

Land Use Around Protected Areas: Rates of Change and Consequences for Biodiversity

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Case Study Sites



Land Use Change

Greater Yellowstone Ecosystem (Hansen et al.)

Only 32% of natural habitats (green) remained on private lands in the GYE by 1995. Rates of change in natural habitat between 1976 to 1995 are indicated by land ownership: NPS (purple), public, non-reserve (gray), and private (red, green, and cream).

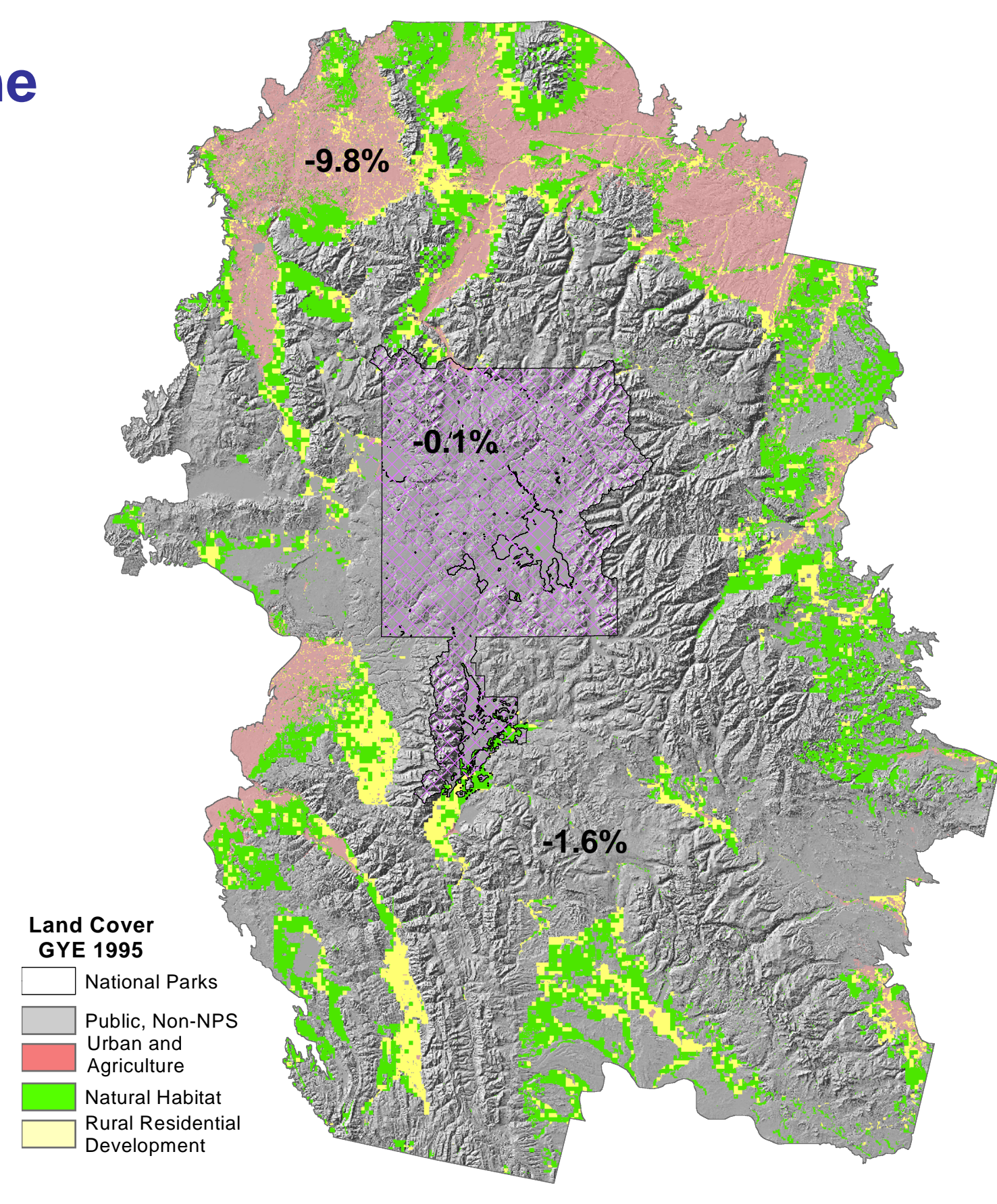
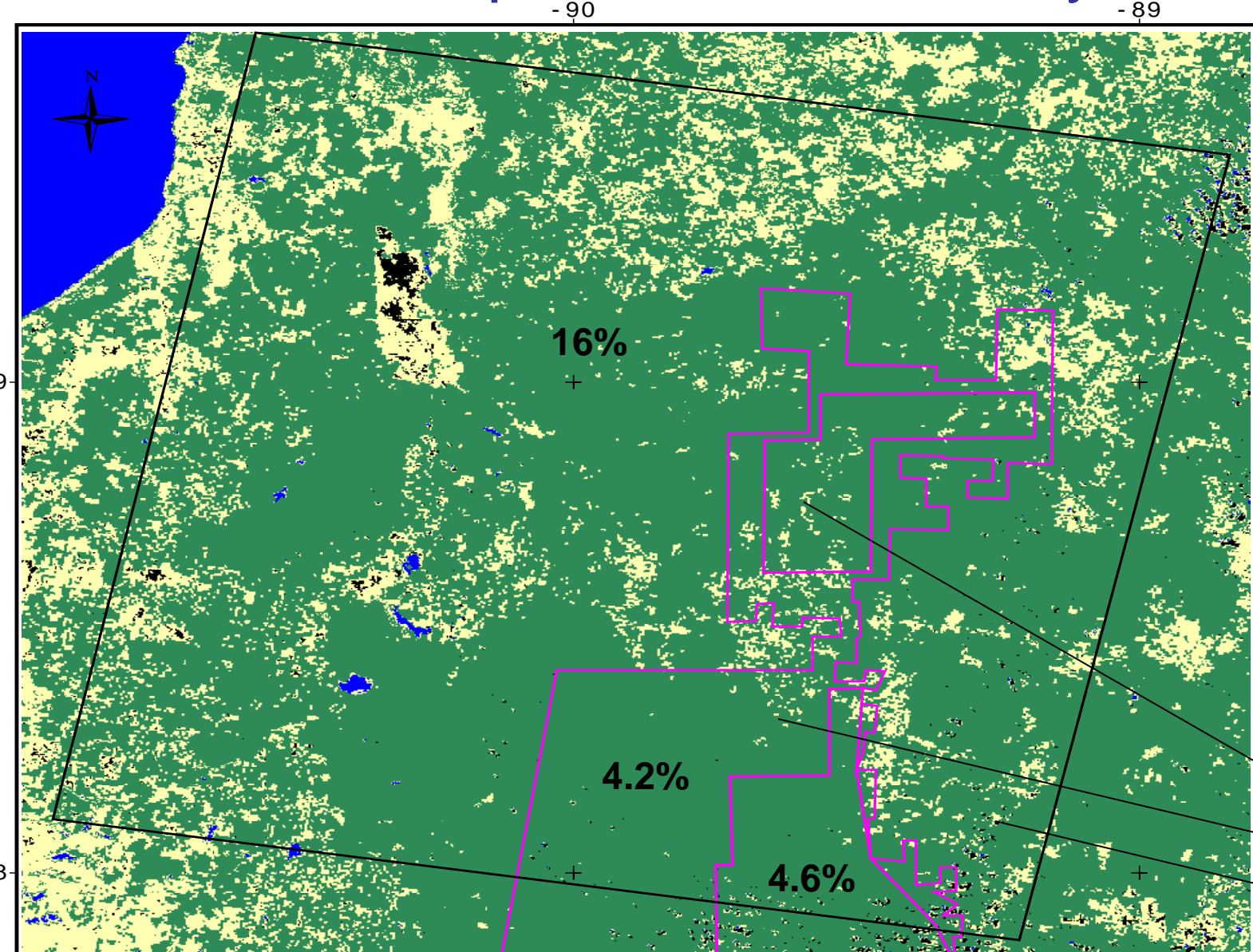


Table 1. Preliminary results of land use change analysis. Total loss of natural habitats and rates of loss will be quantified inside and outside reserves at all sites.

Region	Pilot Analysis Area	Time Period	Type of Change	Key Land Use / Cover Changes
Greater Yellowstone USA	Greater Yellowstone Ecosystem	1976 - 1995	Rural residential development	<ul style="list-style-type: none"> Total habitat loss by 1995: 27% entire GYE, 68% private lands Key habitat loss by 1995: 72% of private riparian habitats, 51% of hardwoods
Maasailand East Africa	Serengeti/Mara system	1975 - 1995	Agriculture	<ul style="list-style-type: none"> Change in suitable wildlife habitat: +0.84% in protected areas, -2.71% outside protected areas
Mayan Forest Mexico	Calakmul BR and surroundings	1987 - 1997	Logging and swidden agriculture	<ul style="list-style-type: none"> Decrease in forest cover by 1997: 4.6% inside core reserve, 16% outside core, up to 25% on reserve border
Santarém Region Brazil	Tapajós NF + surrounding areas	1986 - 2001	Logging and swidden agriculture	<ul style="list-style-type: none"> Forest loss 1 km belts from NF edge: From 2.4% to 24%
Wolong Region China	Wolong and 5km buffer	1975 - 1995	Logging, agriculture	<ul style="list-style-type: none"> Loss of panda habitat: 8% inside reserve, from -0.5 to 1%/year outside
Borneo Indonesia	Gunung Palung NP + 10 km buffer	To be decided	Logging, agriculture	Rapid deforestation, rate yet to be determined.

Calakmul Biosphere Reserve, Mayan Forest (Turner et al.)



Percent change in intact habitat in and outside Calakmul Biosphere Reserve (pink). In fast changing areas, such as the within black box, up to 25% of land area has been converted.

MODIS data from 14 March 2001. Preliminary forest / non forest classification: green - forest, yellow - non forest.

Reserve core
Reserve buffer
Unprotected

Introduction

Many nature reserves are located near human population centers.

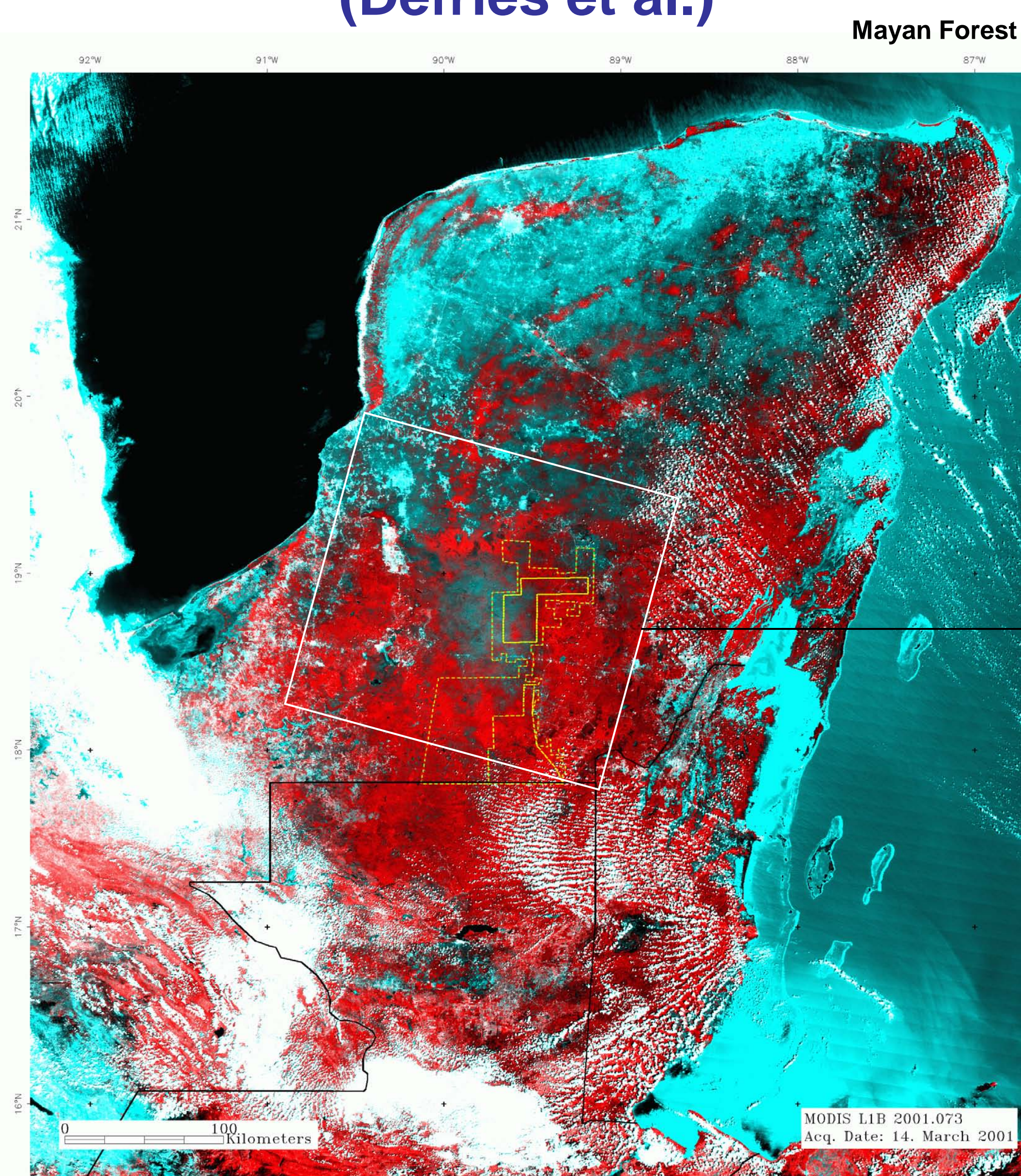
The initial studies of land cover change using satellite imagery are striking in the rapid rate of land-use intensification in many regions of the world.

This land use intensification in the buffers around reserves may decrease the functional size of the protected areas and increase species extinction.

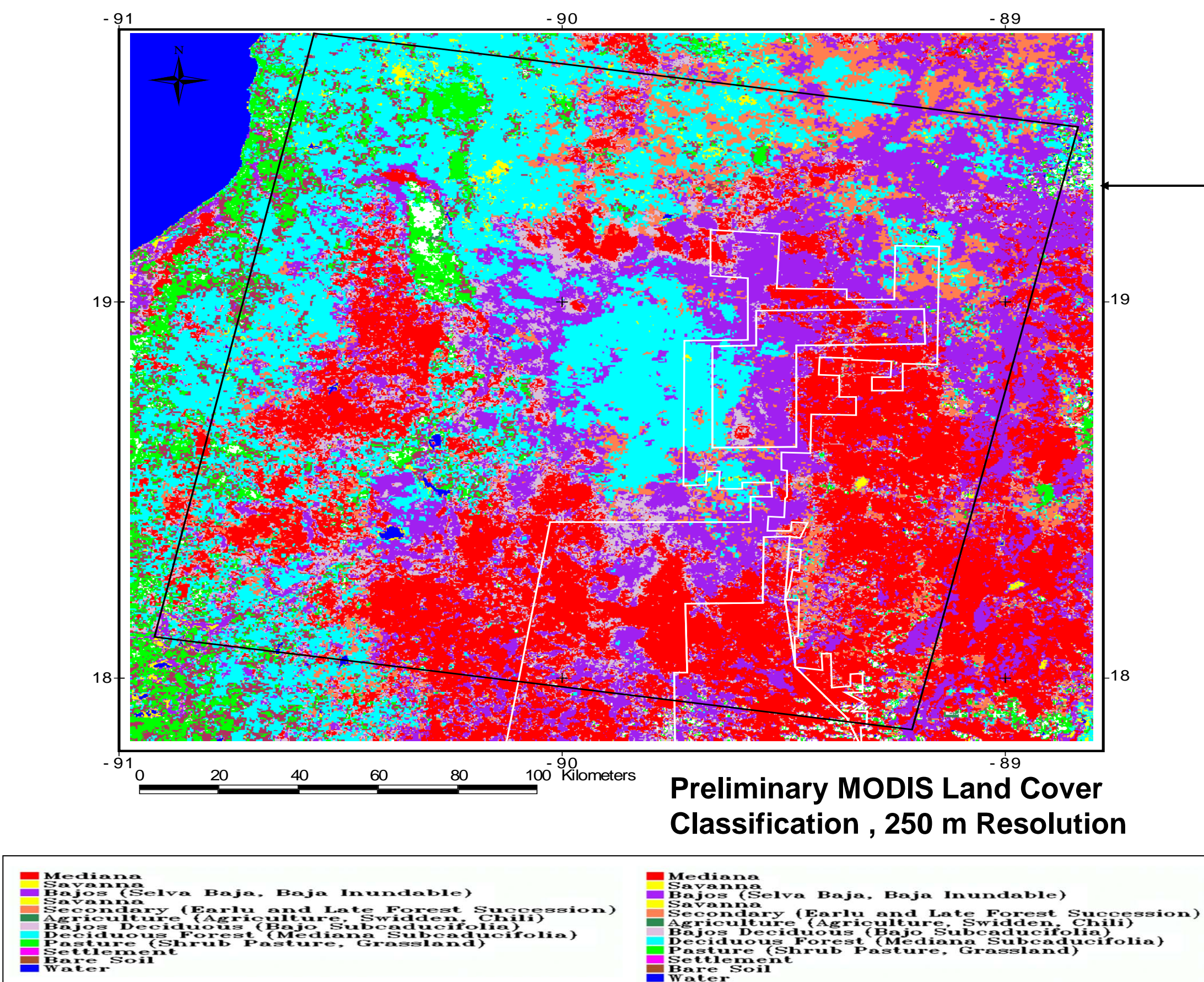
Objectives

1. Quantify rates of change in land cover and use in and around nature reserves in a range of biomes.
2. Determine the consequences of this change for biodiversity.
3. Test the feasibility of monitoring future change using coarse-resolution MODIS data.

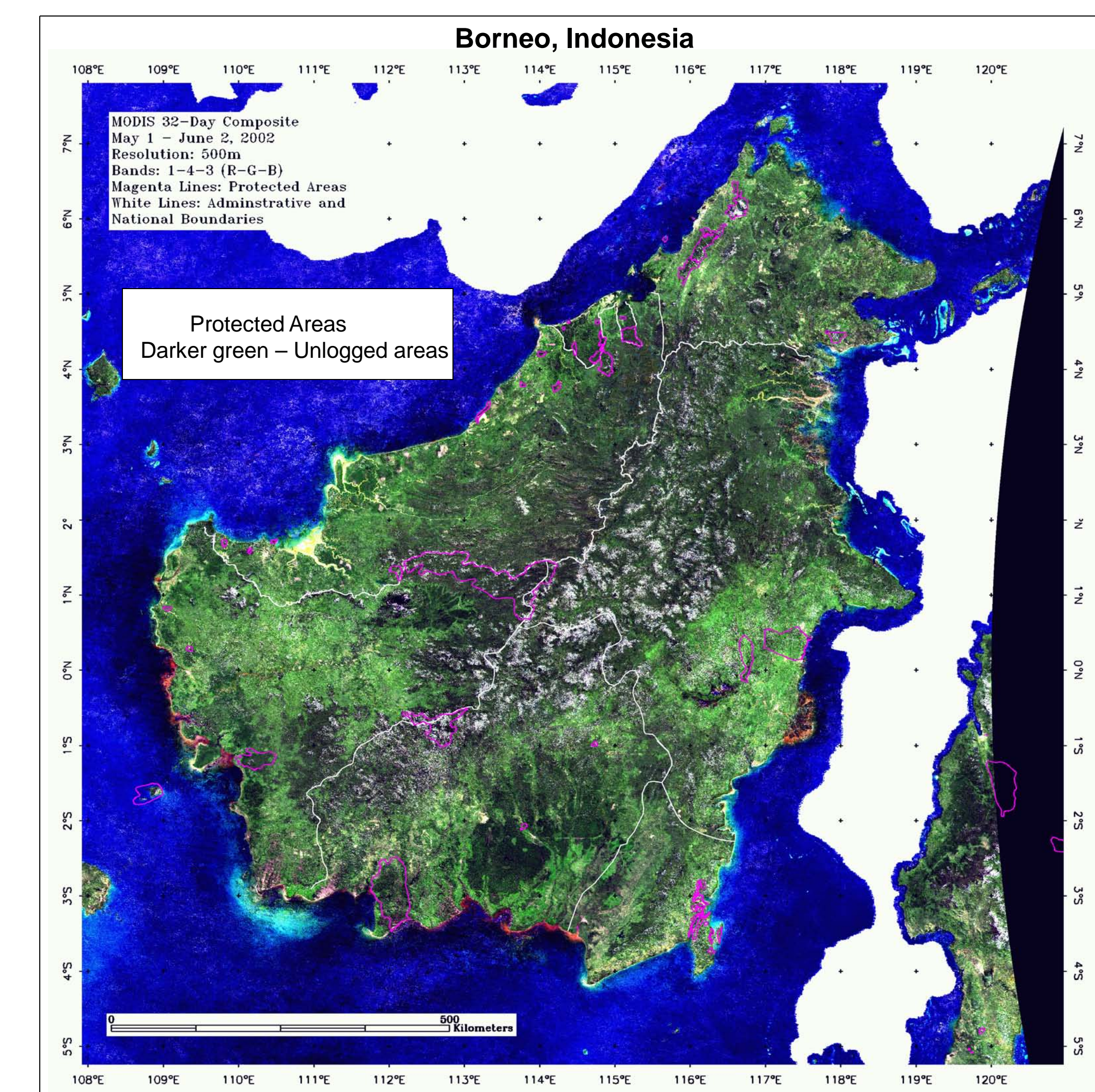
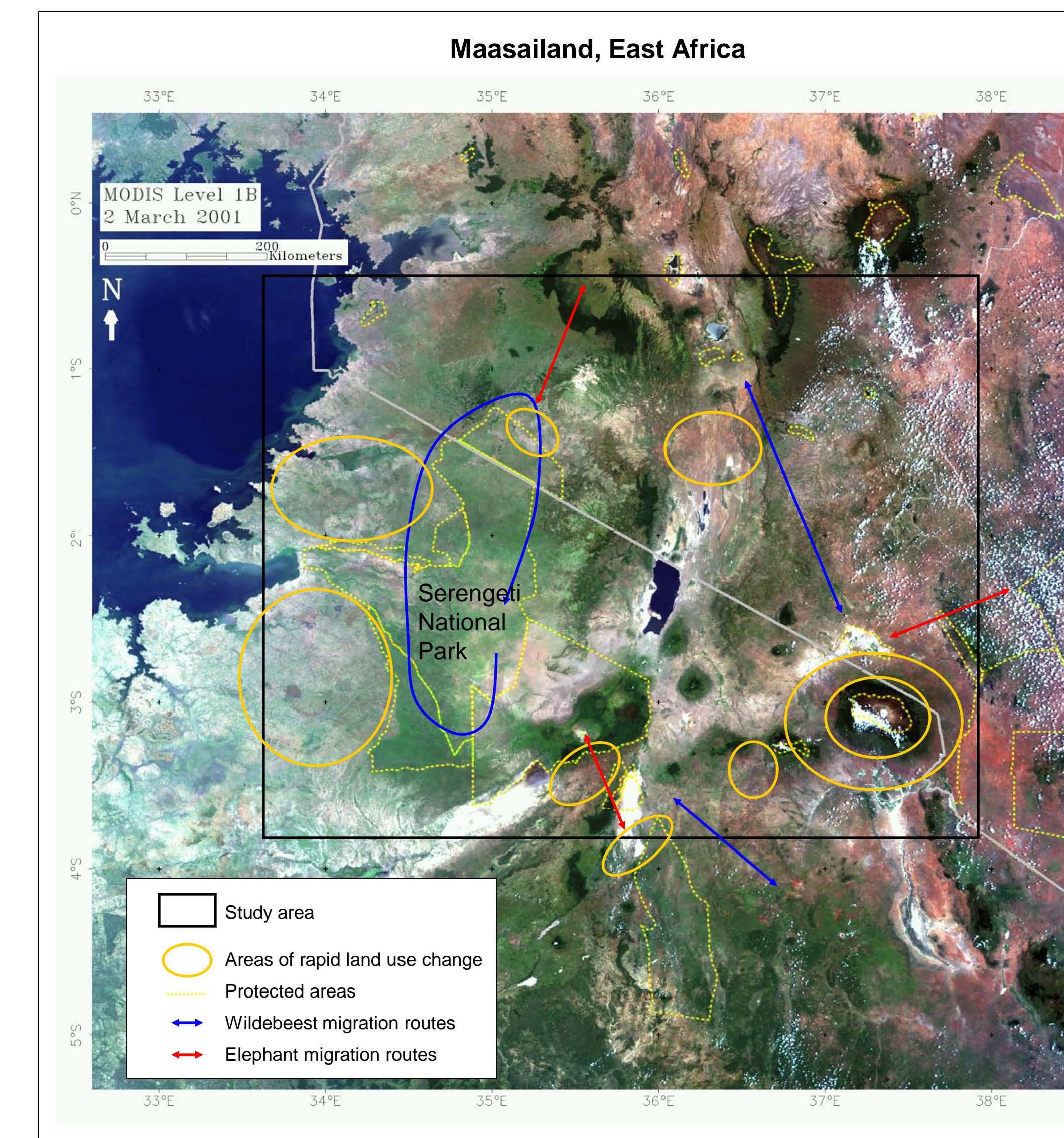
MODIS Land Cover Classification (Defries et al.)



MODIS Scene, Level 1B, 250 m resolution. Acquisition date: 14 March 2001. Band combination R-B-G = 2-1-1 (NIR-R-R).



Objectives



MODIS Land Cover Classification (Defries et al.)

MODIS data was used to derive land cover maps for the Mayan Forest (left), Maasailand, GYE, and the Santarém region, Brazil. The classification was carried out using a decision tree approach. For the Mayan Forest and Maasailand, bands 1, 2, 3, 4, and 6 of Level 1-B MODIS data were used. For GYE, MODIS bands 1, 2 (250m) and NDVI's of three dates were used in decision tree classification. In Santarém, single date 500m MODIS data (7 bands) were used.

The MODIS classification showed good results over homogeneous areas, but proved to be problematic in areas with small-scale land cover variations. Due to the relatively coarse resolution of 250 m - 500 m, many pixels contain mixed spectral signatures of different land cover types. Current work is in progress using methods to identify sub-pixel vegetation types.

Consequences for Biodiversity

Consequences for Nature Reserves: Migration Habitats (Reid et al.)

Possible migration routes for large mammals in Maasailand, East Africa (left) extend outside of protected areas. Intensive human land use occurs within routes influencing large mammal population sizes.



Table 2. Mechanisms by which land use surrounding nature reserves may alter ecological processes and biodiversity within reserves.

Mechanism	Type	Examples
Change in Effective Size of Reserve	<ul style="list-style-type: none"> Minimum Dynamic Area Species Area Effect Trophic Structure 	<ul style="list-style-type: none"> YNP and 1988 fires Bird species loss in Kenya predicted by change in forest area Synchronous fruiting Diptocarp tree species declining in Borneo, seed predators focus on seeds in the reserve
Alteration of Ecological Flows	<ul style="list-style-type: none"> Disturbance Initiation and Runoff Zones Placement in Watershed or Airshed 	<ul style="list-style-type: none"> Clear-cutting on the windward side of YNP has reduced incidence of fire spreading into the park. Exotics in Grand Canyon NP due to agriculture and water diversion higher in the watershed
Loss of Critical Habitats Outside Reserve	<ul style="list-style-type: none"> Ephemeral Habitats Dispersal or Migration Habitats Population Source Habitats 	<ul style="list-style-type: none"> Bird species richness and abundance lower inside YNP due to harsh physical conditions, avian hotspots found outside reserve Ungulates in Serengeti NP migrate to dry-season habitats outside park

Consequences for Nature Reserves: Trophic Structure (Curran et al.)

Approximately 250 species of Diptocarp trees fruit simultaneously in lowland forests of Borneo (left), swamping the seed predator community. Timber harvest has reduced regional extent of fruit masting, resulting in the concentration of seed predators in small remaining forest patches and reserves, reducing diptocarp reproduction rates. Also, 7-10% remaining orangutans occur within the study area with population levels rapidly decreasing due to logging.



Progress to Date

- Detailed work plans completed for all sites.
- Preliminary land cover/use change analyses completed for 5 of the 6 study sites during a workshop held September 2002.
- Initial MODIS evaluations completed for all sites.
- Land cover classification done for 3 sites.
- Biodiversity approaches defined for each site.



Funded by: NASA Land Cover Land Use Change Program