the results of the above research, if large numbers of AGCs are found in non-PAs, more PAs should be created.
   - Government department should be responsible for this, and it should be carried out as soon as possible.
   - These new PAs should include strategic areas of AGC distribution.

3. *Develop a strategic plan for habitat restoration.*
   - This should be the responsibility of the PA authority, and they may engage consultants, NGOs and other assistants.
   - It should be a long-term plan, with an evaluation held after every five years.
   - It should be formulated based on the results of the survey as mentioned above to ensure the restoration of suitable AGC habitat in a scientific manner.

4. *Develop corridors between fragmented habitats.*
   - The main purpose of these corridors is to allow animal movement between fragmented AGC populations.
   - These corridors should be created after analyzing the results of the survey and incorporating known paths of AGCs, other similar species, or prey species.
   - This can be facilitated by planting suitable indigenous species along these areas.
   - Both government organizations (GOs) and non-government organizations (NGOs) should work together to create and maintain corridors.

Human-Wildlife Conflict

Definition

Disagreement between AGCs and humans as a result of increased interaction between the two.

Issues

- Deforestation leads to habitat loss and thus a decline in prey species. AGCs may wander to the fringes of PAs in search of prey and may end up preying on livestock. This may lead to the persecution of AGCs by farmers.
- In some cases, both AGCs and humans may be hunting for the same prey species. AGCs may also be opportunistically hunted directly by humans.
- Focus on other species, such as tigers, may result in higher density of these species, which may out-compete smaller predators like AGCs. AGCs may then move out to the fringes and into closer contact with people.

Existing Knowledge

- In Thailand, the priority for national parks is recreation, whereas for wildlife sanctuaries, the focus is on wildlife protection.
- There are about 20 – 25 million visitors to PAs across the country per year.
- Although it is illegal, some human settlement does occur in protected AGC habitat.
  - Of 44 wildlife sanctuaries in Thailand, only 6 have no humans living within them.
  - More than 1 million people live in the PAs.
  - Law enforcement is difficult.
- The killing of livestock (such as chickens and goats) by wild predators does occur. It is possible that AGCs do prey on livestock.
- Currently, there is a debate within the government whether or not, and how, to achieve a balance between human settlement within PAs and conservation.
- Agar wood (*Acquilaria agallocha*) harvesters in PAs may increase disturbance within AGC habitat. They may also hunt animals opportunistically, including AGCs.

Gaps in Knowledge

- The maximum number of visitors that should be allowed into each PA within a specific timeframe, such that the ecology within each PA will not be aversely affected.
- Whether AGCs actually prey on livestock and how frequently and where this occurs.
- The number, frequency and other details of AGCs killed by villagers due to predation on livestock.
- The status of AGC prey (e.g., small reptiles, small mammals and birds).
- The relationship and competition between AGCs and other predators.
- The carrying capacity of each habitat.
- Details of AGCs hunted by aloe wood harvesters and other poachers.

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Goals/Solutions

1. Conduct a survey of human traffic and human settlement in PAs. This should include the number and distribution of people in PAs, the impact of human activity on PAs, and how dependent these people are on PAs.
2. Improve habitat management.
3. Practice strict law enforcement (with regard to illegal harvesting of forest products).

Actions

1. *Conduct survey of human traffic and settlement in PAs.*
   - Survey should include the number and distribution of visitors to specific areas, number and distribution of human settlements, and the number of people living in these settlements. The activities of visitors and villagers, dependency of people on PAs, and an assessment of impact of activities on PAs should also be carried out.
   - This survey should be conducted in all PAs and surrounding regions, as well as known AGC habitat outside of PAs.
   - It could be carried out by different researchers from different universities, working in their locality, together with government agencies and NGOs.
   - Questionnaires and interviews may be useful in this survey.
   - This will give a clearer idea of distribution and impact of people on PAs and on AGC habitat, which will help to guide further plans.

2. *Improve habitat management*
   - Areas where human activity overlap AGC habitat should be high priority, as well as areas with greatest human impact, as shown by the survey mentioned above.
   - Find ways to relocate and rehabilitate people that live within PAs away from these areas.
   - If the above is not possible, then try to harmonize human settlement and conservation activities in AGC habitat. One possible way of achieving this is by dividing up PAs into settlement areas, buffer zones, and core wildlife protection areas.
   - Minimize the dependency of people on the forest by providing alternative livelihoods. For example, create eco-development opportunities through participatory rural appraisal, where eco-development activities are initiated by the people.
   - Encourage better management of farming practices, such that AGCs and other predators are not able to prey on livestock.
   - Involve local people in conservation activities, such as by hiring former poachers for protection of wildlife and as research assistants.
   - Restrict the number of visitors to PAs.

3. *Practice strict law enforcement.*
   - GOs and NGOs should widely publicize the provisions of the law and the punishment for offence.
   - Increase the number of rangers, staff and equipment.
   - Provide regular training for government officials and PA staff on current wildlife laws and prosecution, protocol for evidence collection, AGC and other wildlife knowledge.
   - Improve coordination between customs, police and PA staff.
   - Authority to arrest offenders should be bestowed on suitable PA staff.
   - Enforcement should be strengthened as soon as possible.

Lack of Public Awareness

Definition

The lack of information and communication between everyone (including all Thai people and in the wider international community), which affects the status and conservation practices of the AGC. This may lead to a possible population decline or extinction of the AGC. Information includes legal status, conservation value and threats.

Issues

- The lack of information on all aspects of the AGC.
- AGC is not a prominent species, compared to other species such as the tiger.
- Traditional ecological knowledge is lacking.
- There is little communication between traditional people and conservationists.

Existing Knowledge

- Very few people know about the AGC – what it looks like, its ecology, etc.
- The awareness of the AGC is very low, across the board.
- There is no specific strategy for creating awareness or other aspects of AGC conservation.

Gaps in Knowledge

- Traditional ecological knowledge shared among tribal people.
- Status of the AGC.
- Specific threats to AGC.
- Which agency should be responsible for creating public awareness of AGCs. Should it be government-led, involving the Department of NPs, Wildlife, and Plant Conservation, non-governmental organizations (NGOs) or interested individuals?

Goals/Solutions

1. Develop and initiate education programs for teachers, students and local people through government and non-government organizations.
2. Set up a campaign to educate the general public.
3. Involve local people in conservation activities.
4. Improve the relationship between park rangers and local people, such as by supporting entry point activities initiated by villagers.

Actions

1. *Education programs for local people, including students and teachers within local areas.*
    - Utilize local radio stations to educate local people, through the provision of AGC information to these stations.
    - Develop a conservation education program especially for AGC for local communities. This may include talks, publication of materials, plays and skits.
    - Develop a conservation education program specifically for AGC for local schools.
    - NGOs, in cooperation with government agencies, may be most suitable for developing these programs.

2. *Develop campaign to educate the general public.*
    - Incorporate conservation into the general nursery, primary, and secondary education curricula.
    - Utilize television and other media to disseminate information on the AGC and other conservation issues.
    - Zoos should play a more active and effective role in educating the public on the status of the AGC – both *ex situ* and *in situ*.

3. *Involve local people in conservation activities.*
    - Hire former poachers for protection of wildlife.
    - Hire local people as research assistants.
    - The choice of hired people is critical and should be carefully carried out.

Harvesting

Definition

The removal of AGCs from their natural habitats for various purposes.

Issues

- Animals are either poached live or are made into different products. In the former case, they are traded live in markets and probably bought by private collectors. In the latter, the coat and leather are most commonly traded.
- Traditional hunting is very general, although AGCs may also be taken.
- Some international trading occurs.

Existing Knowledge

- Legally, the AGC is protected under the Wildlife Resource and Conservation Act, 1992. Thus, hunting is totally prohibited.
- Some harvesting of AGCs occurs – for commercial and for personal use, both of which are illegal.
- Some products arrive from Myanmar, Laos and Cambodia to Bangkok.

Gaps in Knowledge

- The numbers of AGCs hunted and where they are taken from.
- The specific purpose of the harvest and trade, and types of products derived from AGCs.
- Where the products or live animals are traded to, i.e. modality of trade.
- The status of the AGC.
- The impact of harvest on the AGC.
- The number of people prosecuted for AGC hunting to date.

Goals/Solutions

1. Conduct a comprehensive survey of AGC harvest, poachers and trade.
2. Promote effective enforcement in PAs and strengthen security measures.

Other important related goals included in previous sections:

- Conduct a comprehensive AGC population survey across the country.
- Publicize legislation widely to educate and reinforce current knowledge on legislation.

Actions

1. *Conduct a comprehensive survey of AGC harvest, poachers and trade.*
    - Information needs to be obtained for where hunting occurs, types and uses of products, the method of hunting, who carries out the poaching, whether middle men are involved, where the products are traded to, who are the sellers and buyers, and where they are from.
    - The survey should be conducted by GOs (wildlife officials, customs and police) and NGOs.
    - Information can be collected by intelligence gathering, confiscations, interviews and past records.

2. *Promote effective enforcement and strengthening of security measures.*
    - Develop an intelligence network for gathering information on wildlife harvesting and trade.

- Monitor the activities of suspected poachers.
- GOs and NGOs should widely publicize the provisions of the law and associated punishments.
- Increase the number of rangers, staff and suitable equipment.
- Regular training for government officials and PA staff on current wildlife laws and prosecution, protocol for evidence collection, AGC and other wildlife knowledge.
- There should be more coordination among customs, police and PA staff.
- Authority to arrest offenders should be bestowed on suitable PA staff.
- Enforcement should be strengthened as soon as possible.

Transmission of Disease

Definition

The spread of communicable diseases from one animal to another.

Issues

- Two wild-caught AGCs have been known to be infected with toxoplasmosis.
- Bird flu has affected tigers and domestic cats. AGCs may be similarly infected.
- Tribes graze cattle and rear livestock in and around protected areas. This increases the possibility of transmission of diseases from the consumption of infected livestock.

Existing Knowledge

- Several diseases can be transmitted from domestic animals to wild cat species.
  - AGCs can be infected by toxoplasmosis. Two wild-caught individuals were infected upon inspection. However, it is unknown how they were infected and what happened between the hunting and inspection interval.
  - Canine distemper has been known to be spread from domestic dogs to hyenas to lions. More than 20% of Serengeti lions died this way.
  - One Siberian tiger died recently of canine distemper.
  - Tigers can be infected by bird flu after eating infected meat.
  - FIV and FeLV are present in captive tigers.
  - Ectoparasites, such as ticks and fleas, and endoparasites (*Ascaris*) have been transmitted from domestic to captive felids.
- There is no vaccination of cattle in the fringe area of PAs against communicable diseases.

Gaps in Knowledge

- Whether there are any specific cases of transmission from domestic animals to AGCs.
- What kind of diseases AGCs have naturally in the wild and the effect of these diseases on the individuals and on the species.

Goals/Solutions

1. Immunize livestock found in and around PAs against common communicable diseases.
2. Improve management of livestock,
3. Find out whether there are any specific cases of disease transmission from domestic animals to AGCs and what kind of diseases occur naturally in wild AGCs.

Actions

1. *Immunize and deworm livestock found in and around PAs.*
   - This should be carried out by the livestock department of Thailand.
   - Immunize and deworm all livestock and pets found inside and within a 5km radius of PAs, against as many communicable diseases as possible.
   - Immunizations and deworming should be carried out as early as possible.
   - Develop and conduct education programs for wildlife staff and farmers on the necessity of immunization – health and safety of livestock and also for the transmission to other animals.

2. *Improve management of livestock.*
   - Educate farmers and provide equipment and assistance for the construction of better facilities, for example, sheltered yards for livestock such that AGCs are not able to prey on these animals. This will also prevent livestock from wandering into PAs.
   - Encourage proper disposal of livestock and pet carcasses, so that AGCs are not able to scavenge on these.
   - This should be the responsibility of PA staff, livestock department and NGOs.
   - All livestock and pets found inside and within a 5km radius of PAs should be included in the plans.

3. *Find out AGC disease details.*
   - Conduct and assist research investigating naturally occurring diseases of AGCs and other carnivores, as well as transmission of diseases from domestic animals to AGCs or between wild carnivores.
   - Accurate necropsy of carcasses for all carnivore species inside and around PAs should be done, including AGCs, clouded leopards, domestic and feral cats and dogs, when the opportunity arises. Data should be collated and disseminated.
   - As much information as possible should be obtained from sedated animals (e.g., size, weight, blood, tissue and fecal samples, ectoparasites).
   - Regular health checks should be carried out for domestic and feral dogs and cats. Funds may be obtained in part from the ministry of public health.
   - Set up a comprehensive network among wildlife agencies, veterinary institutions and zoos for necropsies, diagnostic processes, and disease research.

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APPENDIX I

Workshop Participant Information

PHVA Workshop Participants

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Participant Introductions

At the beginning of the PHVA workshop, the participants were asked to respond to the following questions. Their responses are listed below.

1. What is your expertise regarding golden cats, related felids or other Thai wildlife species?

- Genetic research and population modeling research on phylogeography of Asiatic leopard cats.
- Knowledge of local villagers and hunters.
- Concern over habitat loss and increasing human population.
- Management of golden cats in captivity (on- and off-exhibit).
- Management of mega-species such as tigers, leopards and rhinoceros.
- Worked in National Park in Assam, India, which manages one-horned rhinoceros.
- Past experience working in national parks containing golden cats (India); experience with captive management of golden cats.
- Conservation efforts to preserve wildlife and wildlands; information on relative abundance, distribution and extent of trade of golden cats in Sumatra.
- Field surveys of tigers and leopards in Thailand, which also resulted in distribution data for golden cats.
- Surveys on wild mammals in protected areas of Thailand (e.g., tiger, leopard).
- Wildlife diseases survey, confiscated animals rescue in Thailand, future reintroduction.

2. What do you hope to contribute to the workshop?

- Suggest research priorities for golden cats, especially for genetic research; also help to estimate population model parameters based on literature.
- Contribute knowledge of threats from local villages.
- Want to learn out to conserve wildlife such as the Asiatic golden cat.
- Contribute information from golden cat captive breeding program; possible future research efforts.
- Share conservation success and constraints for mega-species in Nepal; also learn more about restoration of golden cat habitat and captive management.
- Have small idea on one-horned rhinoceros and its habitat in Assam.
- Share experience in managing habitat and also in managing golden cats in captivity.
- Incorporate information on golden cat distribution and trade into the Vortex model, and help to design a conservation strategy for the golden cat.
- Share my data, which hopefully can promote understanding of the distribution of golden cats.
- Provide information on the distribution of golden cats in protected areas in Thailand.
- Give comments on wildlife diseases as risk factors for golden cats (rescue, confiscated animals, reintroduction).

3. What is the primary issue/threat to golden cat viability?

- Habitat loss / conversion **
- Poaching (shooting)
- Deforestation
- Lack of information (distribution in the wild, also *ex situ*) ***
- Human disturbance
- Habitat fragmentation / lack of corridors ***
- Disease (toxoplasmosis)
- Competition with other predators for prey / decline of prey **
- Factors affecting reproductive success
- Lack of public awareness / attention
- Conflicts with humans (livestock depredation)

* indicates threat was identified by an additional workshop participant

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APPENDIX II

Introduction to CBSG Processes

CBSG Workshop and Training Processes

Information on capabilities of the IUCN/SSC Conservation Breeding Specialist Group

Introduction

There is a lack of generally accepted tools to evaluate and integrate the interaction of biological, physical, and social factors on the population dynamics of threatened species and populations. There is an urgent need for tools and processes to characterize the risk of species and habitat extinction, on the possible impacts of future events, on the effects of management interventions, and on how to develop and sustain learning-based cross-institutional management programs.

The Conservation Breeding Specialist Group (CBSG) of IUCN's Species Survival Commission (SSC) has more than 15 years of experience in developing, testing and applying a series of scientifically based tools and processes to assist risk characterization and species management decision making. These tools, based on small population and conservation biology (biological and physical factors), human demography, and the dynamics of social learning are used in intensive, problem-solving workshops to produce realistic and achievable recommendations for both *in situ* and *ex situ* population management.

Our workshop processes provide an objective environment, expert knowledge, and a neutral facilitation process that supports sharing of available information across institutions and stakeholder groups, reaching agreement on the issues and available information, and then making useful and practical management recommendations for the taxon and habitat system under consideration. The process has been remarkably successful in unearthing and integrating previously unpublished information for the decision-making process. Their proven heuristic value and constant refinement and expansion have made CBSG workshop processes one of the most imaginative and productive organizing forces for species conservation today (Conway 1995; Byers and Seal 2003; Westley and Miller 2003).

Integration of Science, Management, and Stakeholders

The CBSG PHVA Workshop process is based upon biological and sociological science. Effective conservation action is best built upon a synthesis of available biological information, but is dependent on actions of humans living within the range of the threatened species as well as established national and international interests. There are characteristic patterns of human behavior that are cross-disciplinary and cross-cultural which affect the processes of communication, problem-solving, and collaboration: 1) in the acquisition, sharing, and analysis of information; 2) in the perception and characterization of risk; 3) in the development of trust among individuals; and 4) in 'territoriality' (personal, institutional, local, national). Each of these has strong emotional components that shape our interactions. Recognition of these patterns has been essential in the development of processes to assist people in working groups to reach agreement on needed conservation actions, collaboration needed, and to establish new working relationships.

Frequently, local management agencies, external consultants, and local experts have identified management actions. However, an isolated narrow professional approach which focuses primarily on the perceived biological problems seems to have little effect on the needed political and social changes (social learning) for collaboration, effective management and conservation of habitat fragments or protected areas and their species components. CBSG workshops are organized to bring together the full range of groups with a strong interest in conserving and managing the species in its habitat or the consequences of such management. One goal in all workshops is to reach a common understanding of the state of scientific knowledge available and its possible application to the decision-making process and to needed management actions. We have found that the decision-making driven workshop process with risk characterization tools, stochastic simulation modeling, scenario testing, and deliberation among stakeholders is a powerful tool for extracting, assembling, and exploring information. This process encourages developing a shared understanding across wide boundaries of training and expertise. These tools also support building of working agreements and instilling local ownership of the problems, the decisions required, and their management during the workshop process. As participants appreciate the complexity of the problems as a group, they take more ownership of the process as well as the ultimate recommendations made to achieve workable solutions. This is essential if the management recommendations generated by the workshops are to succeed.

Participants have learned a host of lessons in more than 120 CBSG Workshop experiences in nearly 50 countries. Traditional approaches to endangered species problems have tended to emphasize our lack of information and the need for additional research. This has been coupled with a hesitancy to make explicit risk assessments of species status and a reluctance to make immediate or non-traditional management recommendations. The result has been long delays in preparing action plans, loss of momentum, and dependency on crisis-driven actions or broad recommendations that do not provide useful guidance to the managers.

CBSG's interactive and participatory workshop approach produces positive effects on management decision-making and in generating political and social support for conservation actions by local people. Modeling is an important tool as part of the process and provides a continuing test of assumptions, data consistency, and of scenarios. CBSG participants recognize that the present science is imperfect and that management policies and actions need to be designed as part of a biological and social learning process. The workshop process essentially provides a means for designing management decisions and programs on the basis of sound science while allowing new information and unexpected events to be used for learning and to adjust management practices.

Workshop Processes and Multiple Stakeholders

Experience: The Chairman and Program Staff of CBSG have conducted and facilitated more than 120 species and ecosystem workshops in 50 countries including the USA during the past 6 years. *Reports from these workshops are available from the CBSG Office*. We have worked on a continuing basis with agencies on specific taxa (e.g., Florida panther, Atlantic Forest primates in Brazil, Sumatran tiger) and have assisted in the development of national conservation strategies for other taxa (e.g., Sumatran elephant, Sumatran tiger, Mexican wolf).

Facilitator's Training and Manual: A manual has been prepared to assist CBSG workshop conveners, collaborators, and facilitators in the process of organizing, conducting, and completing a CBSG workshop. It was developed with the assistance of two management science professionals and 30 people from 11 countries with experience in CBSG workshops. These facilitator's training workshops have proven very popular with 2 per year planned through 2000 in several countries including the USA. *Copies of the Facilitator's Manual are available from the CBSG Office.*

Scientific Studies of Workshop Process: The effectiveness of these workshops as tools for eliciting information, assisting the development of sustained networking among stakeholders, impact on attitudes of participants, and in achieving consensus on needed management actions and research has been extensively debated. We initiated a scientific study of the process and its long term aftermath four years ago in collaboration with an independent team of researchers (Westley and Vredenburg, 2003). A survey questionnaire is administered at the beginning and end of each workshop. They have also conducted extensive interviews with participants in workshops held in five countries. A book detailing our experiences with this expanded approach to Population and Habitat Viability Assessment workshops (Westley and Miller, 2003) will provide practical guidance to scientists and managers on quantitative approaches to threatened species conservation. The study also is undertaking follow up at one and two years after each workshop to assess longer-term effects. To the best of our knowledge there is no comparable systematic scientific study of conservation and management processes. *We would apply the same scientific study tools to the workshops in this program and provide an analysis of the results after the workshop.*

CBSG Workshop Toolkit

Our basic set of tools for workshops include: small group dynamic skills; explicit use in small groups of problem restatement; divergent thinking sessions; identification of the history and chronology of the problem; causal flow diagramming (elementary systems analysis); matrix methods for qualitative data and expert judgments; paired and weighted ranking for making comparisons between sites, criteria, and options; utility analysis; stochastic simulation modeling for single populations and metapopulations; and deterministic and stochastic modeling of local human populations. Several computer packages are used to assist collection and analysis of information with these tools. We provide training in several of these tools in each workshop as well as intensive special training workshops for people wishing to organize their own workshops.

Stochastic Simulation Modeling

<u>Integration of Biological, Physical and Social Factors:</u> The workshop process, as developed by CBSG, generates population and habitat viability assessments based upon in-depth analysis of information on the life history, population dynamics, ecology, and history of the populations. Information on demography, genetics, and environmental factors pertinent to assessing population status and risk of extinction under current management scenarios and perceived threats are assembled in preparation for and during the workshops. Modeling and simulations provide a neutral externalization focus for assembly of information, identifying assumptions, projecting possible outcomes (risks), and examining for internal consistency. Timely reports from the workshop are necessary to have impact on stakeholders and decision makers. Draft reports are distributed within 3-4 weeks of the workshop and final reports within about 3 months.

<u>Human Dimension:</u> We have collaborated with human demographers in 5 CBSG workshops on endangered species and habitats. They have utilized computer models incorporating human population characteristics and events at the local level in order to provide projections of the likely course of population growth and the utilization of local resources. This information was then incorporated into projections of the likely viability of the habitat of the threatened species and used as part of the population projections and risk assessments. We are preparing a series of papers on the human dimension of population and habitat viability assessment. It is our intention to further develop these tools and to utilize them as part of the scenario assessment process.

<u>Risk Assessment and Scenario Evaluation:</u> A stochastic population simulation model is a kind of model that attempts to incorporate the uncertainty, randomness or unpredictability of life history and environmental events into the modeling process. Events whose occurrence is uncertain, unpredictable, and random are called stochastic. Most events in an animal's life have some level of uncertainty. Similarly, environmental factors, and their effect on the population process, are stochastic - they are not completely random, but their effects are predictable within certain limits. Simulation solutions are usually needed for complex models including several stochastic parameters.

There are a host of reasons why simulation modeling is valuable for the workshop process and development of management tools. The primary advantage, of course, is to simulate scenarios and the impact of numerous variables on the population dynamics and potential for population extinction. Interestingly, not all advantages are related to generating useful management recommendations. The side-benefits are substantial.

- Population modeling supports consensus and instills ownership and pride during the workshop process. As groups begin to appreciate the complexity of the problems, they have a tendency to take more ownership of the process and the ultimate recommendations to achieve workable solutions.
- Population modeling forces discussion on biological and physical aspects and specification of assumptions, data, and goals. The lack of sufficient data of useable quality rapidly becomes apparent and identifies critical factors for further study (driving research and decision making), management, and monitoring. This not only influences assumptions, but also the group's goals.
- Population modeling generates credibility by using technology that non-biologically oriented groups can use to relate to population biology and the "real" problems. The acceptance of the computer as a tool for performing repetitive tasks has led to a common ground for persons of diverse backgrounds.
- Population modeling explicitly incorporates what we know about dynamics by allowing the simultaneous examination of multiple factors and interactions - more than can be considered in analytical models. The ability to alter these parameters in a systematic fashion allows testing a multitude of scenarios that can guide adaptive management strategies.
- Population modeling can be a neutral computer "game" that focuses attention while providing persons of diverse agendas the opportunity to reach consensus on difficult issues.
- Population modeling results can be of political value for people in governmental agencies by providing support for perceived population trends and the need for action. It helps managers to justify resource allocation for a program to their superiors and budgetary agencies as well as identify areas for intensifying program efforts.

Modeling Tools: At the present time, our preferred model for use in the population simulation modeling process is called *VORTEX*. This model, developed by Bob Lacy (Chicago Zoological Society), is designed specifically for use in the stochastic simulation of the extinction process in small wildlife populations. It has been developed in collaboration and cooperation with the CBSG PHVA process. The model simulates deterministic forces as well as demographic, environmental, and genetic events in relation to their probabilities. It includes modules for catastrophes, density dependence, metapopulation dynamics, and inbreeding effects. The *VORTEX* model analyzes a population in a stochastic and probabilistic fashion. It also makes predictions that are testable in a scientific manner, lending more credibility to the process of using population-modeling tools.

There are other commercial models, but presently they have some limitations such as failing to measure genetic effects, being difficult to use, or failing to model individuals. *VORTEX* has been successfully used in more than 90 PHVA workshops in guiding management decisions. *VORTEX* is general enough for use when dealing with a broad range of species, but specific enough to incorporate most of the important processes. It is continually evolving in conjunction with the PHVA process. *VORTEX* has, as do all models, its limitations, which may restrict its utility. The model analyzes a population in a stochastic and probabilistic fashion. It is now at Version 9.45 through the cooperative contributions of dozens of biologists. It has been the subject of a series of both published and in-press validation studies and comparisons with other modeling tools. More than 2000 copies of *VORTEX* are in circulation and it is being used as a teaching tool in university courses.

We use this model and the experience we have with it as a central tool for the population dynamic aspects of the workshop process. Additional modules, building on other simulation modeling tools for human population dynamics (which we have used in 3 countries) with potential impacts on water usage, harvesting effects, and physical factors such as hydrology and water diversion will be developed to provide input into the population and habitat models which can then be used to evaluate possible effects of different management scenarios. No such composite models are available.

CBSG Resources as a Unique Asset

Expertise and Costs: The problems and threats to endangered species everywhere are complex and interactive with a need for information from diverse specialists. No agency or country encompasses all of the useful expert knowledge. Thus, there is a need to include a wide range of people as resources and analysts. It is important that the invited experts have reputations for expertise, objectivity, initial lack of local stake, and for active transfer of wanted skills. CBSG has a volunteer network of more than 800 experts with about 250 in the USA. More than 3,000 people from 400 organizations have assisted CBSG on projects and participated in workshops on a volunteer basis contributing tens of thousands of hours of time. We will call upon individual experts to assist in all phases of this project.

Indirect cost contributions to support: Use of CBSG resources and the contribution of participating experts provide a matching contribution more than equaling the proposed budget request for projects.

Manuals and Reports: We have manuals available that provide guidance on the goals, objectives, and preparations needed for CBSG workshops. These help to reduce startup time and costs and allow us to begin work on organizing the project immediately with proposed participants and stockholders. We have a process manual for use by local organizers, which goes into detail on all aspects of organizing, conducting, and preparing reports from the workshops. Draft reports are prepared during the workshop so that there is agreement by participants on its content and recommendations. Reports are also prepared on the mini-workshops (working groups) that will be conducted in information gathering exercises with small groups of experts and stakeholders. We can print reports within 24-48 hours of preparation of final copy. We also have CD-ROM preparation facilities, software and experience.

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APPENDIX III

Simulation Modeling and PVA

Simulation Modeling and Population Viability Analysis

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A model is any simplified representation of a real system. We use models in all aspects of our lives, in order to: (1) extract the important trends from complex processes, (2) permit comparison among systems, (3) facilitate analysis of causes of processes acting on the system, and (4) make predictions about the future. A complete description of a natural system, if it were possible, would often decrease our understanding relative to that provided by a good model, because there is "noise" in the system that is extraneous to the processes we wish to understand. For example, the typical representation of the growth of a wildlife population by an annual percent growth rate is a simplified mathematical model of the much more complex changes in population size. Representing population growth as an annual percent change assumes constant exponential growth, ignoring the irregular fluctuations as individuals are born or immigrate, and die or emigrate. For many purposes, such a simplified model of population growth is very useful, because it captures the essential information we might need regarding the average change in population size, and it allows us to make predictions about the future size of the population. A detailed description of the exact changes in numbers of individuals, while a true description of the population, would often be of much less value because the essential pattern would be obscured, and it would be difficult or impossible to make predictions about the future population size.

In considerations of the vulnerability of a population to extinction, as is so often required for conservation planning and management, the simple model of population growth as a constant annual rate of change is inadequate for our needs. The fluctuations in population size that are omitted from the standard ecological models of population change can cause population extinction, and therefore are often the primary focus of concern. In order to understand and predict the vulnerability of a wildlife population to extinction, we need to use a model which incorporates the processes which cause fluctuations in the population, as well as those which control the long-term trends in population size (Shaffer 1981). Many processes can cause fluctuations in population size: variation in the environment (such as weather, food supplies, and predation), genetic changes in the population (such as genetic drift, inbreeding, and response to natural selection), catastrophic effects (such as disease epidemics, floods, and droughts), decimation of the population or its habitats by humans, the chance results of the probabilistic events in the lives of individuals (sex determination, location of mates, breeding success, survival), and interactions among these factors (Gilpin and Soulé 1986).

Models of population dynamics which incorporate causes of fluctuations in population size in order to predict probabilities of extinction, and to help identify the processes which contribute to a population's vulnerability, are used in "Population Viability Analysis" (PVA) (Lacy 1993/4). For the purpose of predicting vulnerability to extinction, any and all population processes that impact population dynamics can be important. Much analysis of conservation issues is conducted by largely intuitive assessments by biologists with experience with the system. Assessments by experts can be quite valuable, and are often contrasted with "models" used to evaluate population vulnerability to extinction. Such a contrast is not valid, however, as *any* synthesis of facts and understanding of processes constitutes a model, even if it is a mental model within the mind of the expert and perhaps only vaguely specified to others (or even to the expert himself or herself).

A number of properties of the problem of assessing vulnerability of a population to extinction make it difficult to rely on mental or intuitive models. Numerous processes impact population dynamics, and many of the factors interact in complex ways. For example, increased fragmentation of habitat can make it more difficult to locate mates, can lead to greater mortality as individuals disperse greater distances across unsuitable habitat, and can lead to increased inbreeding which in turn can further reduce ability to attract mates and to survive. In addition, many of the processes impacting population dynamics are intrinsically probabilistic, with a random component. Sex determination, disease, predation, mate acquisition -- indeed, almost all events in the life of an individual -- are stochastic events, occurring with certain probabilities rather than with absolute certainty at any given time. The consequences of factors influencing population dynamics are often delayed for years or even generations. With a long-lived species, a population might persist for 20 to 40 years beyond the emergence of factors that ultimately cause extinction. Humans can synthesize mentally only a few factors at a time, most people have difficulty assessing probabilities intuitively, and it is difficult to consider delayed effects. Moreover, the data needed for models of population dynamics are often very uncertain. Optimal decision-making when data are uncertain is difficult, as it involves correct assessment of probabilities that the true values fall within certain ranges, adding yet another probabilistic or chance component to the evaluation of the situation.

The difficulty of incorporating multiple, interacting, probabilistic processes into a model that can utilize uncertain data has prevented (to date) development of analytical models (mathematical equations developed from theory) which encompass more than a small subset of the processes known to affect wildlife population dynamics. It is possible that the mental models of some biologists are sufficiently complex to predict accurately population vulnerabilities to extinction under a range of conditions, but it is not possible to assess objectively the precision of such intuitive assessments, and it is difficult to transfer that knowledge to others who need also to evaluate the situation. Computer simulation models have increasingly been used to assist in PVA. Although rarely as elegant as models framed in analytical equations, computer simulation models can be well suited for the complex task of evaluating risks of extinction. Simulation models can include as many factors that influence population dynamics as the modeler and the user of the model want to assess. Interactions between processes can be modeled, if the nature of those interactions can be specified. Probabilistic events can be easily simulated by computer programs, providing output that gives both the mean expected result and the range or distribution of possible outcomes. In theory, simulation programs can be used to build models of population dynamics that include all the knowledge of the system which is available to experts. In practice, the models will be simpler, because some factors are judged unlikely to be important, and because the persons who developed the model did not have access to the full array of expert knowledge.

Although computer simulation models can be complex and confusing, they are precisely defined and all the assumptions and algorithms can be examined. Therefore, the models are objective, testable, and open to challenge and improvement. PVA models allow use of all available data on the biology of the taxon, facilitate testing of the effects of unknown or uncertain data, and expedite the comparison of the likely results of various possible management options.

PVA models also have weaknesses and limitations. A model of the population dynamics does not define the goals for conservation planning. Goals, in terms of population growth, probability of persistence, number of extant populations, genetic diversity, or other measures of population performance must be defined by the management authorities before the results of population modeling can be used. Because the models incorporate many factors, the number of possibilities to test can seem endless, and it can be difficult to determine which of the factors that were analyzed are most important to the population dynamics. PVA models are necessarily incomplete. We can model only those factors which we understand and for which we can specify the parameters. Therefore, it is important to realize that the models probably underestimate the threats facing the population. Finally, the models are used to predict the long-term effects of the processes presently acting on the population. Many aspects of the situation could change radically within the time span that is modeled. Therefore, it is important to reassess the data and model results periodically, with changes made to the conservation programs as needed (see Lacy and Miller (2002), Nyhus et al. (2002) and Westley and Miller (2003) for more details).

The *VORTEX* Population Viability Analysis Model

For the analyses presented here, the *VORTEX* computer software (Lacy 1993a) for population viability analysis was used. *VORTEX* models demographic stochasticity (the randomness of reproduction and deaths among individuals in a population), environmental variation in the annual birth and death rates, the impacts of sporadic catastrophes, and the effects of inbreeding in small populations. *VORTEX* also allows analysis of the effects of losses or gains in habitat, harvest or supplementation of populations, and movement of individuals among local populations.

Density dependence in mortality is modeled by specifying a carrying capacity of the habitat. When the population size exceeds the carrying capacity, additional morality is imposed across all age classes to bring the population back down to the carrying capacity. The carrying capacity can be specified to change linearly over time, to model losses or gains in the amount or quality of habitat. Density dependence in reproduction is modeled by specifying the proportion of adult females breeding each year as a function of the population size.

VORTEX models loss of genetic variation in populations, by simulating the transmission of alleles from parents to offspring at a hypothetical genetic locus. Each animal at the start of the simulation is assigned two unique alleles at the locus. During the simulation, *VORTEX* monitors how many of the original alleles remain within the population, and the average heterozygosity and gene diversity (or “expected heterozygosity”) relative to the starting levels. *VORTEX* also monitors the inbreeding coefficients of each animal, and can reduce the juvenile survival of inbred animals to model the effects of inbreeding depression.

VORTEX is an *individual-based* model. That is, *VORTEX* creates a representation of each animal in its memory and follows the fate of the animal through each year of its lifetime. *VORTEX* keeps track of the sex, age, and parentage of each animal. Demographic events (birth, sex determination, mating, dispersal, and death) are modeled by determining for each animal in each year of the simulation whether any of the events occur. (See figure below.). Events occur according to the specified age and sex-specific probabilities. Demographic stochasticity is therefore a consequence of the uncertainty regarding whether each demographic event occurs for any given animal.

VORTEX requires a lot of population-specific data. For example, the user must specify the amount of annual variation in each demographic rate caused by fluctuations in the environment. In addition, the frequency of each type of catastrophe (drought, flood, epidemic disease) and the effects of the catastrophes on survival and reproduction must be specified.

Rates of migration (dispersal) between each pair of local populations must be specified. Because *VORTEX* requires specification of many biological parameters, it is not necessarily a good model for the examination of population dynamics that would result from some generalized life history. It is most usefully applied to the analysis of a specific population in a specific environment.

Further information on *VORTEX* is available in Miller and Lacy (1999) and Lacy (2000).

Dealing with Uncertainty

It is important to recognize that uncertainty regarding the biological parameters of a population and its consequent fate occurs at several levels and for independent reasons. Uncertainty can occur because the parameters have never been measured on the population. Uncertainty can occur because limited field data have yielded estimates with potentially large sampling error. Uncertainty can occur because independent studies have generated discordant estimates. Uncertainty can occur because environmental conditions or population status have been changing over time, and field surveys were conducted during periods which may not be representative of long-term averages. Uncertainty can occur because the environment will change in the future, so that measurements made in the past may not accurately predict future conditions.

Sensitivity testing is necessary to determine the extent to which uncertainty in input parameters results in uncertainty regarding the future fate of the pronghorn population. If alternative plausible parameter values result in divergent predictions for the population, then it is important to try to resolve the uncertainty with better data. Sensitivity of population dynamics to certain parameters also indicates that those parameters describe factors that could be critical determinants of population viability. Such factors are therefore good candidates for efficient management actions designed to ensure the persistence of the population.

The above kinds of uncertainty should be distinguished from several more sources of uncertainty about the future of the population. Even if long-term average demographic rates are known with precision, variation over time caused by fluctuating environmental conditions will cause uncertainty in the fate of the population at any given time in the future. Such environmental variation should be incorporated into the model used to assess population dynamics, and will generate a range of possible outcomes (perhaps represented as a mean and standard deviation) from the model. In addition, most biological processes are inherently stochastic, having a random component. The stochastic or probabilistic nature of survival, sex determination, transmission of genes, acquisition of mates, reproduction, and other processes preclude exact determination of the future state of a population. Such demographic stochasticity should also be incorporated into a population model, because such variability both increases our uncertainty about the future and can also change the expected or mean outcome relative to that which would result if there were no such variation. Finally, there is "uncertainty" which represents the alternative actions or interventions which might be pursued as a management strategy. The likely effectiveness of such management options can be explored by testing alternative scenarios in the model of population dynamics, in much the same way that sensitivity testing is used to explore the effects of uncertain biological parameters.

Results
Results reported for each scenario include:

Deterministic r -- The deterministic population growth rate, a projection of the mean rate of growth of the population expected from the average birth and death rates. Impacts of harvest, inbreeding, and density dependence are not considered in the calculation. When r = 0, a population with no growth is expected; r < 0 indicates population decline; r > 0 indicates long-term population growth. The value of r is approximately the rate of growth or decline per year.

The deterministic growth rate is the average population growth expected if the population is so large as to be unaffected by stochastic, random processes. The deterministic growth rate will correctly predict future population growth if: the population is presently at a stable age distribution; birth and death rates remain constant over time and space (i.e., not only do the probabilities remain constant, but the actual number of births and deaths each year match the expected values); there is no inbreeding depression; there is never a limitation of mates preventing some females from breeding; and there is no density dependence in birth or death rates, such as an Allee effects or a habitat "carrying capacity" limiting population growth. Because some or all of these assumptions are usually violated, the average population growth of real populations (and stochastically simulated ones) will usually be less than the deterministic growth rate.

Stochastic r -- The mean rate of stochastic population growth or decline demonstrated by the simulated populations, averaged across years and iterations, for all those simulated populations that are not extinct. This population growth rate is calculated each year of the simulation, prior to any truncation of the population size due to the population exceeding the carrying capacity. Usually, this stochastic r will be less than the deterministic r predicted from birth and death rates. The stochastic r from the simulations will be close to the deterministic r if the population growth is steady and robust. The stochastic r will be notably less than the deterministic r if the population is subjected to large fluctuations due to environmental variation, catastrophes, or the genetic and demographic instabilities inherent in small populations.

P(E) -- the probability of population extinction, determined by the proportion of, for example, 500 iterations within that given scenario that have gone extinct in the simulations. "Extinction" is defined in the VORTEX model as the lack of either sex.

N -- mean population size, averaged across those simulated populations which are not extinct.

SD(N) -- variation across simulated populations (expressed as the standard deviation) in the size of the population at each time interval. SDs greater than about half the size of mean N often indicate highly unstable population sizes, with some simulated populations very near extinction. When SD(N) is large relative to N, and especially when SD(N) increases over the years of the simulation, then the population is vulnerable to large random fluctuations and may go extinct even if the mean population growth rate is positive. SD(N) will be small and often declining relative to N when the population is either growing steadily toward the carrying capacity or declining rapidly (and deterministically) toward extinction. SD(N) will also decline considerably when the population size approaches and is limited by the carrying capacity.

H -- the gene diversity or expected heterozygosity of the extant populations, expressed as a percent of the initial gene diversity of the population. Fitness of individuals usually declines proportionately with gene diversity (Lacy 1993b), with a 10% decline in gene diversity typically causing about 15% decline in survival of captive mammals (Ralls et al. 1988). Impacts of inbreeding on wild populations are less well known, but may be more severe than those observed in captive populations (Jiménez et al. 1994). Adaptive response to natural selection is also expected to be proportional to gene diversity. Long-term conservation programs often set a goal of retaining 90% of initial gene diversity (Soulé et al. 1986). Reduction to 75% of gene diversity would be equivalent to one generation of full-sibling or parent-offspring inbreeding.

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Asiatic Golden Cat in Thailand

Population & Habitat Viability Assessment

Chonburi, Thailand

5 – 7 September 2005

FINAL REPORT

APPENDIX IV

IUCN Guidelines

IUCN Technical Guidelines on the Management of *Ex-situ* Populations for Conservation

Approved at the 14th Meeting of the Programme Committee of Council, Gland Switzerland, 10 December 2002

PREAMBLE

IUCN affirms that a goal of conservation is the maintenance of existing genetic diversity and viable populations of all taxa in the wild in order to maintain biological interactions, ecological processes and function. Conservation managers and decision-makers should adopt a realistic and integrated approach to conservation implementation. The threats to biodiversity in situ continue to expand, and taxa have to survive in increasingly human-modified environments. Threats, which include habitat loss, climate change, unsustainable use, and invasive and pathogenic organisms, can be difficult to control. The reality of the current situation is that it will not be possible to ensure the survival of an increasing number of threatened taxa without effectively using a diverse range of complementary conservation approaches and techniques including, for some taxa, increasing the role and practical use of ex situ techniques.

If the decision to bring a taxon under ex situ management is left until extinction is imminent, it is frequently too late to effectively implement, thus risking permanent loss of the taxon. Moreover, ex situ conservation should be considered as a tool to ensure the survival of the wild population. Ex situ management should be considered only as an alternative to the imperative of in situ management in exceptional circumstances, and effective integration between in situ and ex situ approaches should be sought wherever possible.

The decision to implement an ex situ conservation programme as part of a formalised conservation management or recovery plan and the specific design of and prescription for such an ex situ programme will depend on the taxon's circumstances and conservation needs. A taxon-specific conservation plan may involve a range of ex situ objectives, including short-, medium- and long-term maintenance of ex situ stocks. This can utilise a variety of techniques including reproduction propagation, germplasm banking, applied research, reinforcement of existing populations and re-introduction into the wild or controlled environments. The objectives and overall purpose should be clearly stated and agreed among organisations participating in the programme, and other relevant stakeholders including landowners and users of the taxon involved. In order to maximise their full potential in conservation, ex situ facilities and their co-operative networks should adopt the guidelines defined by the Convention on Biological Diversity (CBD), the International Agenda for Botanic Gardens in Conservation, Center for Plant Conservation and the World Zoo Conservation Strategy, along with other guidelines, strategies, and relevant legislative requirements at national and regional levels. IUCN recognizes the considerable set of resources committed worldwide to ex situ conservation by the world's zoological and botanical gardens, gene banks and other ex situ facilities. The effective utilisation of these resources represents an essential component of conservation strategies at all levels.

VISION

To maintain present biodiversity levels through all available and effective means including, where appropriate, ex situ propagation, translocation and other ex situ methodologies.

GOAL

Those responsible for managing ex situ plant and animal populations and facilities will use all resources and means at their disposal to maximise the conservation and utilitarian values of these populations, including:
1) increasing public and political awareness and understanding of important conservation issues and the significance of extinction;
2) co-ordinated genetic and demographic population management of threatened taxa;
3) re-introduction and support to wild populations;
4) habitat restoration and management;
5) long-term gene and biomaterial banking;
6) institutional strengthening and professional capacity building;
7) appropriate benefit sharing;
8) research on biological and ecological questions relevant to in situ conservation; and
9) fundraising to support all of the above.

Ex situ agencies and institutions must follow national and international obligations with regard to access and benefit sharing (as outlined in the CBD) and other legally binding instruments such as CITES, to ensure full collaboration with all range States. Priority should be given to the ex situ management of threatened taxa (according to the latest IUCN Red List Categories) and threatened populations of economic or social/cultural importance. Ex situ programmes are often best situated close to or within the ecogeographic range of the target taxa and where possible within the range State. Nevertheless a role for international and extra regional support for ex situ conservation is also recognised. The option of locating the ex situ programme outside the taxa's natural range should be considered if the taxa is threatened by natural catastrophes, political and social disruptions, or if further germplasm banking, propagation, research, isolation or reintroduction facilities are required and cannot be feasibly established. In all cases, ex situ populations should be managed in ways that minimize the loss of capacity for expression of natural behaviours and loss of ability to later again thrive in natural habitats.

TECHNICAL GUIDELINES

The basis for responsible ex situ population management in support of conservation is founded on benefits for both threatened taxa and associated habitats.

- The primary objective of maintaining ex situ populations is to help support the conservation of a threatened taxon, its genetic diversity, and its habitat. Ex situ programmes should give added value to other complementary programmes for conservation.

  Although there will be taxa-specific exceptions due to unique life histories, the decision to initiate ex situ programmes should be based on one or more of the appropriate IUCN Red List Criteria, including:

1. When the taxa/population is prone to effects of human activities or stochastic events or

2. When the taxa/population is likely to become Critically Endangered, Extinct in the Wild, or Extinct in a very short time. Additional criteria may need to be considered in some cases where taxa or populations of cultural importance, and significant economic or scientific importance, are threatened. All Critically Endangered and Extinct in the Wild taxa should be subject to ex situ management to ensure recovery of wild populations.

- Ex situ conservation should be initiated only when an understanding of the target taxon's biology and ex situ management and storage needs are at a level where there is a reasonable probability that successful enhancement of species conservation can be achieved; or where the development of such protocols could be achieved within the time frame of the taxon's required conservation management, ideally before the taxa becomes threatened in the wild. Ex situ institutions are strongly urged to develop ex situ protocols prior to any forthcoming ex situ management. Consideration must be given to institutional viability before embarking on a long term ex situ project.
- For those threatened taxa for which husbandry and/or cultivation protocols do not exist, surrogates of closely related taxa can serve important functions, for example in research and the development of protocols, conservation biology research, staff training, public education and fundraising.
- While some ex situ populations may have been established prior to the ratification of the CBD, all ex situ and in situ populations should be managed in an integrated, multidisciplinary manner, and where possible, in accordance with the principles and provisions of the CBD.
- Extreme and desperate situations, where taxa/populations are in imminent risk of extinction, must be dealt with on an emergency basis. This action must be implemented with the full consent and support of the range State.
- All ex situ populations must be managed so as to reduce risk of loss through natural catastrophe, disease or political upheaval. Safeguards include effective quarantine procedures, disease and pathogen monitoring, and duplication of stored germplasm samples in different locations and provision of emergency power supplies to support collection needs (e.g. climate control for long term germplasm repositories).
- All ex situ populations should be managed so as to reduce the risk of invasive escape from propagation, display and research facilities. Taxa should be assessed as to their invasive potential and appropriate controls taken to avoid escape and subsequent naturalisation.
- The management of ex situ populations must minimise any deleterious effects of ex situ management, such as loss of genetic diversity, artificial selection, pathogen transfer and hybridisation, in the interest of maintaining the genetic integrity and viability of such material. Particular attention should be paid to initial sampling techniques, which should be designed to capture as much wild genetic variability as practicable. Ex situ practitioners should adhere to, and further develop, any taxon- or region-specific record keeping and genetic management guidelines produced by ex situ management agencies.
- Those responsible for managing ex situ populations and facilities should seek both to increase public awareness, concern and support for biodiversity, and to support the implementation of conservation management, through education, fundraising and professional capacity building programmes, and by supporting direct action in situ.

- Where appropriate, data and the results of research derived from ex situ collections and ex situ methodologies should be made freely available to ongoing in-country management programmes concerned with supporting conservation of in situ populations, their habitats, and the ecosystems and landscapes in which they occur .

NB. Ex situ conservation is defined here, as in the CBD, as "the conservation of components of biological diversity outside their natural habitats". Ex situ collections include whole plant or animal collections, zoological parks and botanic gardens, wildlife research facilities, and germplasm collections of wild and domesticated taxa (zygotes, gametes and somatic tissue).

IUCN/SSC Guidelines For Re-Introductions

Prepared by the SSC Re-introduction Specialist Group
Approved by the 41st Meeting of the IUCN Council, Gland Switzerland, May 1995

INTRODUCTION

These policy guidelines have been drafted by the Re-introduction Specialist Group of the IUCN's Species Survival Commission[1], in response to the increasing occurrence of re-introduction projects worldwide, and consequently, to the growing need for specific policy guidelines to help ensure that the re-introductions achieve their intended conservation benefit, and do not cause adverse side-effects of greater impact. Although IUCN developed a Position Statement on the Translocation of Living Organisms in 1987, more detailed guidelines were felt to be essential in providing more comprehensive coverage of the various factors involved in re-introduction exercises.

These guidelines are intended to act as a guide for procedures useful to re-introduction programmes and do not represent an inflexible code of conduct. Many of the points are more relevant to re-introductions using captive-bred individuals than to translocations of wild species. Others are especially relevant to globally endangered species with limited numbers of founders. Each re-introduction proposal should be rigorously reviewed on its individual merits. It should be noted that re-introduction is always a very lengthy, complex and expensive process.

Re-introductions or translocations of species for short-term, sporting or commercial purposes - where there is no intention to establish a viable population - are a different issue and beyond the scope of these guidelines. These include fishing and hunting activities.

This document has been written to encompass the full range of plant and animal taxa and is therefore general. It will be regularly revised. Handbooks for re-introducing individual groups of animals and plants will be developed in future.

CONTEXT

The increasing number of re-introductions and translocations led to the establishment of the IUCN/SSC Species Survival Commission's Re-introduction Specialist Group. A priority of the Group has been to update IUCN's 1987 Position Statement on the Translocation of Living Organisms, in consultation with IUCN's other commissions.

It is important that the Guidelines are implemented in the context of IUCN's broader policies pertaining to biodiversity conservation and sustainable management of natural resources. The philosophy for environmental conservation and management of IUCN and other conservation bodies is stated in key documents such as "Caring for the Earth" and "Global Biodiversity Strategy" which cover the broad themes of the need for approaches with community involvement and participation in sustainable natural resource conservation, an overall enhanced quality of human life and the need to conserve and, where necessary, restore ecosystems. With regards to the latter, the re-introduction of a species is one specific instance of restoration where, in general, only this species is missing. Full restoration of an array of plant and animal species has rarely been tried to date.

Restoration of single species of plants and animals is becoming more frequent around the world. Some succeed, many fail. As this form of ecological management is increasingly common, it is a priority for the Species Survival Commission's Re-introduction Specialist Group to develop guidelines so that re-introductions are both justifiable and likely to succeed, and that the conservation world can learn from each initiative, whether successful or not. It is hoped that these Guidelines, based on extensive review of case - histories and wide consultation across a range of disciplines will introduce more rigour into the concepts, design, feasibility and implementation of re-introductions despite the wide diversity of species and conditions involved.

Thus the priority has been to develop guidelines that are of direct, practical assistance to those planning, approving or carrying out re-introductions. The primary audience of these guidelines is, therefore, the practitioners (usually managers or scientists), rather than decision makers in governments. Guidelines directed towards the latter group would inevitably have to go into greater depth on legal and policy issues.

1. DEFINITION OF TERMS

"Re-introduction": an attempt to establish a species[2] in an area which was once part of its historical range, but from which it has been extirpated or become extinct[3] ("Re-establishment" is a synonym, but implies that the re-introduction has been successful).

"Translocation": deliberate and mediated movement of wild individuals or populations from one part of their range to another.

"Re-inforcement/Supplementation": addition of individuals to an existing population of conspecifics.

"Conservation/Benign Introductions": an attempt to establish a species, for the purpose of conservation, outside its recorded distribution but within an appropriate habitat and eco-geographical area. This is a feasible conservation tool only when there is no remaining area left within a species' historic range.

2. AIMS AND OBJECTIVES OF RE-INTRODUCTION

a. Aims:

The principle aim of any re-introduction should be to establish a viable, free-ranging population in the wild, of a species, subspecies or race, which has become globally or locally extinct, or extirpated, in the wild. It should be re-introduced within the species' former natural habitat and range and should require minimal long-term management.

b. Objectives:

The objectives of a re-introduction may include: to enhance the long-term survival of a species; to re-establish a keystone species (in the ecological or cultural sense) in an ecosystem; to maintain and/or restore natural biodiversity; to provide long-term economic benefits to the local and/or nataional economy; to promote conservation awareness; or a combination of these.

3. MULTIDISCIPLINARY APPROACH

A re-introduction requires a multidisciplinary approach involving a team of persons drawn from a variety of backgrounds. As well as government personnel, they may include persons from governmental natural resource management agencies; non-governmental organisations; funding bodies; universities; veterinary institutions; zoos (and private animal breeders) and/or botanic gardens, with a full range of suitable expertise. Team leaders should be responsible for coordination between the various bodies and provision should be made for publicity and public education about the project.

4. PRE-PROJECT ACTIVITIES

4a. BIOLOGICAL

(i) Feasibility study and background research

- An assessment should be made of the taxonomic status of individuals to be re-introduced. They should preferably be of the same subspecies or race as those which were extirpated, unless adequate numbers are not available. An investigation of historical information about the loss and fate of individuals from the re-introduction area, as well as molecular genetic studies, should be undertaken in case of doubt as to individuals' taxonomic status. A study of genetic variation within and between populations of this and related taxa can also be helpful. Special care is needed when the population has long been extinct.
- Detailed studies should be made of the status and biology of wild populations(if they exist) to determine the species' critical needs. For animals, this would include descriptions of habitat preferences, intraspecific variation and adaptations to local ecological conditions, social behaviour, group composition, home range size, shelter and food requirements, foraging and feeding behaviour, predators and diseases. For migratory species, studies should include the potential migratory areas. For plants, it would include biotic and abiotic habitat requirements, dispersal mechanisms, reproductive biology, symbiotic relationships (e.g. with mycorrhizae, pollinators), insect pests and diseases. Overall, a firm knowledge of the natural history of the species in question is crucial to the entire re-introduction scheme.
- The species, if any, that has filled the void created by the loss of the species concerned, should be determined; an understanding of the effect the re-introduced species will have on the ecosystem is important for ascertaining the success of the re-introduced population.
- The build-up of the released population should be modelled under various sets of conditions, in order to specify the optimal number and composition of individuals to be released per year and the numbers of years necessary to promote establishment of a viable population.
- A Population and Habitat Viability Analysis will aid in identifying significant environmental and population variables and assessing their potential interactions, which would guide long-term population management.

(ii) Previous Re-introductions

- Thorough research into previous re-introductions of the same or similar species and wide-ranging contacts with persons having relevant expertise should be conducted prior to and while developing re-introduction protocol.

(iii) Choice of release site and type

- Site should be within the historic range of the species. For an initial re-inforcement there should be few remnant wild individuals. For a re-introduction, there should be no remnant population to prevent disease spread, social disruption and introduction of alien genes. In some circumstances, a re-introduction or re-inforcement may have to be made into an area which is fenced or otherwise delimited, but it should be within the species' former natural habitat and range.
- A conservation/ benign introduction should be undertaken only as a last resort when no opportunities for re-introduction into the original site or range exist and only when a significant contribution to the conservation of the species will result.
- The re-introduction area should have assured, long-term protection (whether formal or otherwise).

(iv) Evaluation of re-introduction site

- Availability of suitable habitat: re-introductions should only take place where the habitat and landscape requirements of the species are satisfied, and likely to be sustained for the for-seeable future. The possibility of natural habitat change since extirpation must be considered. Likewise, a change in the legal/ political or cultural environment since species extirpation needs to be ascertained and evaluated as a possible constraint. The area should have sufficient carrying capacity to sustain growth of the re-introduced population and support a viable (self-sustaining) population in the long run.
- Identification and elimination, or reduction to a sufficient level, of previous causes of decline: could include disease; over-hunting; over-collection; pollution; poisoning; competition with or predation by introduced species; habitat loss; adverse effects of earlier research or management programmes; competition with domestic livestock, which may be seasonal. Where the release site has undergone substantial degradation caused by human activity, a habitat restoration programme should be initiated before the re-introduction is carried out.

(v) Availability of suitable release stock

- It is desirable that source animals come from wild populations. If there is a choice of wild populations to supply founder stock for translocation, the source population should ideally be closely related genetically to the original native stock and show similar ecological characteristics (morphology, physiology, behaviour, habitat preference) to the original sub-population.
- Removal of individuals for re-introduction must not endanger the captive stock population or the wild source population. Stock must be guaranteed available on a regular and predictable basis, meeting specifications of the project protocol.
- Individuals should only be removed from a wild population after the effects of translocation on the donor population have been assessed, and after it is guaranteed that these effects will not be negative.
- If captive or artificially propagated stock is to be used, it must be from a population which has been soundly managed both demographically and genetically, according to the principles of contemporary conservation biology.
- Re-introductions should not be carried out merely because captive stocks exist, nor solely as a means of disposing of surplus stock.
- Prospective release stock, including stock that is a gift between governments, must be subjected to a thorough veterinary screening process before shipment from original

source. Any animals found to be infected or which test positive for non-endemic or contagious pathogens with a potential impact on population levels, must be removed from the consignment, and the uninfected, negative remainder must be placed in strict quarantine for a suitable period before retest. If clear after retesting, the animals may be placed for shipment.

- Since infection with serious disease can be acquired during shipment, especially if this is intercontinental, great care must be taken to minimize this risk.
- Stock must meet all health regulations prescribed by the veterinary authorities of the recipient country and adequate provisions must be made for quarantine if necessary.

(vi) Release of captive stock

- Most species of mammal and birds rely heavily on individual experience and learning as juveniles for their survival; they should be given the opportunity to acquire the necessary information to enable survival in the wild, through training in their captive environment; a captive bred individual's probability of survival should approximate that of a wild counterpart.
- Care should be taken to ensure that potentially dangerous captive bred animals (such as large carnivores or primates) are not so confident in the presence of humans that they might be a danger to local inhabitants and/or their livestock.

4b. SOCIO-ECONOMIC AND LEGAL REQUIREMENTS

- Re-introductions are generally long-term projects that require the commitment of long-term financial and political support.
- Socio-economic studies should be made to assess impacts, costs and benefits of the re-introduction programme to local human populations.
- A thorough assessment of attitudes of local people to the proposed project is necessary to ensure long term protection of the re-introduced population, especially if the cause of species' decline was due to human factors (e.g. over-hunting, over-collection, loss or alteration of habitat). The programme should be fully understood, accepted and supported by local communities.
- Where the security of the re-introduced population is at risk from human activities, measures should be taken to minimise these in the re-introduction area. If these measures are inadequate, the re-introduction should be abandoned or alternative release areas sought.
- The policy of the country to re-introductions and to the species concerned should be assessed. This might include checking existing provincial, national and international legislation and regulations, and provision of new measures and required permits as necessary.
- Re-introduction must take place with the full permission and involvement of all relevant government agencies of the recipient or host country. This is particularly important in re-introductions in border areas, or involving more than one state or when a re-introduced population can expand into other states, provinces or territories.
- If the species poses potential risk to life or property, these risks should be minimised and adequate provision made for compensation where necessary; where all other solutions fail, removal or destruction of the released individual should be considered. In the case of migratory/mobile species, provisions should be made for crossing of international/state boundaries.

5. PLANNING, PREPARATION AND RELEASE STAGES

- Approval of relevant government agencies and land owners, and coordination with national and international conservation organizations.
- Construction of a multidisciplinary team with access to expert technical advice for all phases of the programme.
- Identification of short- and long-term success indicators and prediction of programme duration, in context of agreed aims and objectives.
- Securing adequate funding for all programme phases.
- Design of pre- and post- release monitoring programme so that each re-introduction is a carefully designed experiment, with the capability to test methodology with scientifically collected data. Monitoring the health of individuals, as well as the survival, is important; intervention may be necessary if the situation proves unforseeably favourable.
- Appropriate health and genetic screening of release stock, including stock that is a gift between governments. Health screening of closely related species in the re-introduction area.
- If release stock is wild-caught, care must be taken to ensure that: a) the stock is free from infectious or contagious pathogens and parasites before shipment and b) the stock will not be exposed to vectors of disease agents which may be present at the release site (and absent at the source site) and to which it may have no acquired immunity.
- If vaccination prior to release, against local endemic or epidemic diseases of wild stock or domestic livestock at the release site, is deemed appropriate, this must be carried out during the "Preparation Stage" so as to allow sufficient time for the development of the required immunity.
- Appropriate veterinary or horticultural measures as required to ensure health of released stock throughout the programme. This is to include adequate quarantine arrangements, especially where founder stock travels far or crosses international boundaries to the release site.
- Development of transport plans for delivery of stock to the country and site of re-introduction, with special emphasis on ways to minimize stress on the individuals during transport.
- Determination of release strategy (acclimatization of release stock to release area; behavioural training - including hunting and feeding; group composition, number, release patterns and techniques; timing).
- Establishment of policies on interventions (see below).
- Development of conservation education for long-term support; professional training of individuals involved in the long-term programme; public relations through the mass media and in local community; involvement where possible of local people in the programme.
- The welfare of animals for release is of paramount concern through all these stages.

6. POST-RELEASE ACTIVITIES

- Post release monitoring is required of all (or sample of) individuals. This most vital aspect may be by direct (e.g. tagging, telemetry) or indirect (e.g. spoor, informants) methods as suitable.
- Demographic, ecological and behavioural studies of released stock must be undertaken.
- Study of processes of long-term adaptation by individuals and the population.
- Collection and investigation of mortalities.

- Interventions (e.g. supplemental feeding; veterinary aid; horticultural aid) when necessary.
- Decisions for revision, rescheduling, or discontinuation of programme where necessary.
- Habitat protection or restoration to continue where necessary.
- Continuing public relations activities, including education and mass media coverage.
- Evaluation of cost-effectiveness and success of re- introduction techniques.
- Regular publications in scientific and popular literature.

Footnotes:

[1] Guidelines for determining procedures for disposal of species confiscated in trade are being developed separately by IUCN.

[2] The taxonomic unit referred to throughout the document is species; it may be a lower taxonomic unit (e.g. subspecies or race) as long as it can be unambiguously defined.

[3] A taxon is extinct when there is no reasonable doubt that the last individual has died

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The IUCN/SSC Re-introduction Specialist Group (RSG) is a disciplinary group (as opposed to most SSC Specialist Groups which deal with single taxonomic groups), covering a wide range of plant and animal species. The RSG has an extensive international network, a re-introduction projects database and re-introduction library. The RSG publishes a bi-annual newsletter RE-INTRODUCTION NEWS.

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