Documenting the Impacts of Illegal Mining on Guizhou Golden Monkey Habitat

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PROJECT SUMMARY

Problem Statement

Guizhou province in southwestern China contains the only populations of the Guizhou golden snub-nosed monkey (*Rhinopithecus brelichi*), one of four species of snub-nosed monkey in the world, of which three are endemic to China (Li, Pan, & Oxnard, 2002). Highly endangered, these rare monkeys were still an unproven rumor in the 1950s. Recent exploration of their habitat in Fanjingshan National Nature Reserve, which was established in 1978 for their protection (Bleisch, Ao-Song, Xiao-Dong, & Jia-Hua, 1993) has lent preliminary knowledge of golden monkey movements, habitat, and population. Research has yet to include analysis of the impacts of human activities upon the golden monkey habitat. Such human activities include tourism, gathering wood and medicinal plants, and, in the past decade, illegal mining of manganese and copper. Illegal mining can have serious impacts on the environment. Considering the endangered survival of the golden monkeys (International Union for the Conservation of Nature and Natural Resources, 2008), it is therefore important to document and assess potential impacts as soon as possible in order to ensure the species' continued survival. As one of the most pressing issues facing these endangered primates, it is vitally important to document illegal mining impacts in order to address the effects on the golden monkeys to ensure successful conservation.

Study Area

Fanjingshan National Nature Reserve
Guizhou Province, China

Fanjingshan National Nature Reserve was created in 1978 in Guizhou Province as a protective measure to save the Guizhou snub-nosed monkeys.

CHINA

Guizhou Province

Fanjinshan National Nature Reserve

Sarah Wandersee, Feb. 2009
Sources: LANDSAT, ESRI
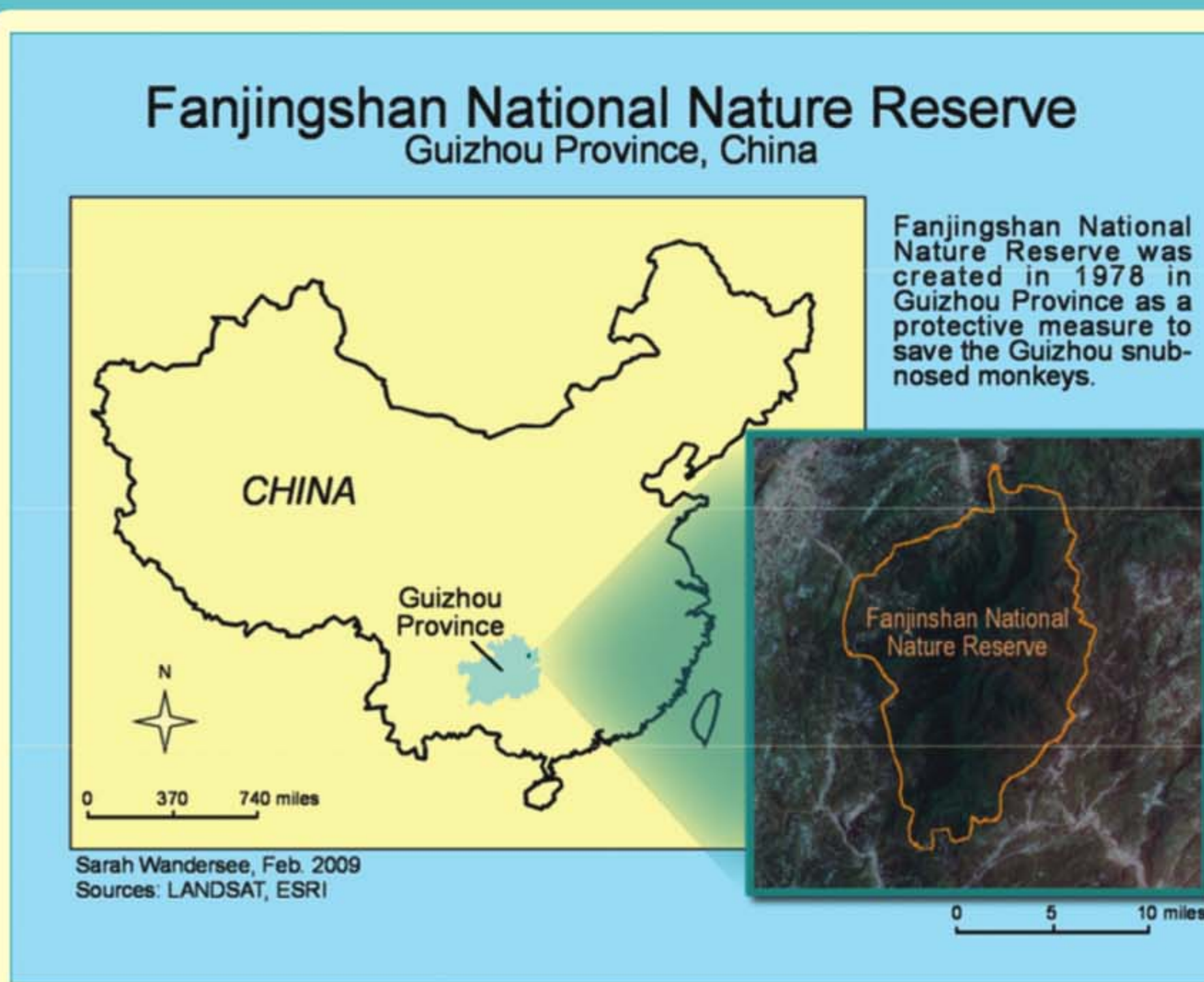
Background

The study of illegal mining effects on golden monkey habitat focuses on the convergence of two contemporary environmental issues—biodiversity loss and mining impacts. Biodiversity loss is a major environmental concern in contemporary society and science. Although it has occurred in the past, the current rate of loss is 100-1,000 times higher than before human activity effects (Chapin III, Zavaleta, Valerie, Naylor, Vitousek, Reynolds et al., 2000). Furthermore, despite extensive studies, the role of biodiversity within ecosystem function is still not completely understood. However, due to the irrevocable nature of biodiversity loss, there was never a greater need for this understanding of its effects and dynamics than now. More controversial, the issue of mining incites heated debate between environmentalists, sociologists, and developers, due to the trade-off between environmental impacts, livelihood effects, need for metals, and profit. Mining impacts have also received more attention of late as the environmental effects of mine waste and acid mine drainage have been publicized and have become better documented and understood, using both on-site chemical analyses and remote sensing. This study will contribute to both discourses by furthering knowledge of an endangered species (*Rhinopithecus brelichi*) and the impacts of illegal mining on its habitat in Fanjinshan National Nature Reserve, China.

The Guizhou snub-nosed monkey

Rhinopithecus brelichi
1 of 4 snub-nosed species
(3 endemic to China)
Habitat: mixed evergreen & deciduous forest, 1500m-2200m
Area: approx. 108 sq. mi.
Movement: arboreal
Population: 700-800 individuals
Family Size: 5-10, 1 adult male
Diet: young leaves, flower and leaf buds, fruit, seeds, bark, insect larvae
Other: no seasonal elevation migration; temporary groups 400+; potentially 2 distinct bands; aggressive intergroup interaction
Source: Bleisch et al. field study
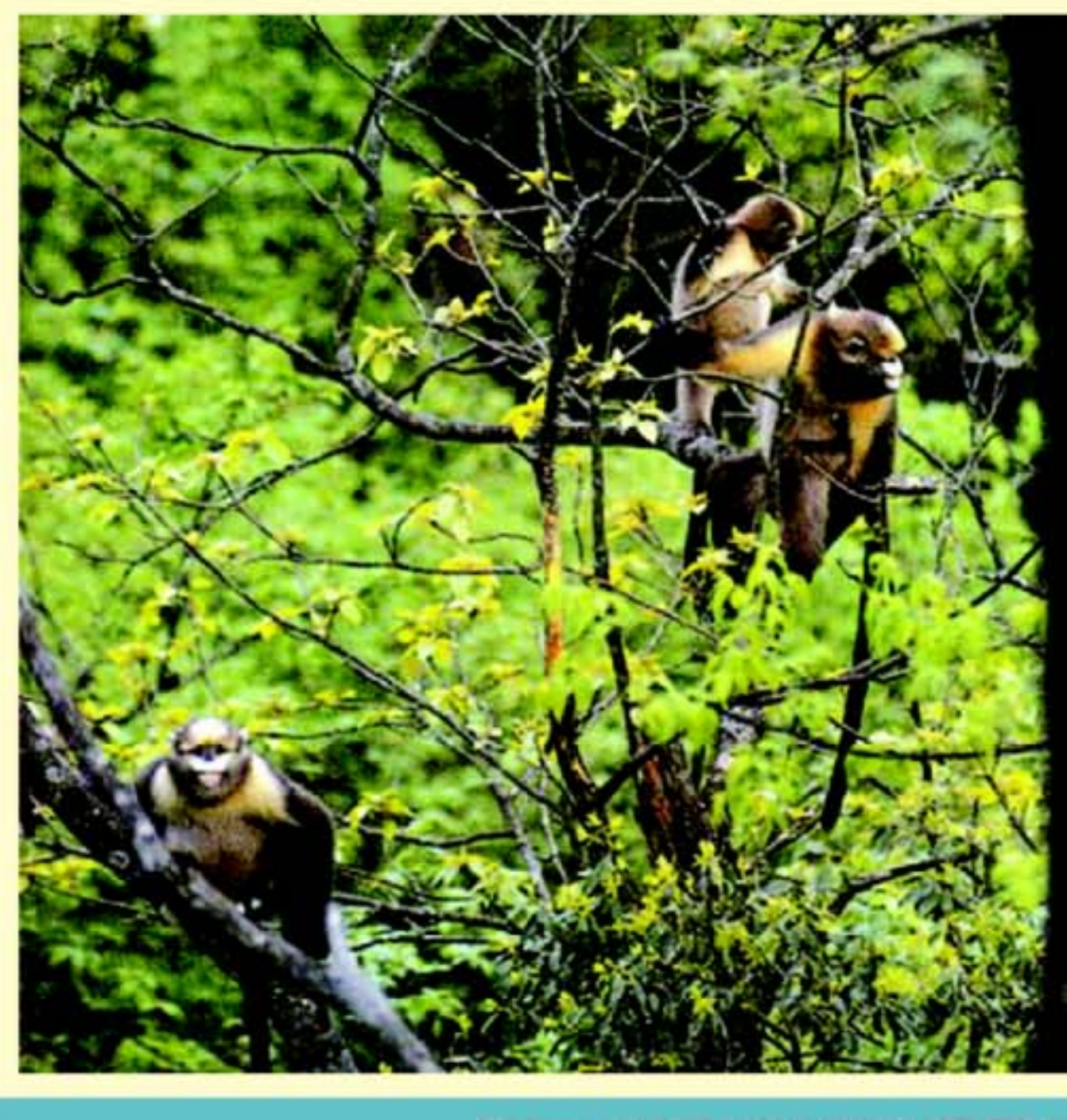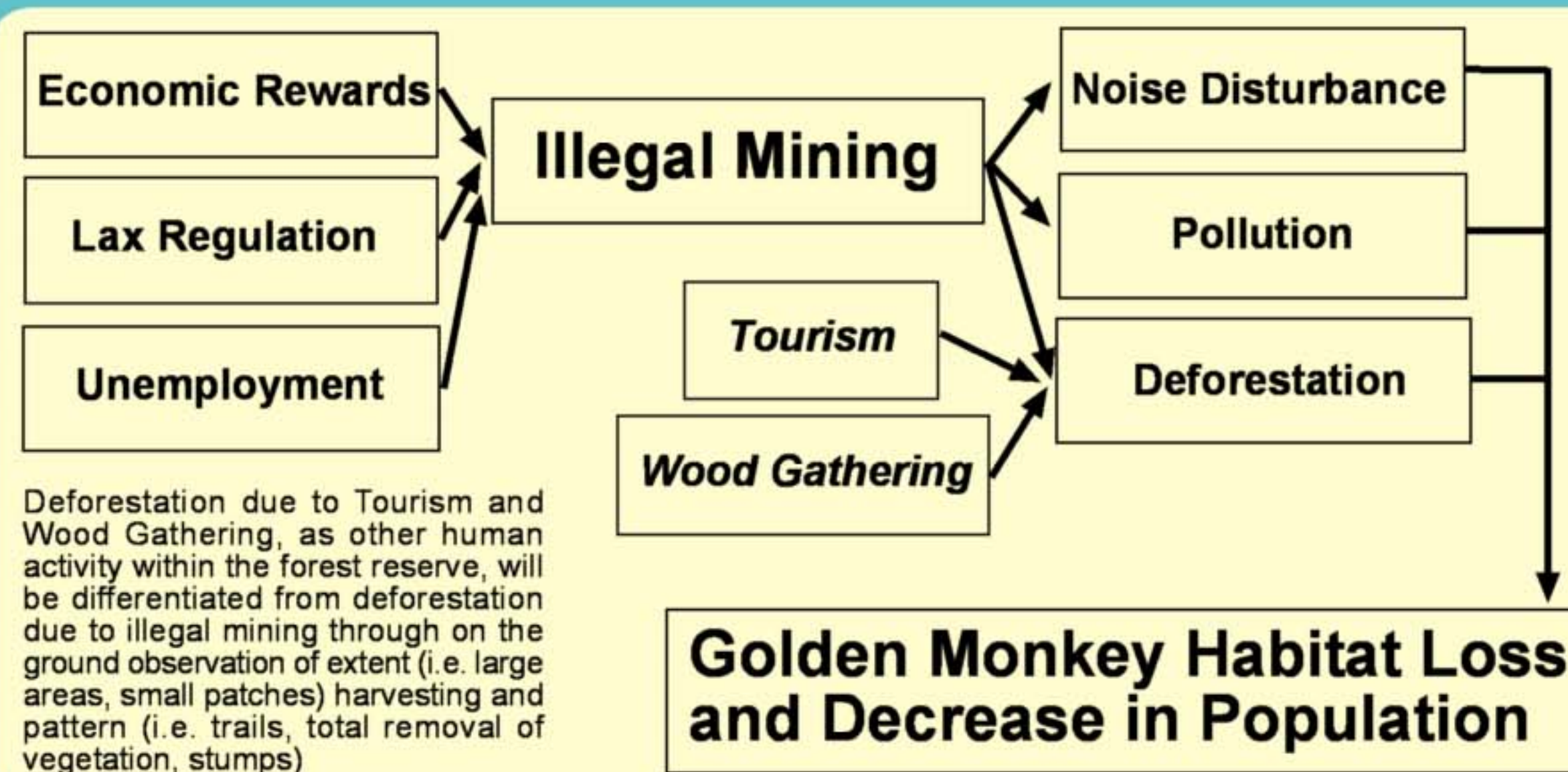
QUESTIONS&METHODS

Research Questions

The main research question for this study is:

Where and why is illegal mining happening within Fanjingshan National Nature Reserve (FNNR), and what is the impact upon golden monkey habitat use?
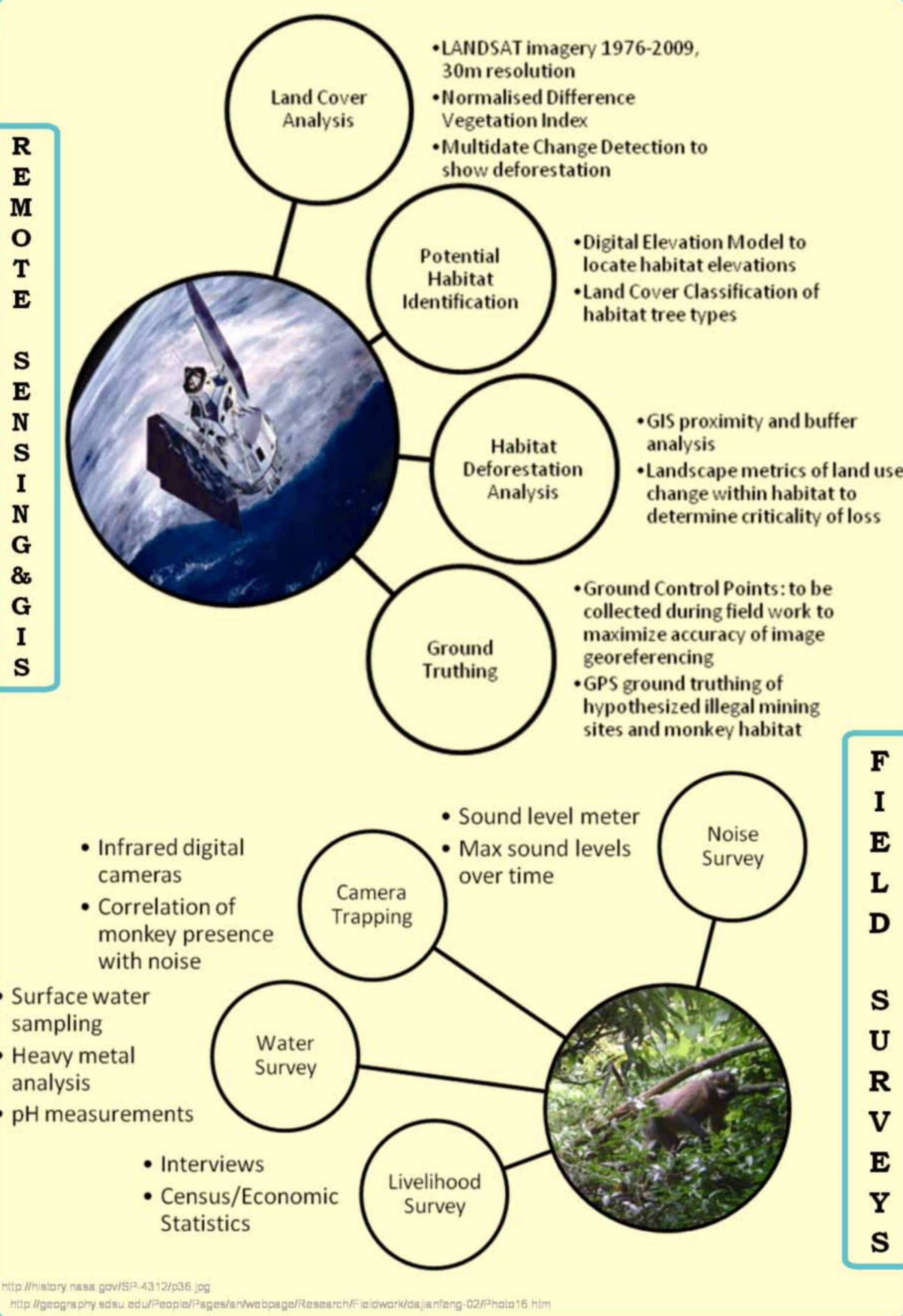
This overarching research question can be broken down into the following components:

- Where is illegal mining activity occurring?
- To what extent, if any, is illegal mining affecting the golden monkey habitat use through deforestation?
- How, if at all, is illegal mining affecting the golden monkey habitat use through pollution and noise disturbance?
- What is driving the illegal mining activity?

Conceptual Model

Economic Rewards → Illegal Mining
Lax Regulation → Illegal Mining
Unemployment → Illegal Mining

Illegal Mining → Noise Disturbance
Illegal Mining → Pollution
Illegal Mining → Deforestation

Tourism → Deforestation
Wood Gathering → Deforestation

Deforestation due to Tourism and Wood Gathering, as other human activity within the forest reserve, will be differentiated from deforestation due to illegal mining through on the ground observation of extent (i.e. large areas, small patches) harvesting and pattern (i.e. trails, total removal of vegetation, stumps)

Golden Monkey Habitat Loss and Decrease in Population

Research Methods

REMOTE SENSING & GIS

Land Cover Analysis
- LANDSAT imagery 1976-2009, 30m resolution
- Normalised Difference Vegetation Index
- Multidate Change Detection to show deforestation

Potential Habitat Identification
- Digital Elevation Model to locate habitat elevations
- Land Cover Classification of habitat tree types

Habitat Deforestation Analysis
- GIS proximity and buffer analysis
- Landscape metrics of land use change within habitat to determine criticality of loss

Ground Truthing
- Ground Control Points: to be collected during field work to maximize accuracy of image georeferencing
- GPS ground truthing of hypothesized illegal mining sites and monkey habitat

FIELD SURVEYS

Noise Survey
- Sound level meter
- Max sound levels over time

Camera Trapping
- Infrared digital cameras
- Correlation of monkey presence with noise

Water Survey
- Surface water sampling
- Heavy metal analysis
- pH measurements

Livelihood Survey
- Interviews
- Census/Economic Statistics

http://history.nasa.gov/SP-4312/p36.jpg
http://geography.sdsu.edu/People/Pages/lanwebpage/Research/nFieldwork/sitejianfeng.02/FPhoto16.htm

PROGRESS

Image Acquisition

Satellite	Year	Date	Cloud Cover	Path
Landsat 1-5 MSS	1973	23-Nov	0%	135
MSS (1972-1987)	1976	14-Apr		135
Landsat 1-5 MSS	1977	02-Jun	30%	135
Landsat 1-5 MSS	1980	25-Aug	80%	136
Landsat 1-5 MSS	1980	05-Nov	70%	136
Landsat 1-5 MSS	1982	19-Dec	50%	136
Landsat 4-5 TM	1989	20-Mar	90%	126
TM (1985-1996)	1993	24-Apr		126
ETM+ Pan (1999-2003)	1999	24-Sep		126
L7 SLC on	1999	24-Sep	0%	126
L7 SLC on	2000	21-May	0.01%	126
L7 SLC on	2001	21-Mar	5.30%	126
L7 SLC on	2002	14-Jul	7.60%	126
L7 SLC on	2002	31-Aug	0.02%	125
L7 SLC on	2003	30-May	0.02%	126
Landsat 4-5 TM	2004	22-Apr	10%	126
Landsat 4-5 TM	2006	03-Sep	28%	126
TM & ETM+ Pan Mosaics	1987-1994			UTM
TM & ETM+ Pan Mosaics	1999-2002			UTM
Landsat 4-5 TM	2009	30-Jan	0%	126

The Landsat imagery collected was received in zipped files that contained all bands of the imagery as GeoTIFFs, including Bands 1 through 8. These bands were processed in ERDAS Imagine and layerstacked. The FNNR boundary file was used within ArcGIS as an estimate of reference accuracy from the pre-delivery corrections completed by NASA. The two major data challenges of the study are imagery availability and lack of ancillary data. Considering the mountainous terrain, ground control points will be acquired during the summer field work to increase the accuracy of the imagery registration.

Imagery NDVIs

1976   1993   2000
2002   2003   2009
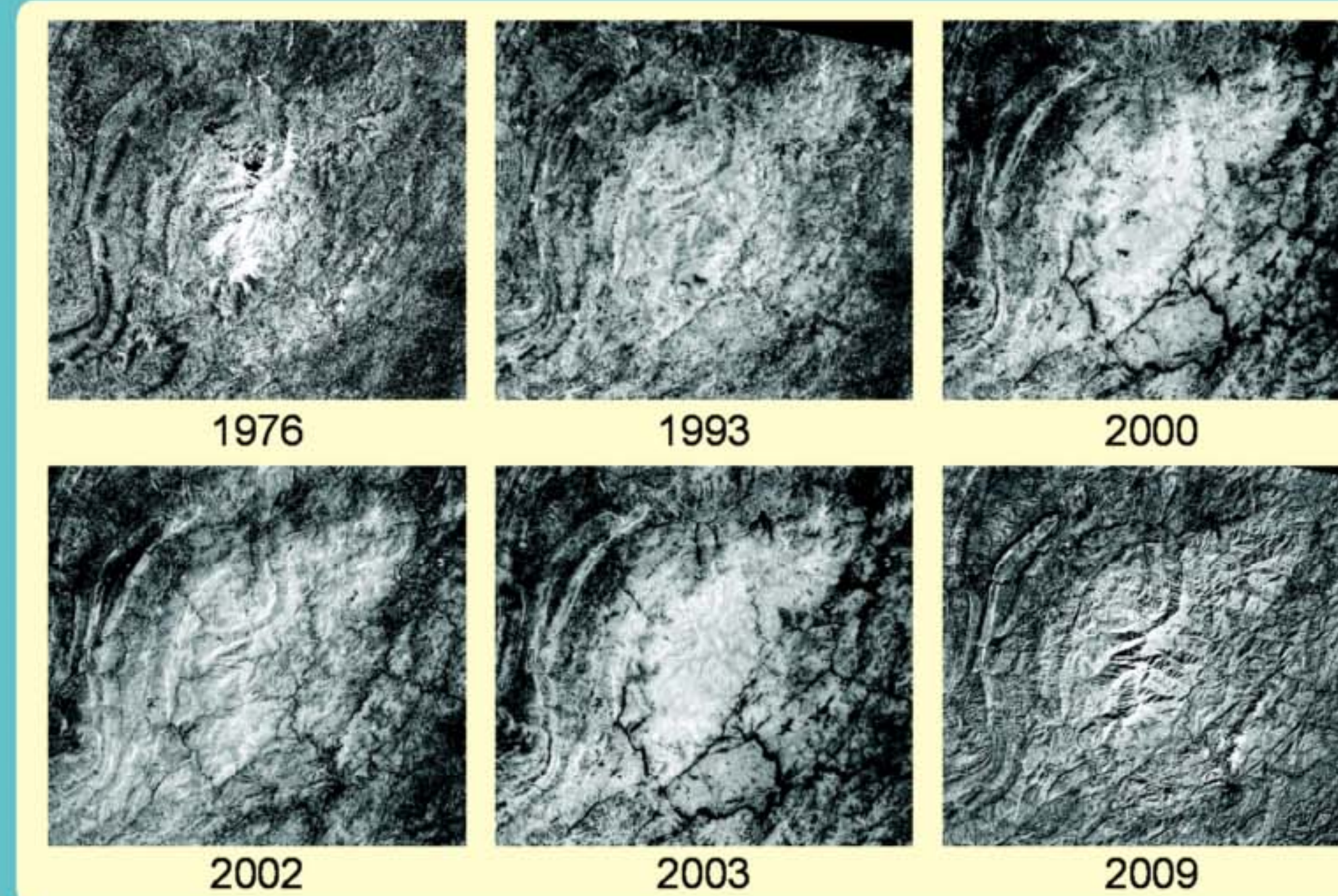
A NDVI (normalized difference vegetation index) was used on cloud free images to illustrate areas of vegetation vs. non-vegetation, ideal for the mountainous terrain since the ratio counteracts illumination effects. Through analysis between years, it is hypothesized that increased areas displayed as black will indicated deforestation, likely from mining, as other development is not occurring in the area.

LANDSAT 7 1999   LANDSAT ETM+ 1999
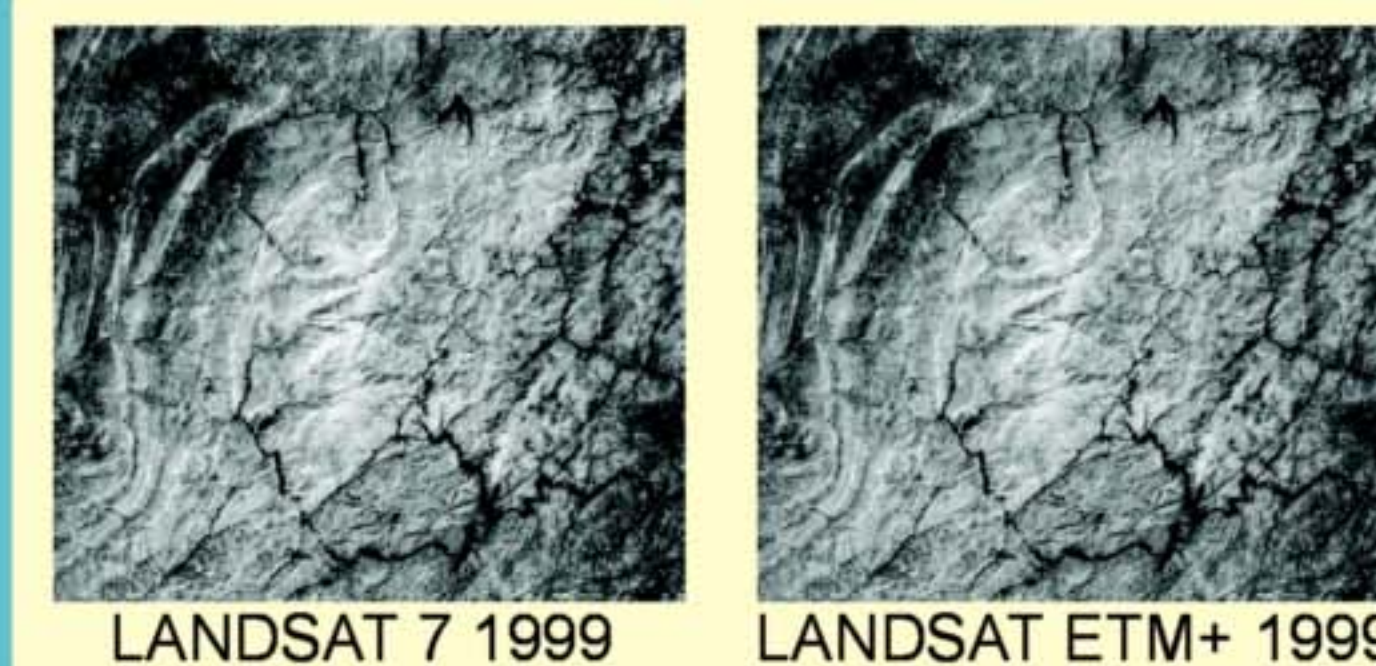
NDVIs from 1999 images taken by different sensors. Although there is obvious similarity, slight nuances illustrate the difficulty of defining deforested areas even within images from the same year.

NDVI Change Detection
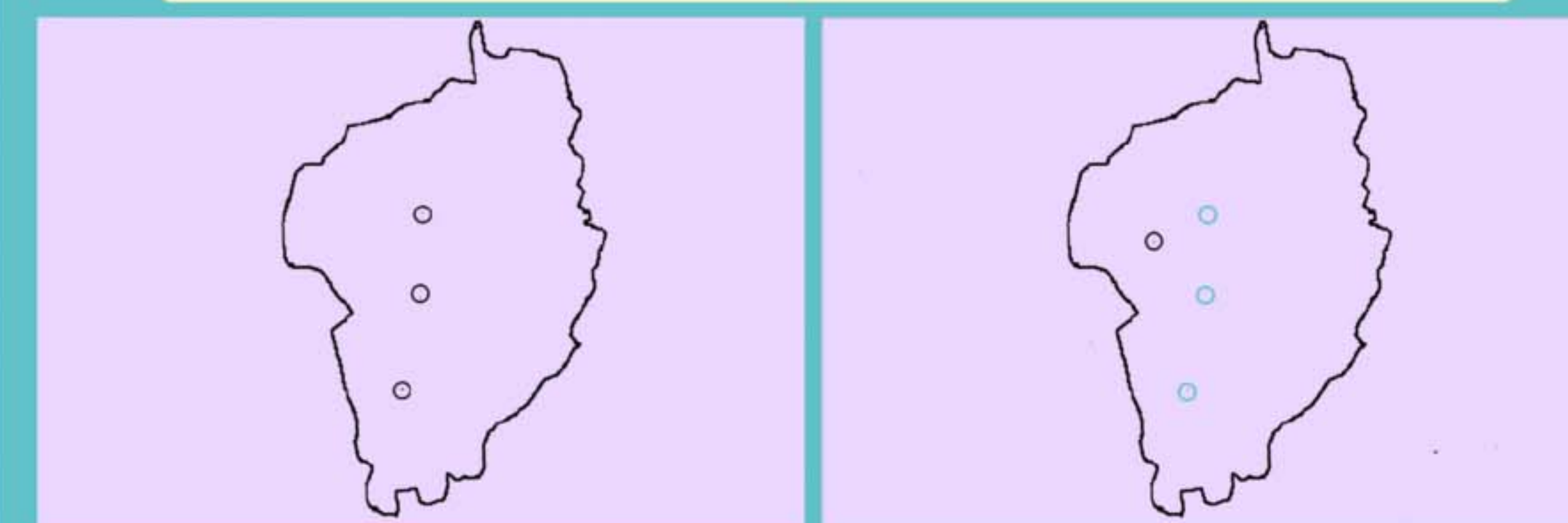
Preliminary change detection on the 1999-2000 (left), 2000-2002 (right), and the 2002-2003 (not shown-no change found) images was run using ERDAS Imagine, using the thresholds of black-> 80% decrease; blue- > 90% increase. Black and turquoise circles indicates areas of decrease/increase respectively.

FUTURE PLANS

Preliminary Results

In general, the preliminary results are inconclusive, indicate a need for more data and analysis, and show the necessity of field work. As expected, NDVI change detection highlights small groups of pixels of decrease or increase that may indicate deforestation and regrowth. However, these changes may be due to weather patterns such as flooding, registration errors, or other causes of deforestation, such as wood gathering. In addition, there is no visually detectable deforestation pattern from 1976-2009, although the spacing between the images may provide time for low shrub or small tree regrowth. Further imagery accuracy assessment is required, as well as area weather data. Also needed are vegetation classification and a higher resolution DEM for habitat identification. The field work and surveys will provide data necessary for methodological accuracy.

Planned Field Work

Trip #1, June 2009, China   **Trip #2, Sept.-Dec. 2009, China**

Date	Task
January 2009	Collect Remote Sensing imagery
February 2009	Register images and run NDVI
March 2009	Analyze map for potential illegal mining activity and golden monkey habitat
	Order equipment for field work and purchase airline tickets
April-May 2009	Prepare maps and detailed itinerary for field work
	Conduct inventory and planning discussion with reserve personnel
June 1-22, 2009	Conduct three weeks of field work, with objectives and duties as previously described (Section V) to be organized as follows:
	1st Week – collect ground control points, analyze potential habitat accuracy
	2nd Week – collect GPS data on mining locations, set sound level meters and cameras at three sites
	3rd Week – sample water by mining sites and streams, conduct interviews
July 2009	Process and analyze data from field work, analyze water samples and sound levels
August 2009	Formulate project report, including results. Create adjusted plan for more extensive field work in the fall, taking into account any problems or newly identified needs
Sept.-Dec. 2009	Field Work Trip #2

Project Evaluation

Following the completion of the first field work trip, the preliminary results will be assessed to determine the usefulness of the methodology in documenting the illegal mining and its impacts on golden monkey habitat. Challenges and inconsistencies will be identified, and methods will be adjusted accordingly to optimize the efficiency of Field Work #2 in the golden monkey project. Also to be incorporated are any additional research needs that may arise during Field Trip #1. The results and adjusted approaches will be discussed with Dr. Chia Tan of the Zoological Society of San Diego and Dr. Li An at San Diego State University for incorporation into future studies, such as Dr. An's Golden Monkey Project.

Significance & Applications

Having groundbreaking global applications, the overall goal of the study is to identify and document illegal mining activity within Fanjingshan National Nature Reserve and analyze the impacts of that activity on the Guizhou snub-nosed monkey population. This work will verify methods and approaches for the documentation and assessment of impacts of illegal mining activity on Guizhou golden monkeys. The resulting data will indicate the areas of illegal mining effects upon the golden monkey population, which will lead to management recommendations for the forest reserve personnel. Data and methods from the study could be further applied to assess environmental degradation and effects on endangered populations of snub-nosed monkeys or other primates and to locate, stop, and prevent illegal mining. The study will raise awareness about endangered species such as the Guizhou golden monkey and contribute towards global conservation efforts.
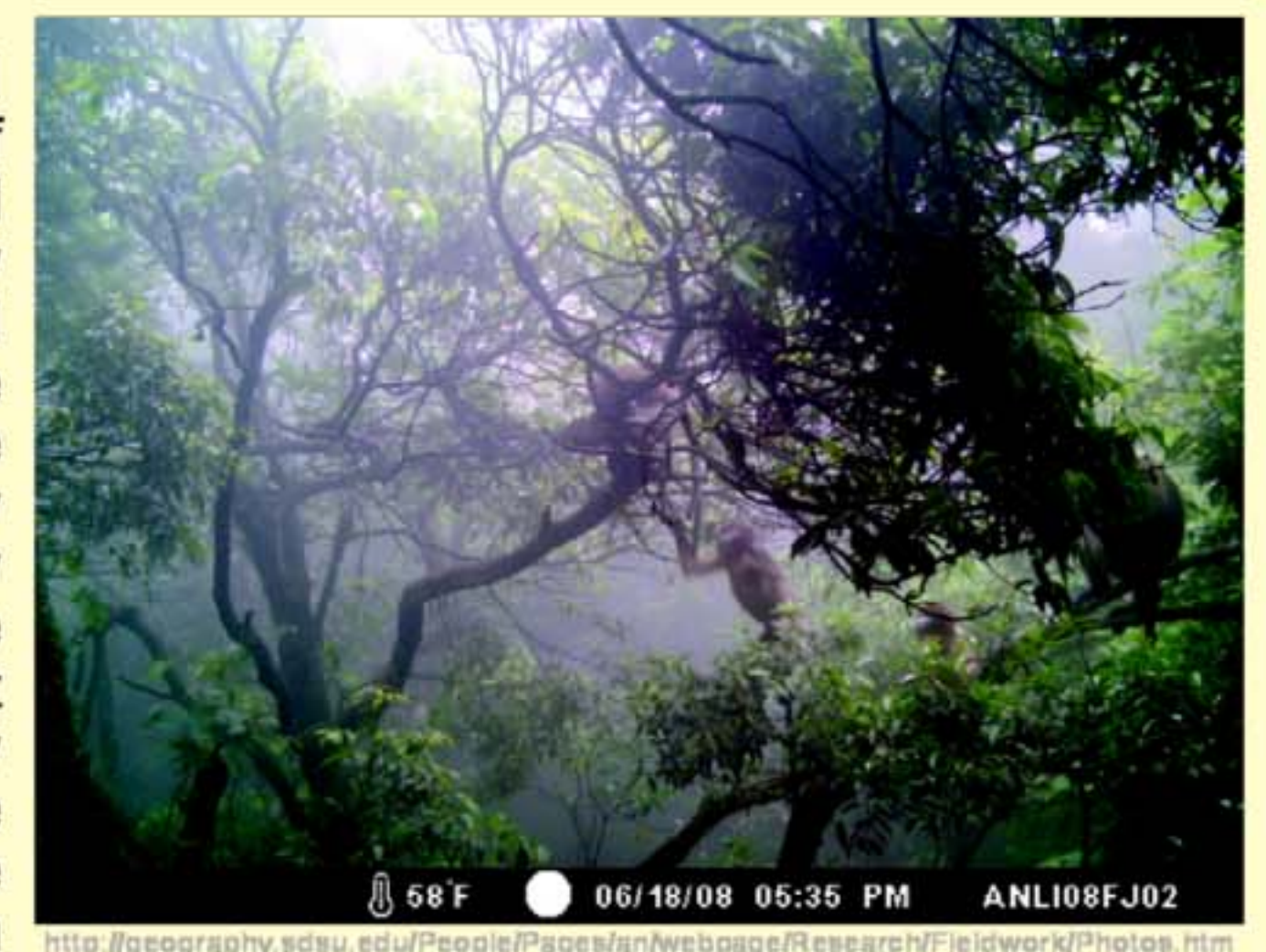
Information Sources:
Citations:
An, L., Lupi, F., Liu, J., Linderman, M. A., & Huang, J. (2002). Modeling the choice to switch from fuelwood to electricity: implications for giant panda habitat conservation. *Ecological Economics*, 42(3), 445-457.
Bleisch, W., Ao-Song, C., Xiao-Dong, R., & Jia-Hua, X. (1993). Preliminary results from a field study of wild Guizhou snub-nosed monkeys (*Rhinopithecus brelichi*). *Folia Primatologica*, 60(1-2), 72-82.
International Union for Conservation of Nature and Natural Resources. (2008) *The IUCN Red List of Threatened Species*. Retrieved from http://www.iucnredlist.org
Tan, C., Guo, S., & Li, B. (2007). Population structure and ranging patterns of Sichuan snub-nosed monkeys (*Rhinopithecus roxellana*) in Zhouzhi National Nature Reserve, Shaanxi, China. *International Journal of Primatology, 28*, 577-591.
Data:
ESRI, NASA, Earth Explorer
Photos:
http://geography.sdsu.edu/People/Pages/lanwebpage/Research/Fieldwork/Photos.htm
http://www.animalinfo.org/image/pygabre2%2065.jpg
http://history.nasa.gov/SP-4312/p36.jpg

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