Designing Protected Areas to Conserve Biodiversity:

A Case Study of the Malagasy Lemurs

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3rd International Conference on Biodiversity & Sustainable Energy Development 2014

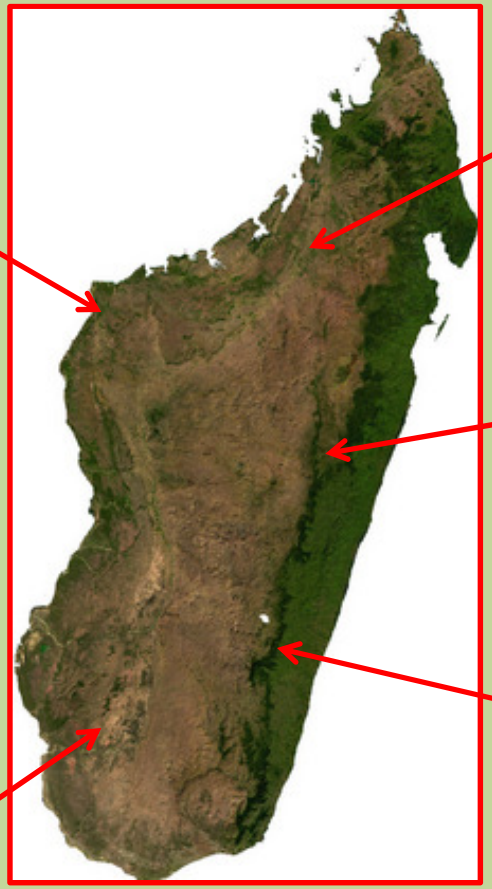
Lemurs – Madagascar's Primates

- Highly diverse: 101 recognized species
- Arboreal primates
- Range of:
  - Sizes: 30 g to ~7 kg
  - Activity pattern
  - Foraging strategies
  - Social structure
- Female dominant
- Umbrella species

Madagascar = Global Conservation Priority

Species Diversity
"Hotspot"

Species Endemism



101 lemur species
94% at risk of extinction

Higher Order Endemism

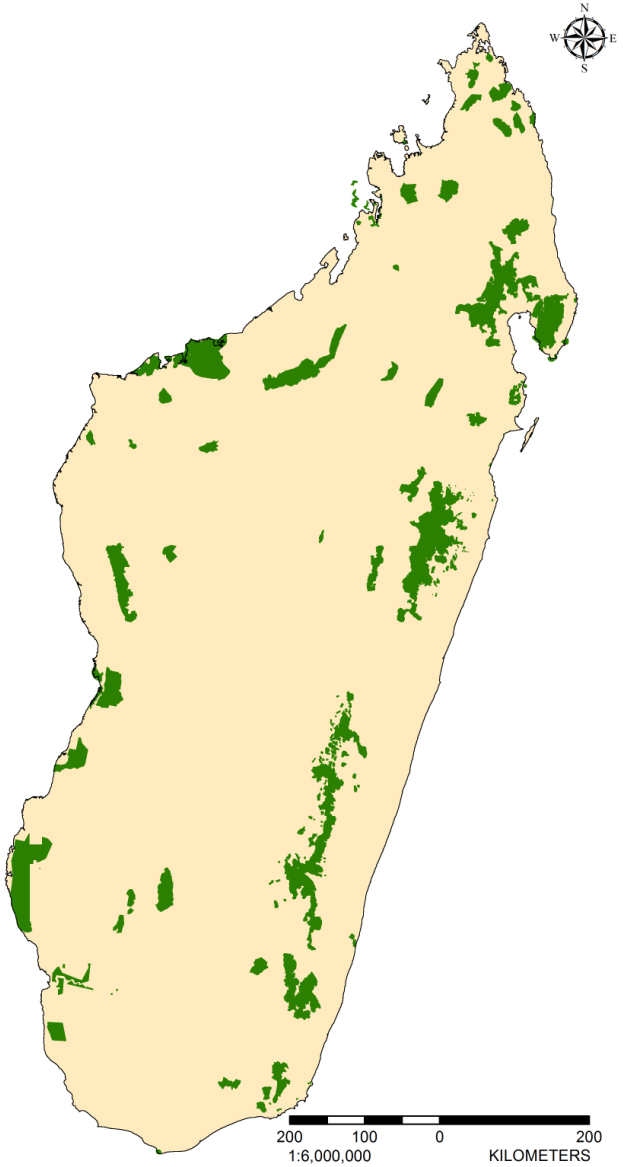
Habitat Diversity

High Rates of Forest Loss

Protected Areas

- One of the most successful measures implemented for the conservation of biodiversity
- Often selected opportunistically
  - Undevelopable land
  - Lower cost to acquire
  - Not necessarily to protect species
    - Recreational or cultural value
- Varying levels of protection –
  - IUCN categories
  - Most with some recreational use or resource extraction

Protected Areas of Madagascar



PAs cover 41,633 km^2

˜ 7-8% of Madagascar

(WDPA 2009)

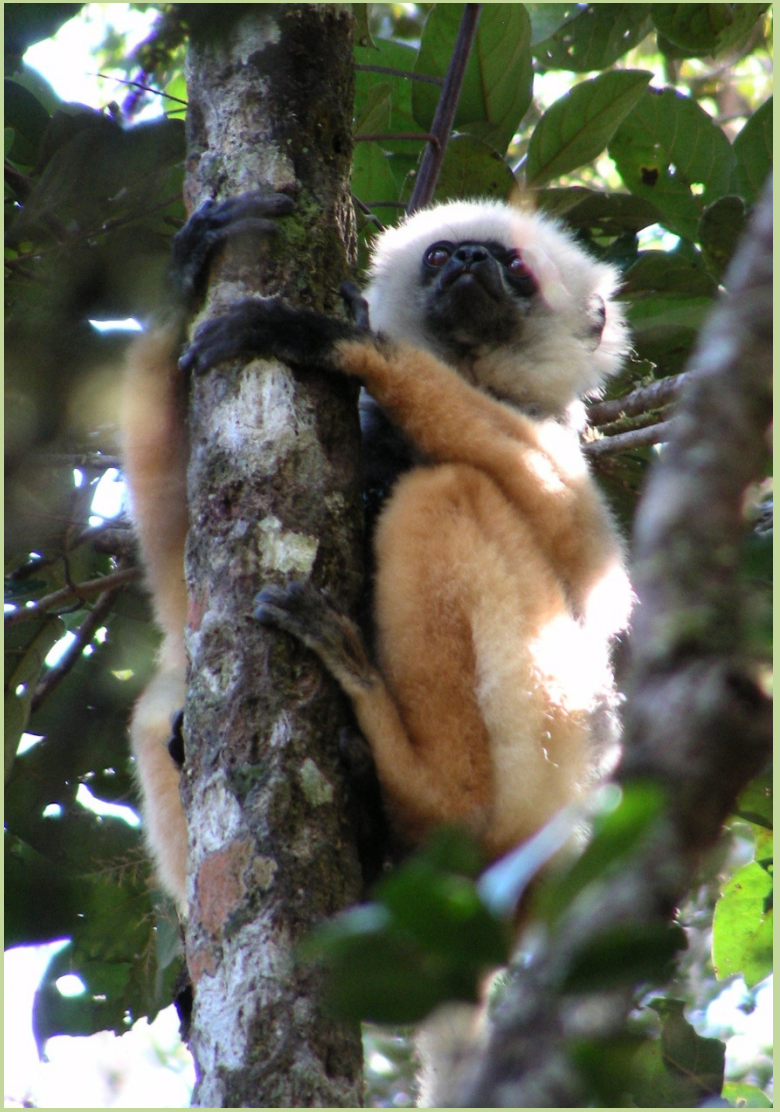
Conservation Planning

- Systematic methods/models
  - Select PAs to maximize biodiversity protection
  - Consider size, shape, connectivity, location and cost

1. Determine patterns of diversity
2. Set conservation targets
3. Evaluate current reserve system
4. Fill in the gaps to meet targets
5. Prioritize where to focus efforts

Research Goal

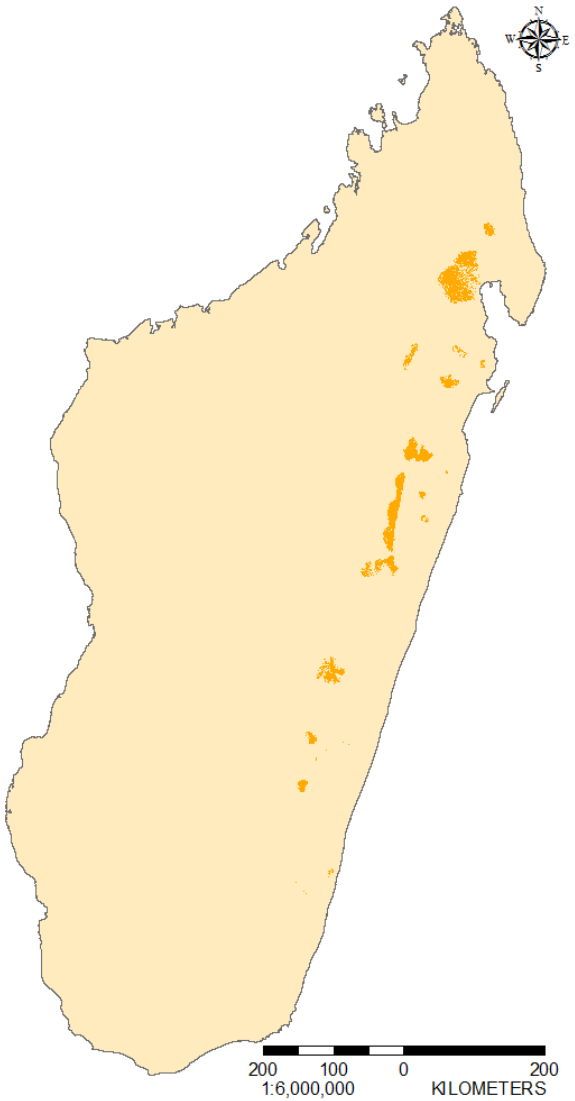
Determine if PAs in Madagascar represent lemur diversity effectively



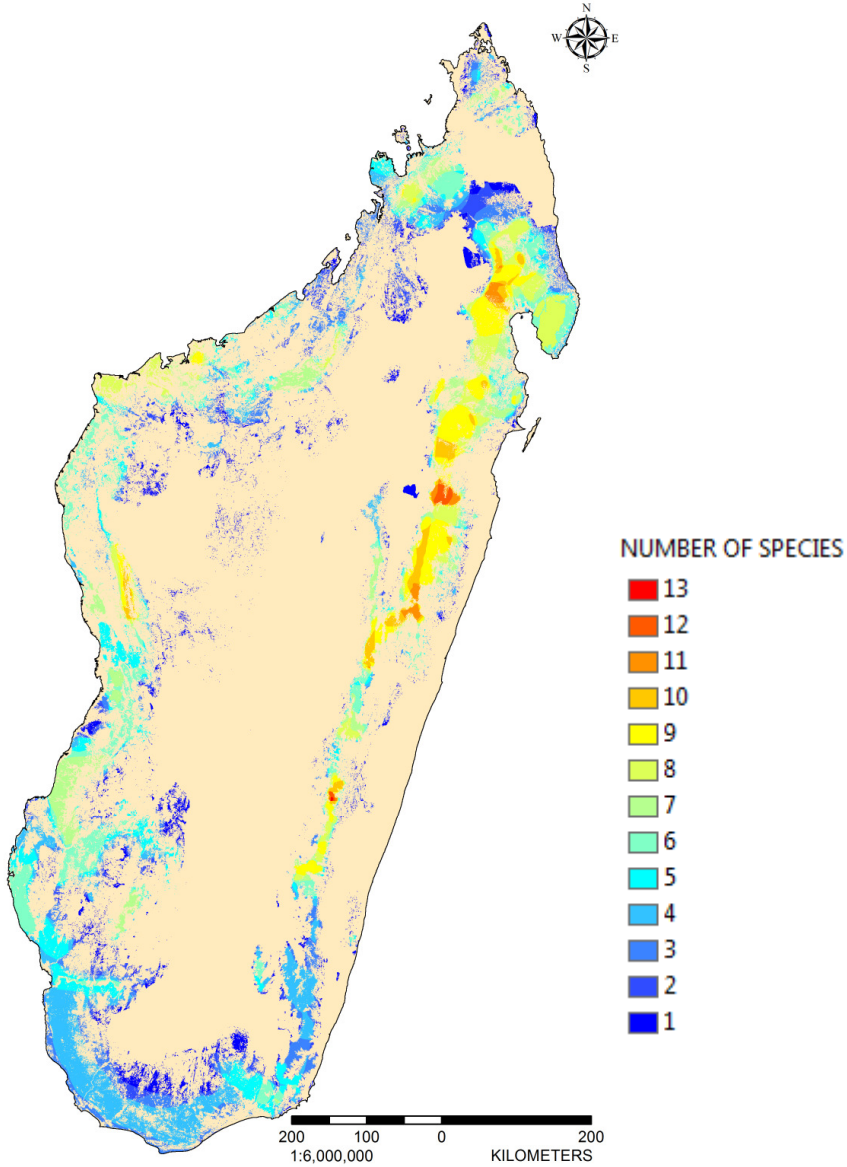
Research Questions

- What are the patterns of lemur diversity?
- How much of lemur geographic ranges are protected within the existing PA network?
- Does the PA network include sufficient lemur habitat to be adequately protected?
- If not, where can the PAs be expanded so that they do?
- Where are the priority areas to conserve first?

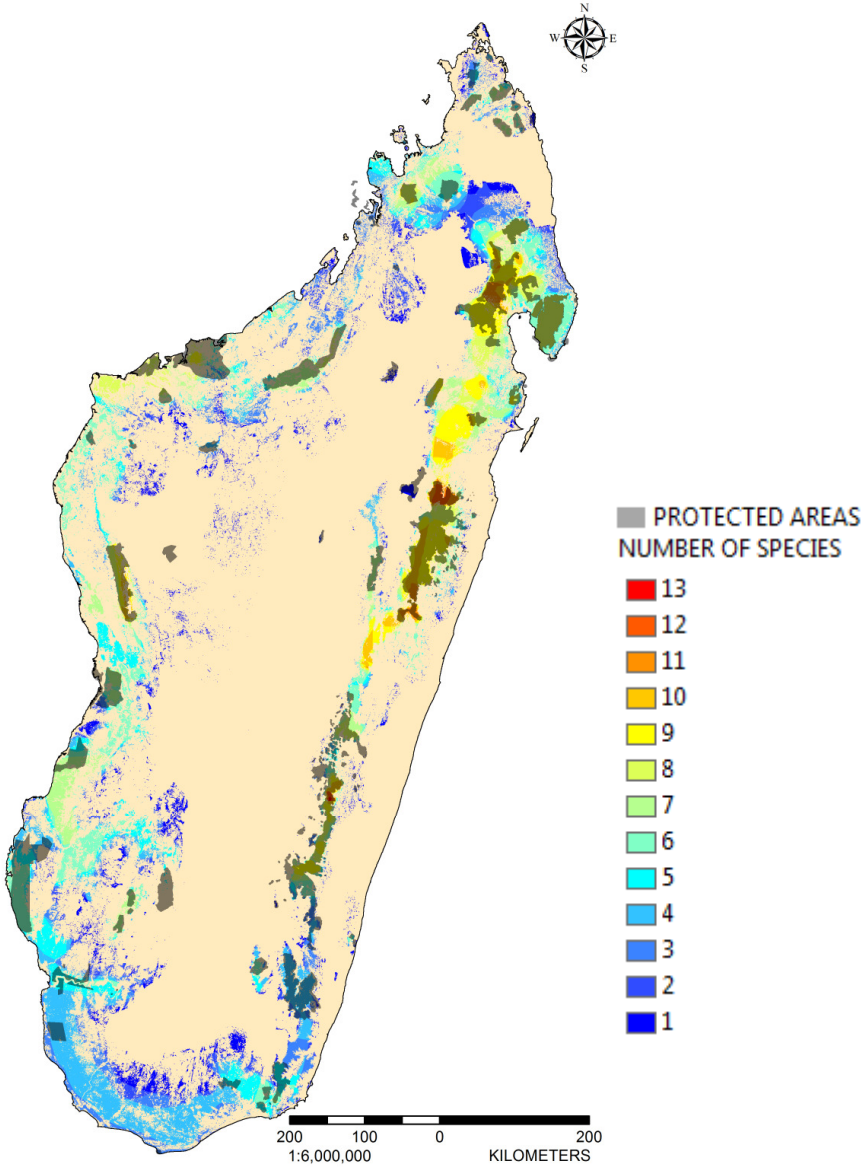
Lemur Ranges



Distribution of Lemur Diversity



Distribution of Lemur Diversity



Conservation Planning

- Algorithm systematically selects areas to be included in reserve network
- Maximizes species protection while minimizing area (cost)
- 2 scenarios:
  - Optimal network
    - Ignoring existing PAs
  - Where to expand current PA network

Conservation Targets

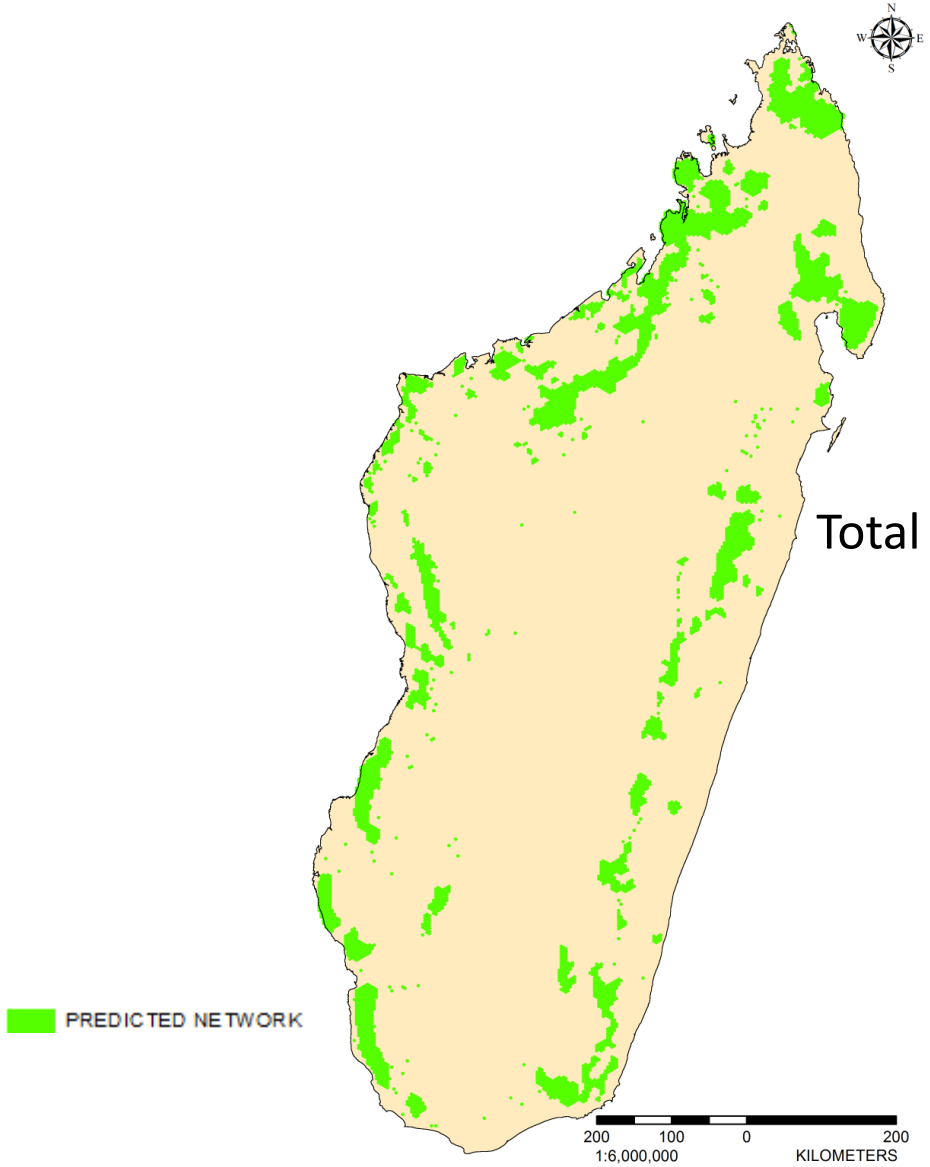
Targets by Area:

Range Size	Area (ha)	% Range to Include
Small	88 - 446	100%
Moderately Small	446 - 1,273	75%
Moderately Large	1,273 - 5,181	50%
Large	5,181 - 43,100	25%

Additional Targets by Status:

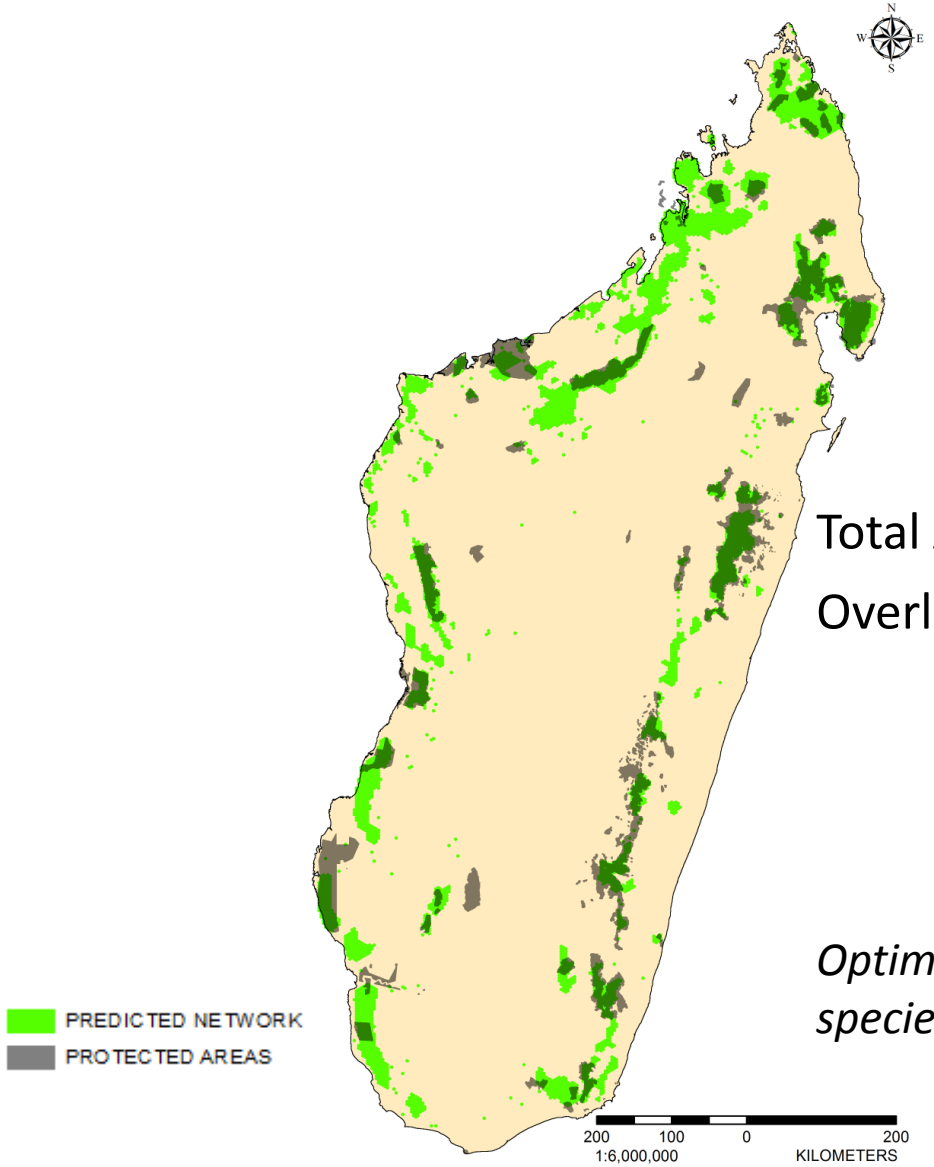
Status	Percent Range Added
Critically Endangered	+25%
Endangered	+20%
Vulnerable	+15%
Near Threatened	+10%
Least Concern	+0%
Data Deficient	+15%

Results: Optimal Network



Total Area = 66,280 km^2

Results: Optimal Network

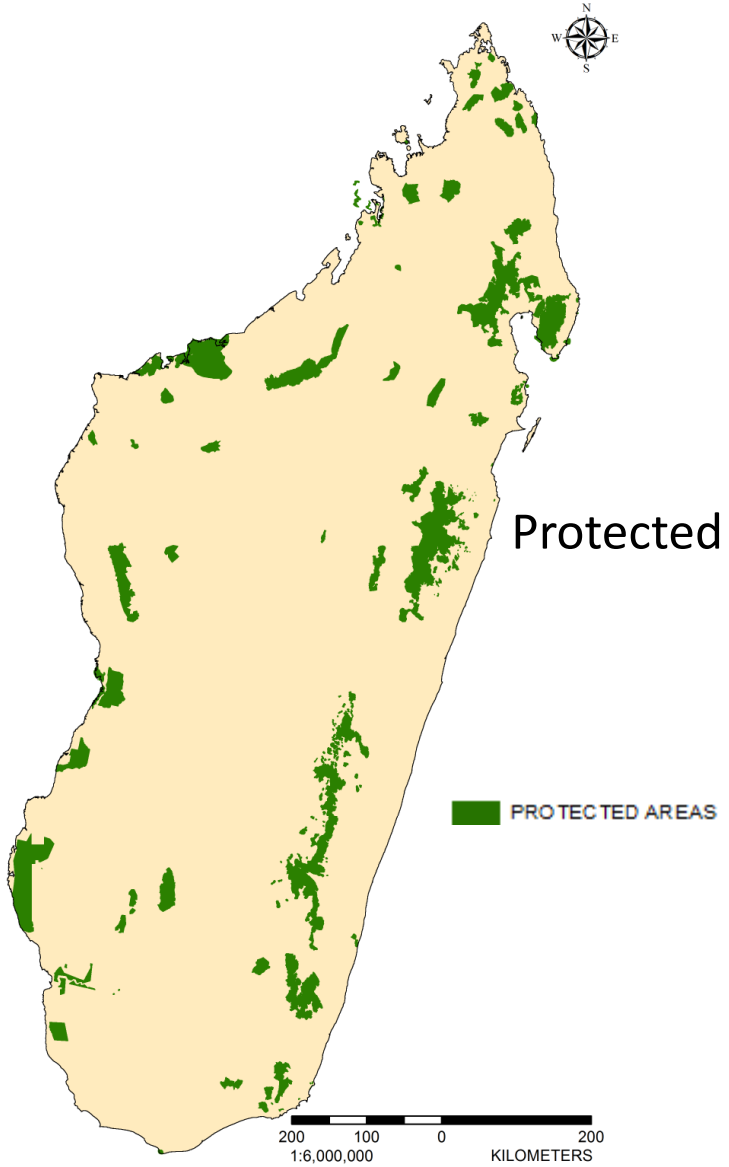


Total Area = 66,280 km^2

Overlap with PA network = 59.5%

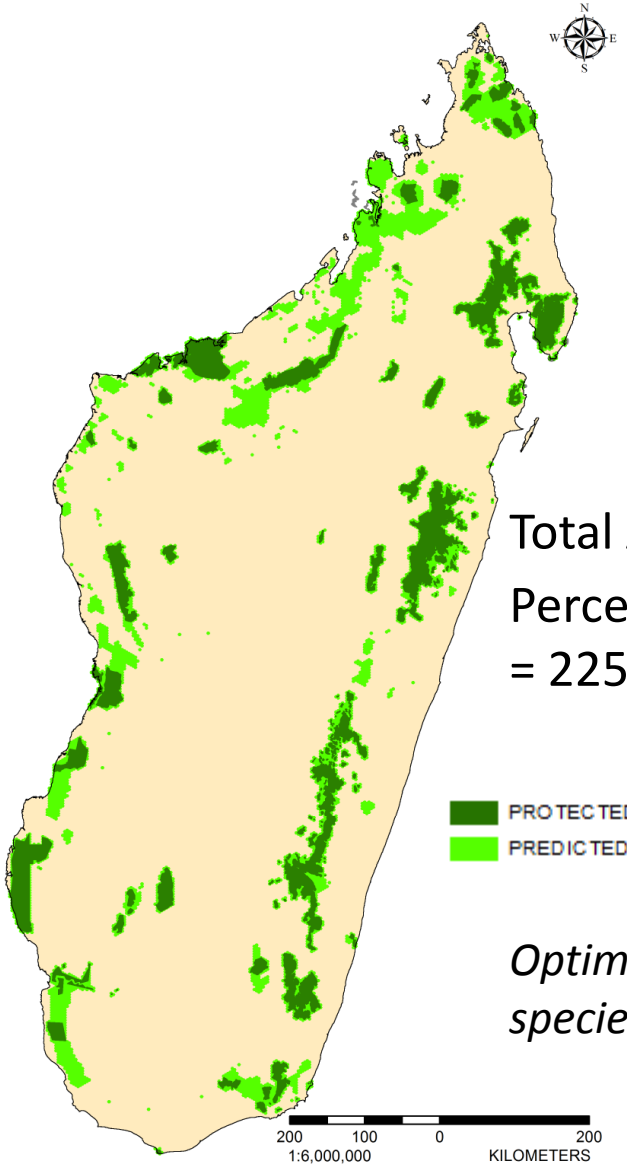
Optimal area requirements for 24 species not met by 9-20% of range

Results: Expansion Scenario



Protected Areas = 41,633 km^2

Results: Expansion Scenario

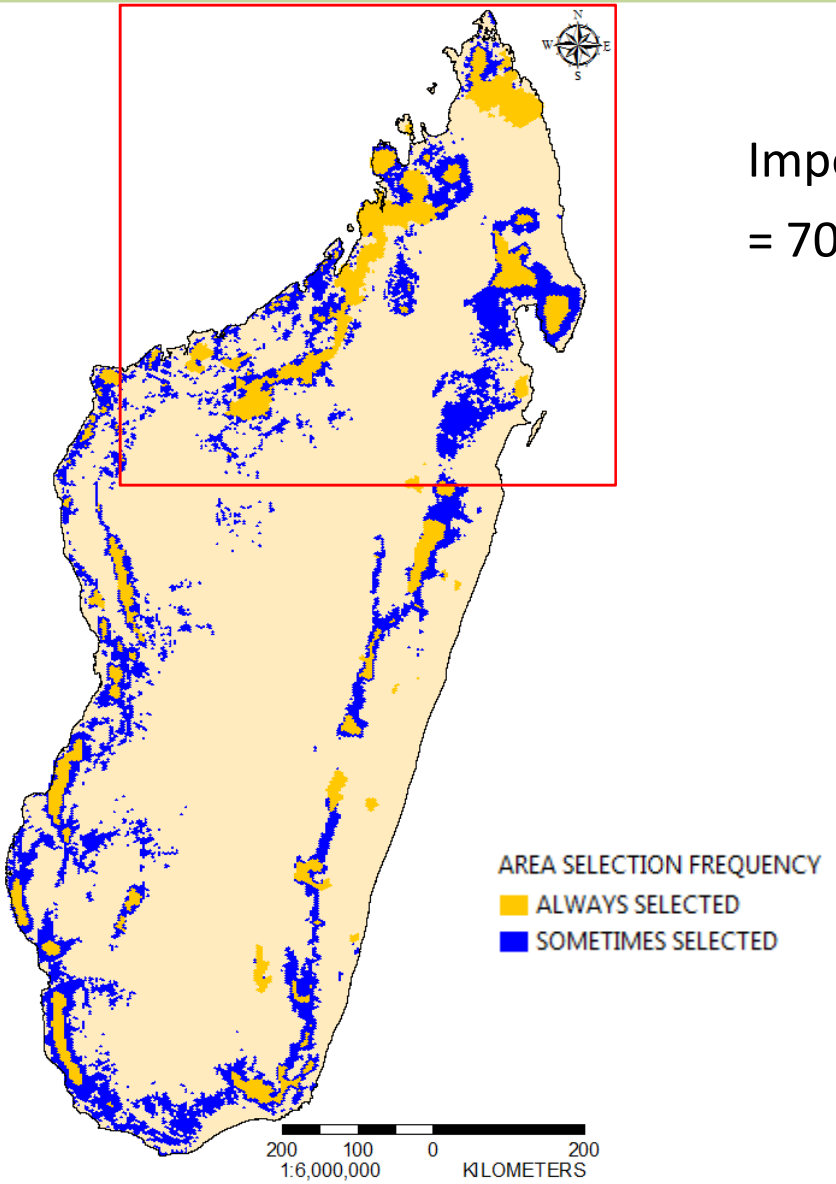


Total Area = 93,500 km^2

Percent greater than PA network = 225%

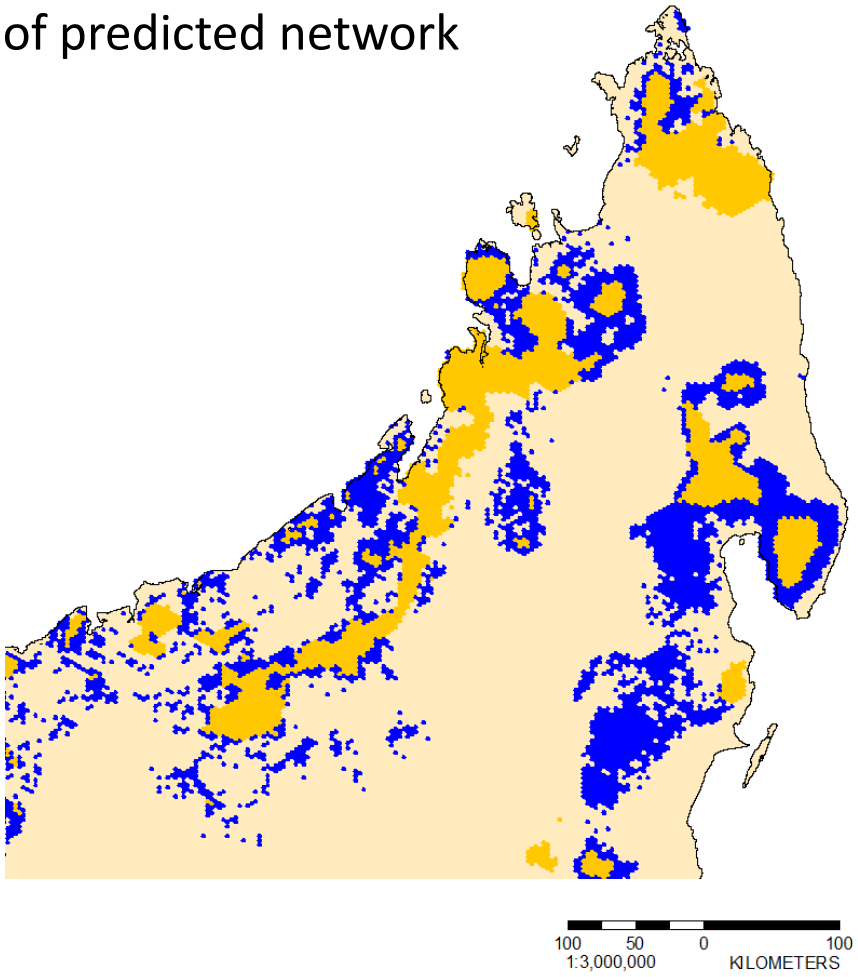
Optimal area requirements for 24 species not met by 9-20% of range

Important Area: Optimal Network

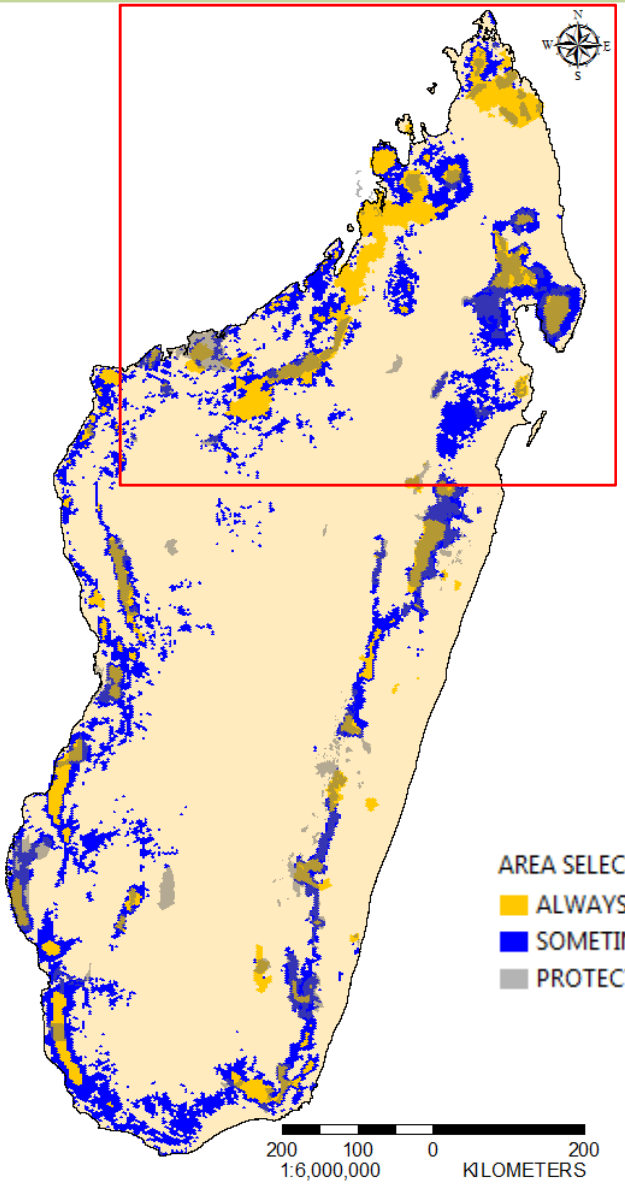


Important Area = 43,370 km^2

= 70% of predicted network



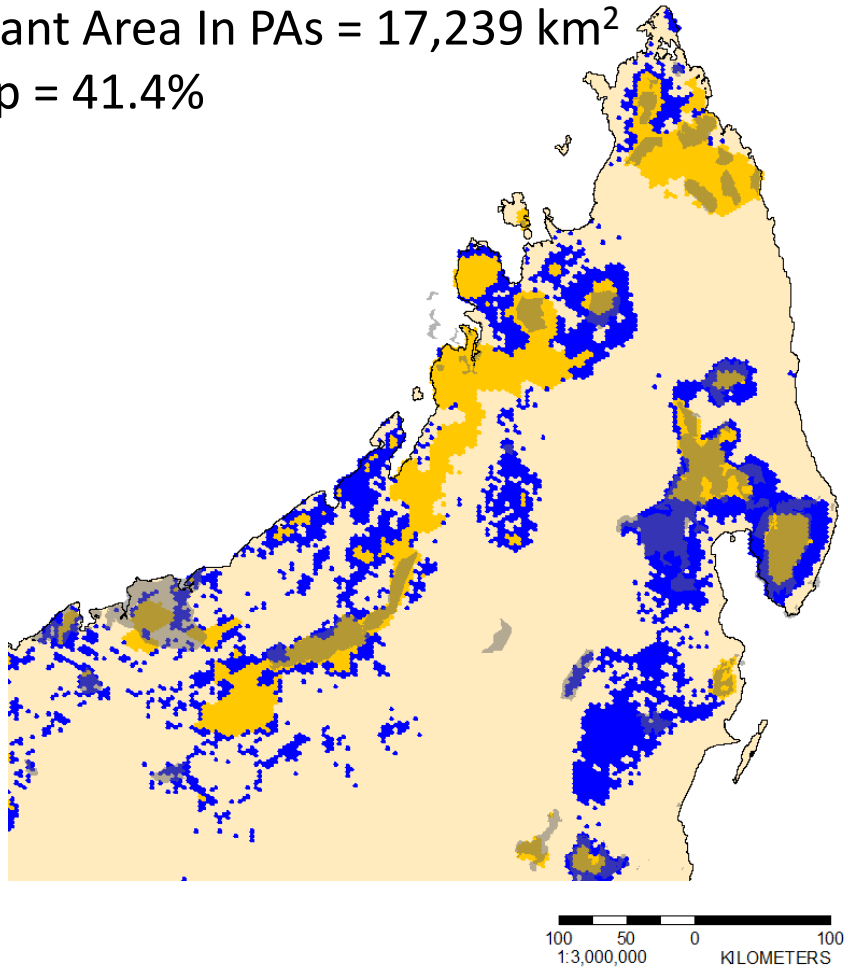
Important Area: Optimal Network



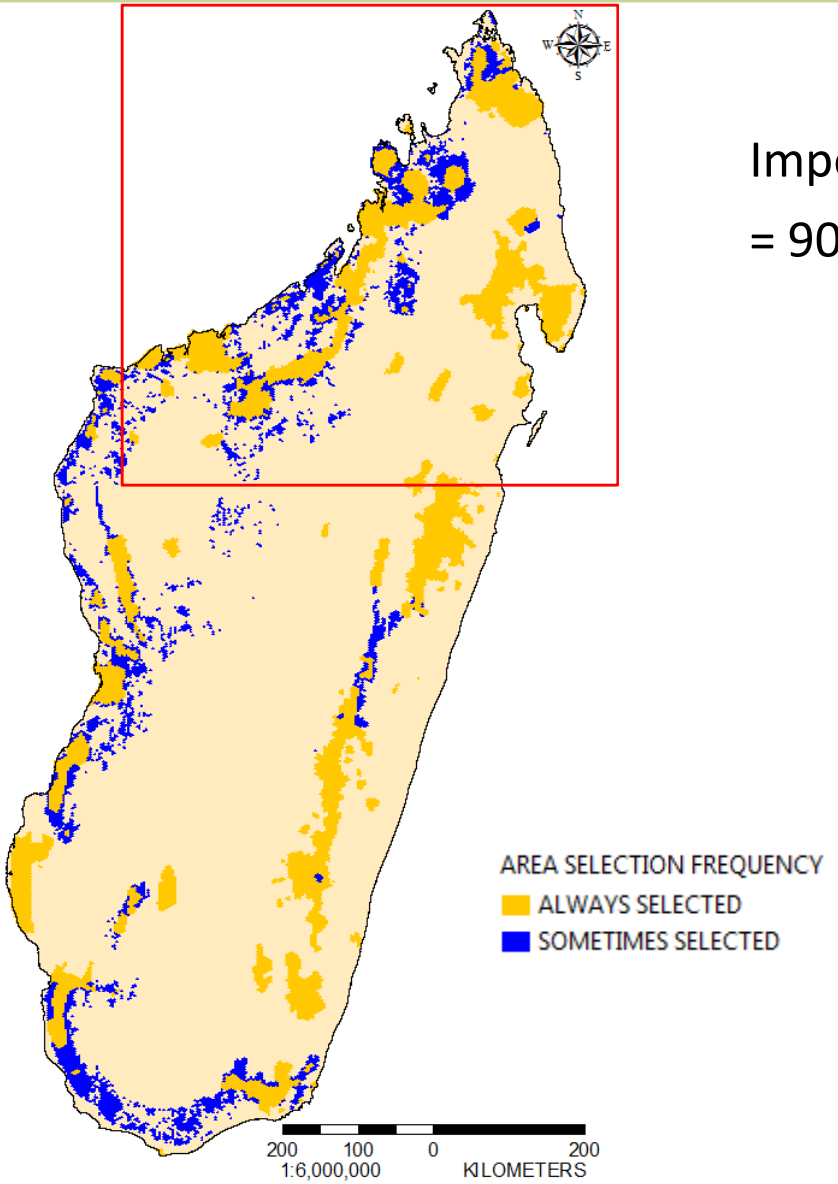
Important Area = 43,370 km^2

Important Area In PAs = 17,239 km^2

Overlap = 41.4%

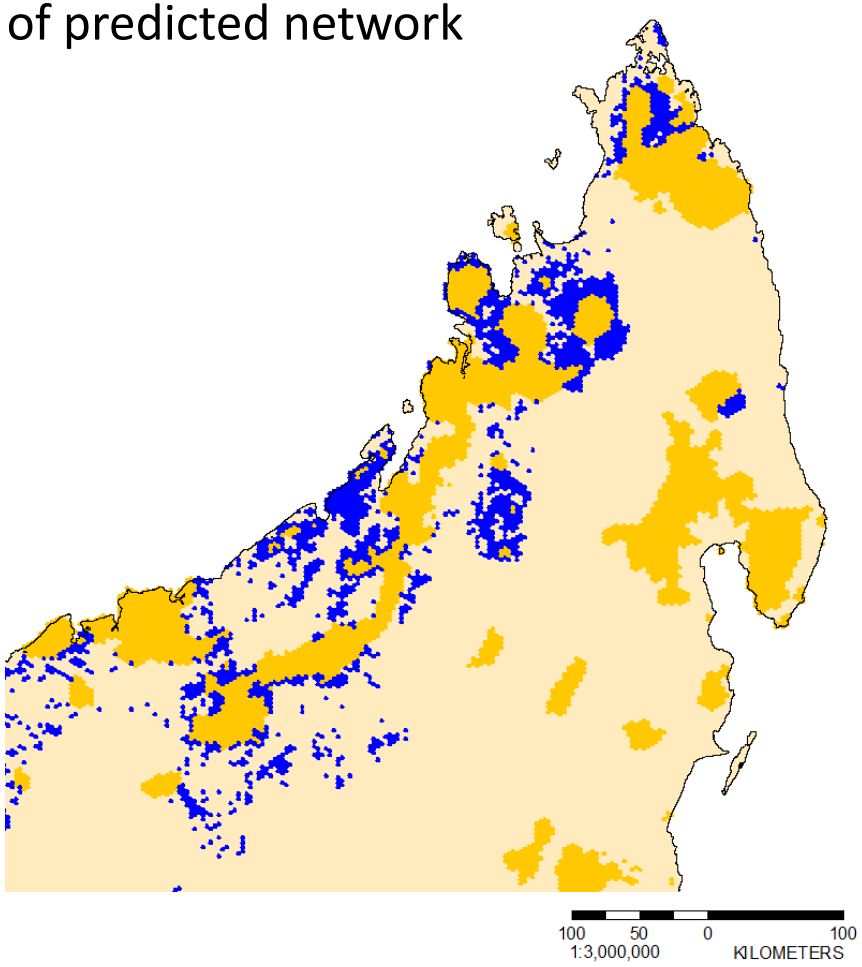


Important Area: Expansion Scenario

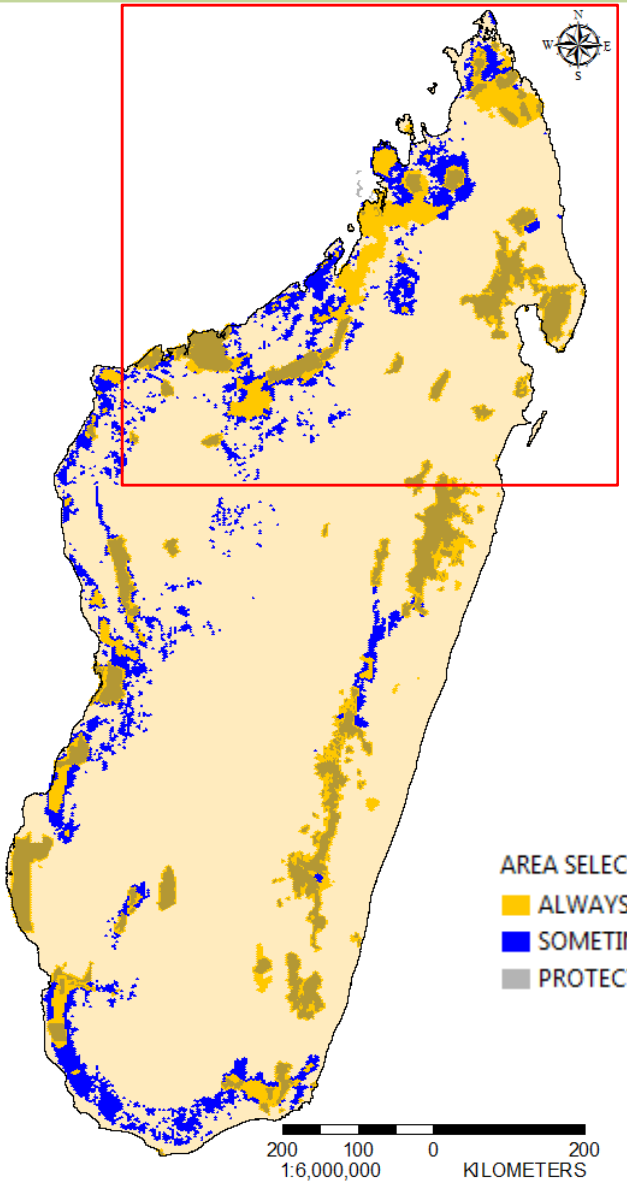


Important Area = 83,460 km^2

= 90% of predicted network



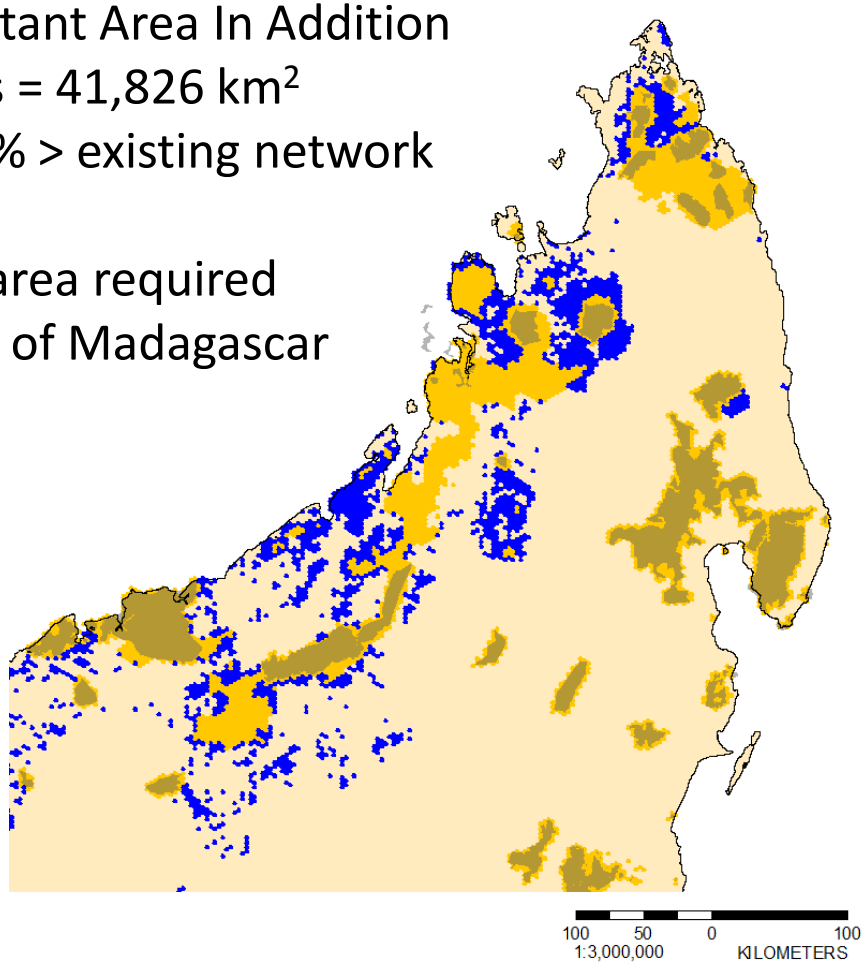
Important Area: Expansion Scenario



Important Area = 83,460 km^2

Important Area In Addition
To PAs = 41,826 km^2
= 100% > existing network

Total area required
= 15% of Madagascar



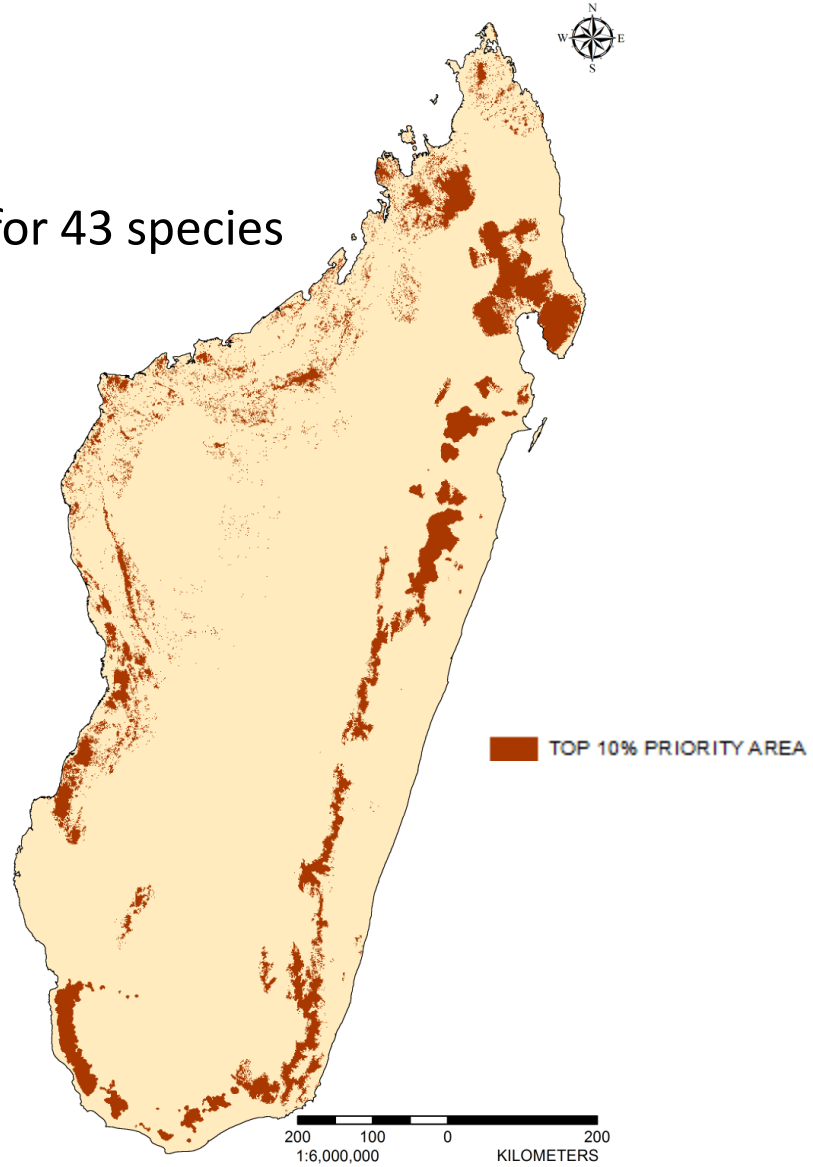
Prioritization

- Algorithm iteratively selects pixels to remove that contribute the least amount of loss
- Keep removing until there are no pixels left
- Looked at top 10% area
  - "Durban Vision"
    - political target

It it enough?

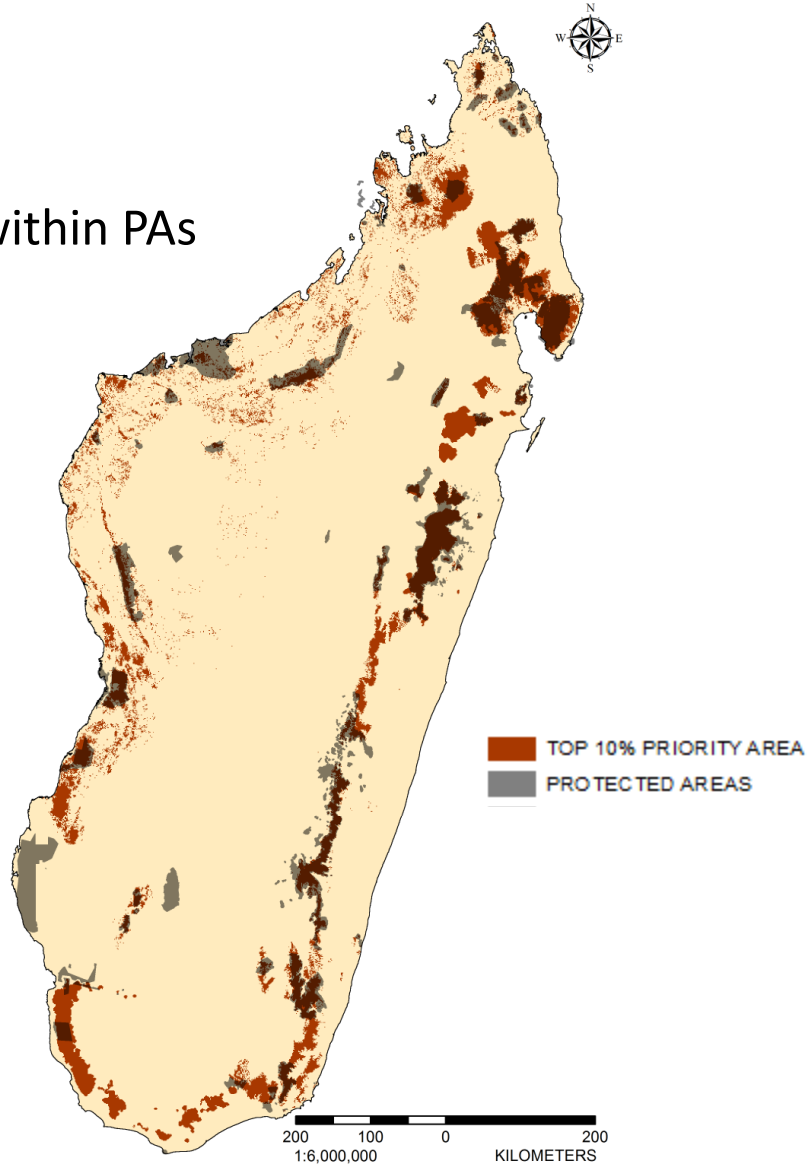
Results: Priority Areas (Top 10%)

Priority area meets targets for 43 species



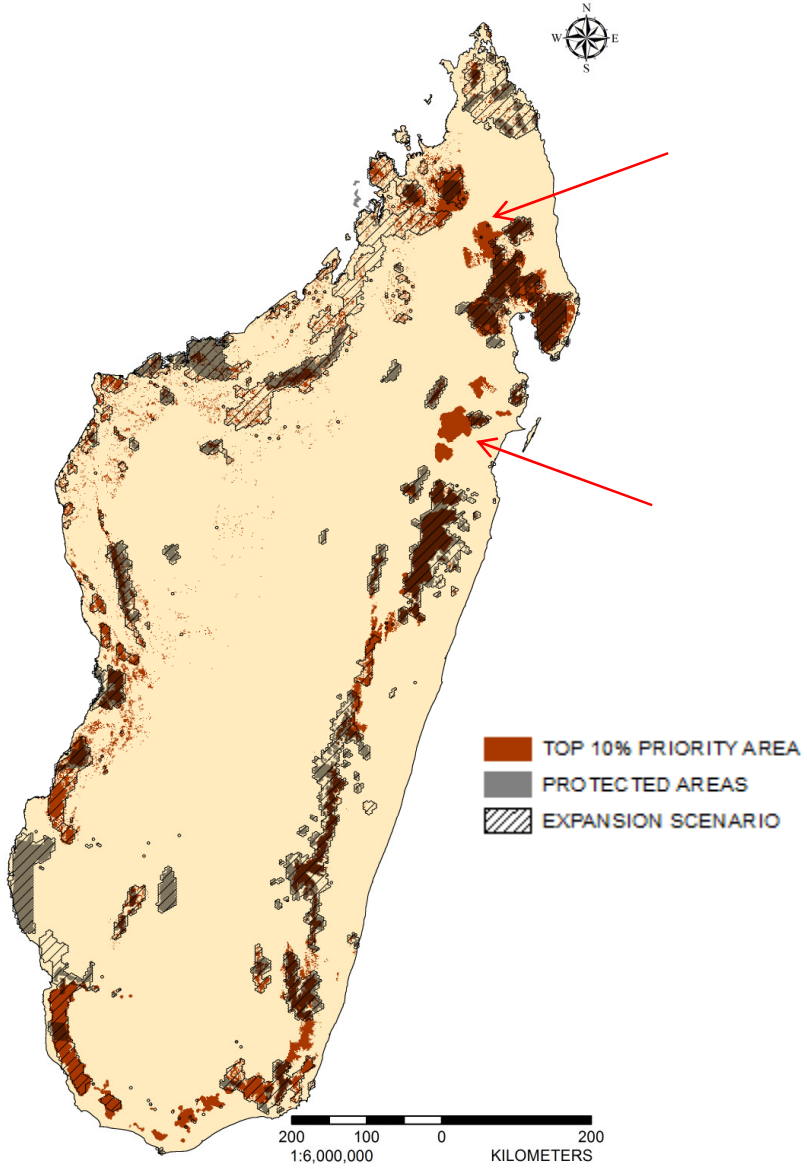
Results: Priority Areas (Top 10%)

Only 39% of Priority Areas within PAs



Results: Priority Areas (Top 10%)

70% of Priority Areas within Expansion Scenario



Key Findings

PA network meets conservation targets for:

- 30 / 98 species
  - ➢ 9 species not represented at all
  - ➢ 22 species only represented by 1 PA

Need to *double* the PA network to meet targets

- To cover ~15% of Madagascar

Top 10% priority area meets conservation targets for:

- 43 / 98 species

Key Findings

- Design PAs for species specific conservation
- Use both methods for comprehensive results
- Methods applicable to other areas of conservation concern:
  - Southeast Asia
  - Africa
  - South and Central America


Thank-you!