

The Effectiveness of Natural Protected Areas in Mexico to Prevent Deforestation and Forest Fragmentation

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Introduction

Forests are exceptionally important in Mexico. They cover one-third of the national territory and harbor nearly 10% of the world's biodiversity, making Mexico megadiverse.^{8,19} These forests provide a number of ecosystem services such as carbon sequestration, capturing water for major cities, air purification, nutrient cycling, as well as fuel and timber sources.^{1,2,20} Mexico is now obligated by recent agreements to protect these forests.

In accordance with the Paris Agreement, Mexico must reach a deforestation rate of 0% by 2030, increase ecological connectivity for all natural protected areas (NPAs), increase carbon storage, and the resilience of its most vulnerable ecosystems.¹⁸ According to the agreements made at the 13th Convention on Biological Diversity and the Aichi Biodiversity Targets, Mexico must declare 17% of its terrestrial land and inland water a NPA by 2020.²

Two assumptions have informed these conservation strategies. 1) The primary cause of forest loss and fragmentation has been due to anthropogenic disturbance; and 2) NPAs are the best way to mitigate this type of disturbance. This atlas looks at NPAs across Mexico and their relationship to deforestation, forest fragmentation, and socioeconomic context. It chronicles forest cover change from 2000 to 2010 to see how effective the primary conservation strategies have been.

Natural Protected Areas

The National Commission of Natural Protected Areas (CONANP) lists 174 NPAs covering 25,384,181 hectares and 12.92% of Mexico's national territory.

The establishment of NPAs has been Mexico's primary strategy in preserving ecosystems, biodiversity, forests, and carbon stocks.^{5,6,21}

However, national budgets allocate less than 1 USD per hectare to management, compared to an average of 28 USD in other North American and European countries. To make matters more complicated, more than 90% of NPAs are privately owned.¹

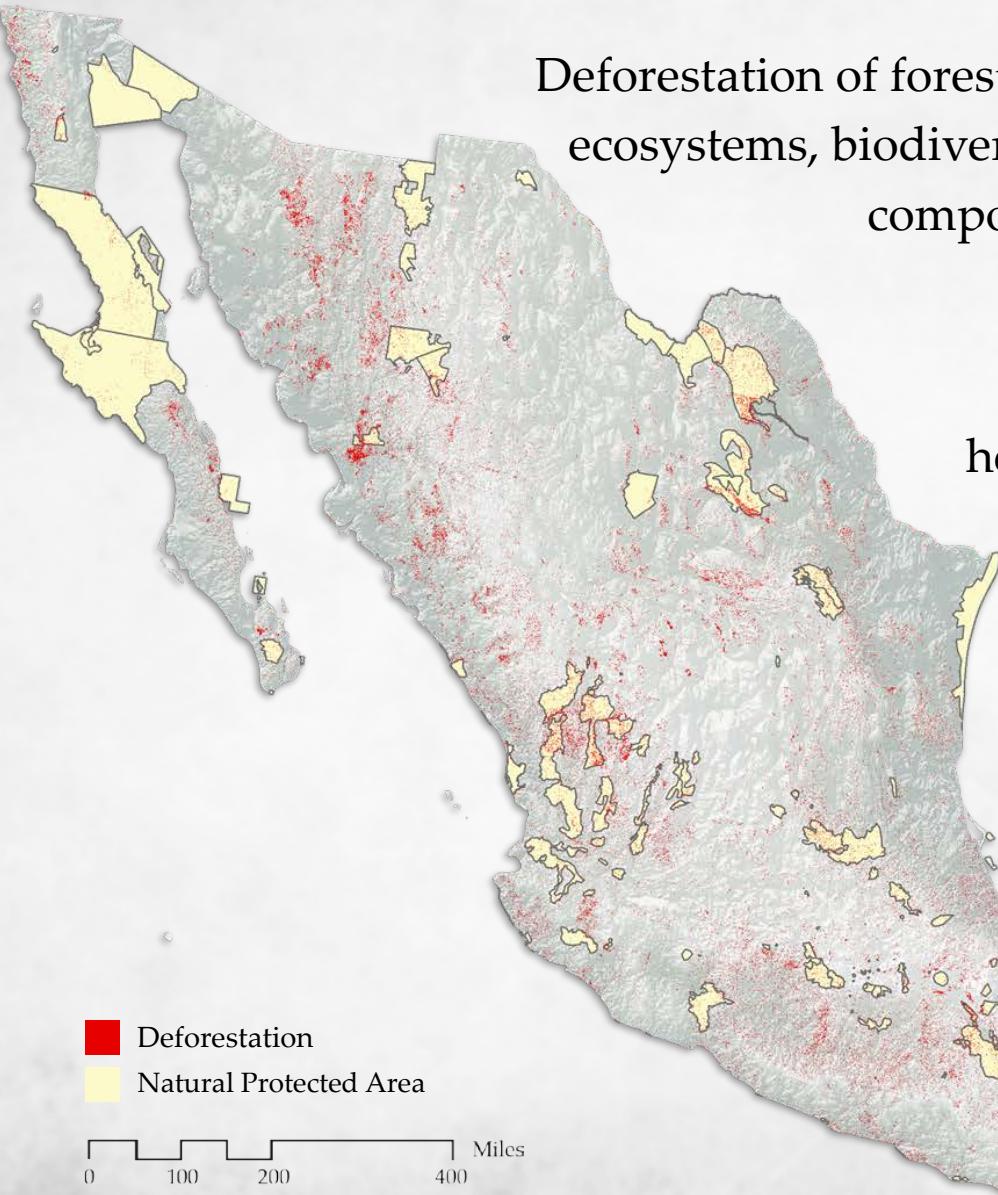


Deforestation

Deforestation of forests in Mexico has remained a concern for ecosystems, biodiversity, carbon sequestration, the chemical composition of soils, erosion, and flooding.^{1,20}

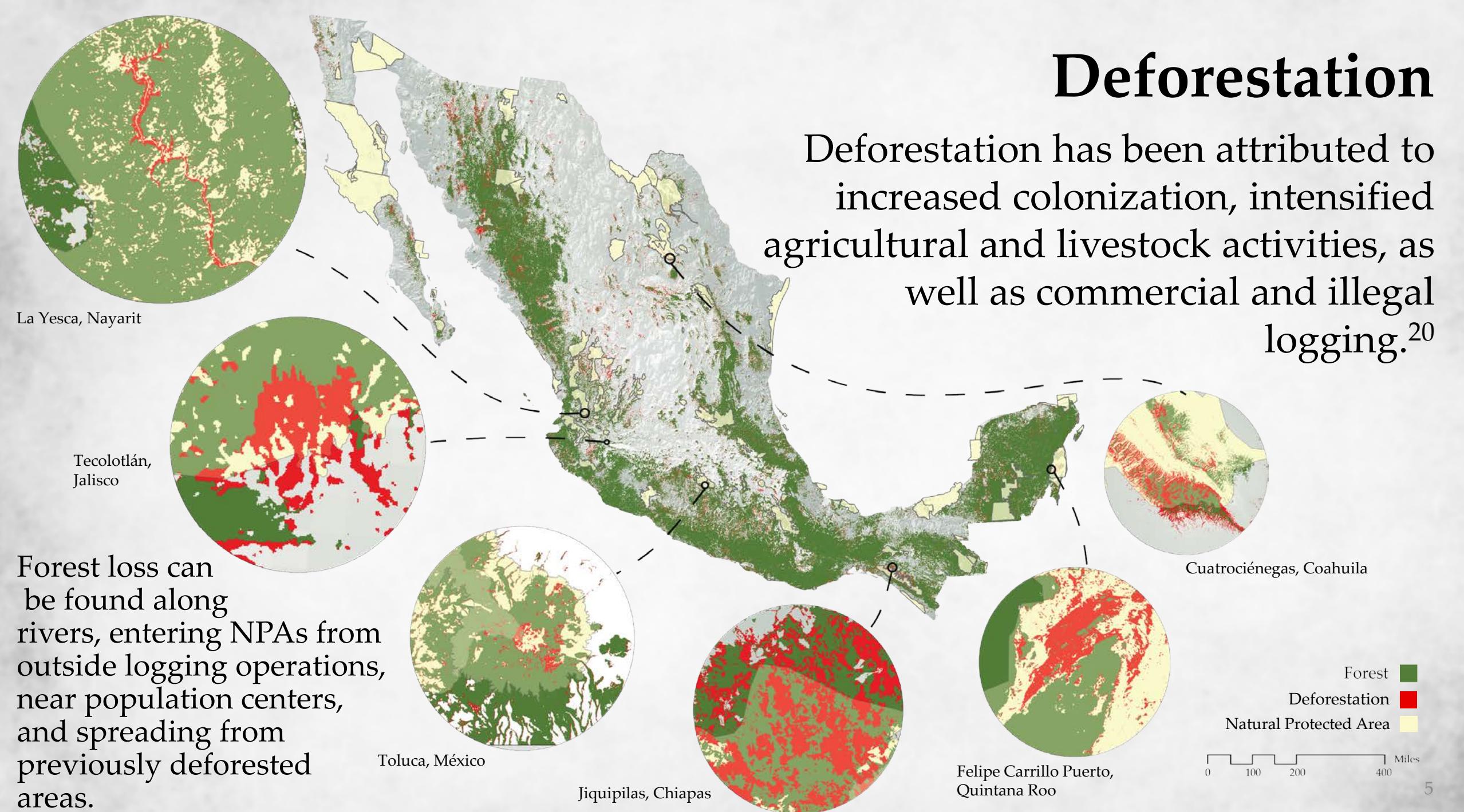
From 2000 to 2010 Mexico lost 334,878 hectares of forest, continuing the average forest loss of 0.5% per year since 1976.¹⁶

6,203,997 hectares were deforested and 5,869,118 hectares became forested.



Deforestation

Deforestation has been attributed to increased colonization, intensified agricultural and livestock activities, as well as commercial and illegal logging.²⁰

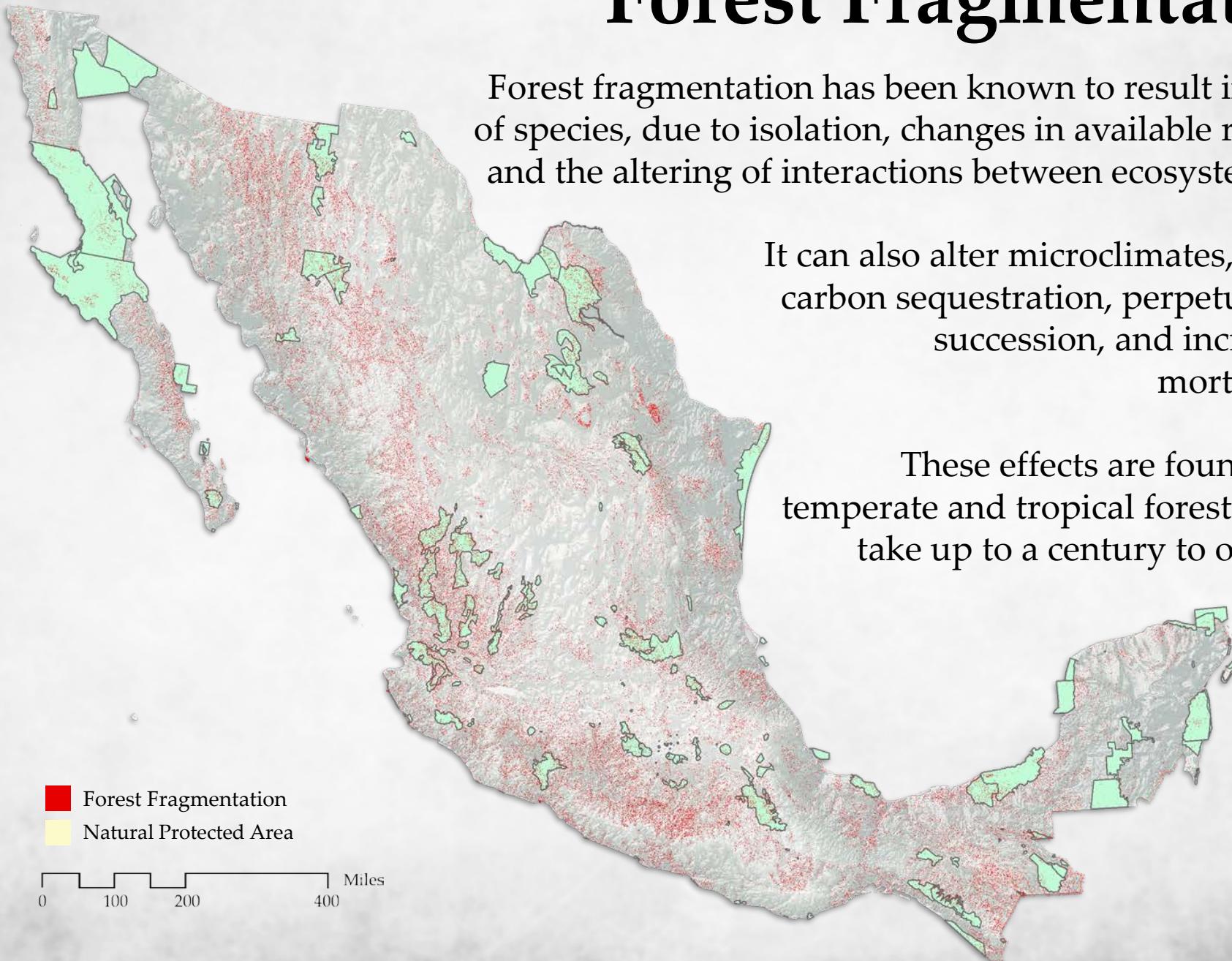


Forest Fragmentation

Forest fragmentation has been known to result in the loss of species, due to isolation, changes in available resources, and the altering of interactions between ecosystems.^{17,23,24}

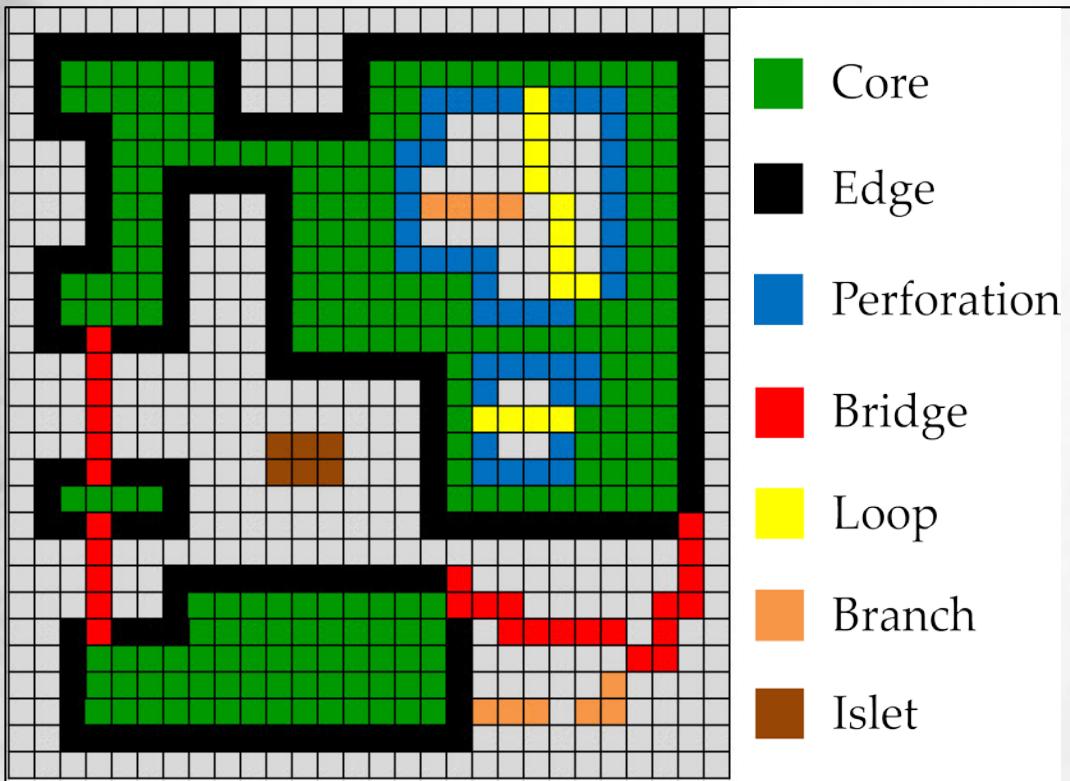
It can also alter microclimates, decrease carbon sequestration, perpetuate early succession, and increase tree mortality.^{9,13,22}

These effects are found in both temperate and tropical forests and can take up to a century to occur.^{3,23,24}



Forest Fragmentation

Forest fragmentation is the division of a forest into smaller, patchier, and/or more exposed forest units. There are generally 7 ways to classify forest relative to its exposure and vulnerability.



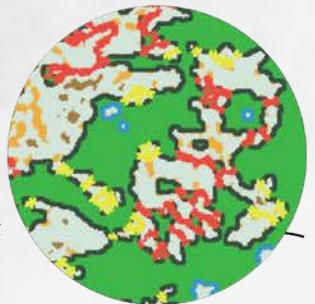
Fragmentation Class	Description
Core	Group of forest cells surrounded in all sides by other forest cells and at a distance from non-forest cells greater than the edge width.
Edge	Forest cells that form the buffer between forest and external non-forest areas.
Perforation	Forest cells that form the transition between forest and non-forest areas for interior regions of forest patches.
Bridge	Forest cells that connect two or more disjoint areas of Core forest.
Loop	Forest cells that connect an area of Core to itself.
Branch	Forest cells that extend from a Core forest area, but do not connect to another area of Core.
Islet	Compact group of forest cells that do not contain any Core cells. It is the only unconnected class.

Fragmented Area = bridge + loop + branch + islet
Non-Fragmented Area = core + edge + perforation.

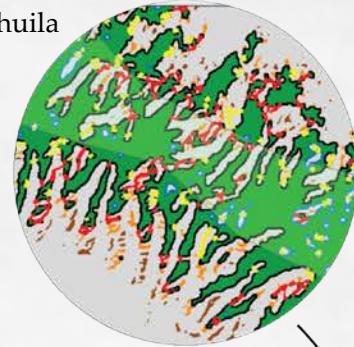


- Natural Protected Area
- Core
- Edge
- Perforation
- Bridge
- Loop
- Branch
- Islet

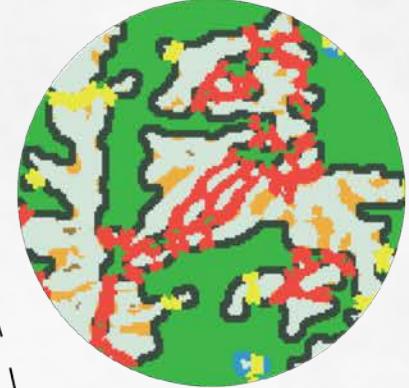
Múzquiz, Coahuila



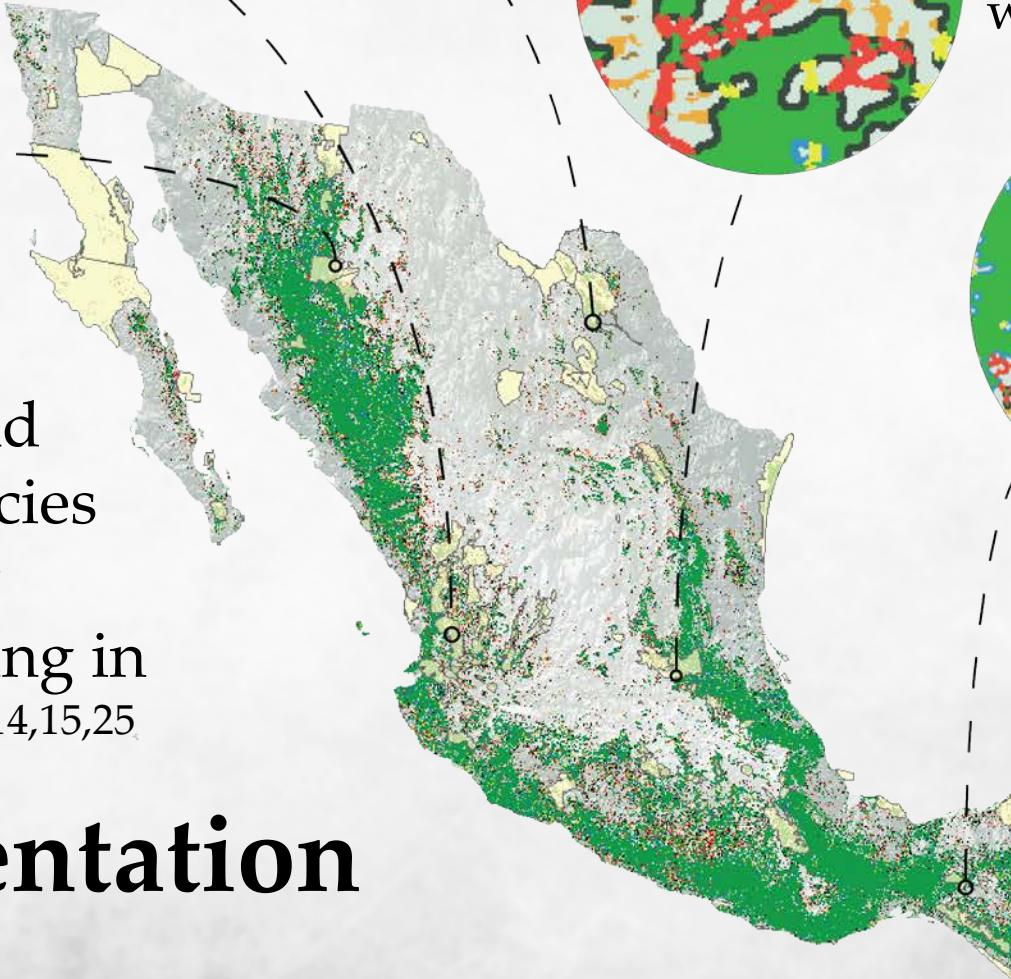
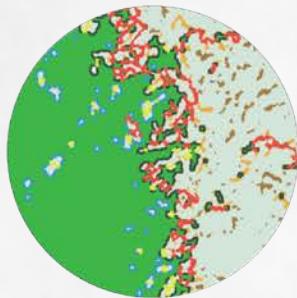
Del Nayar, Nayarit



Pinal de Amoles,
Querétaro



Temósachi,
Chihuahua

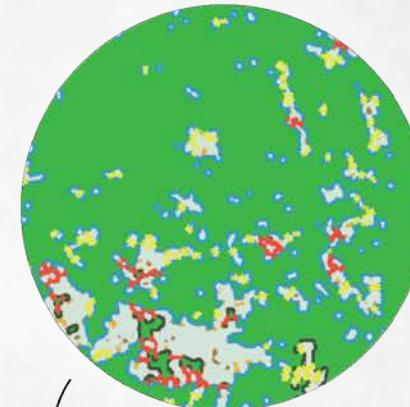


Forest fragmentation breaks apart habitats and causes edge effects. Species become exposed to new ecosystems often resulting in increased vulnerability.^{14,15,25}

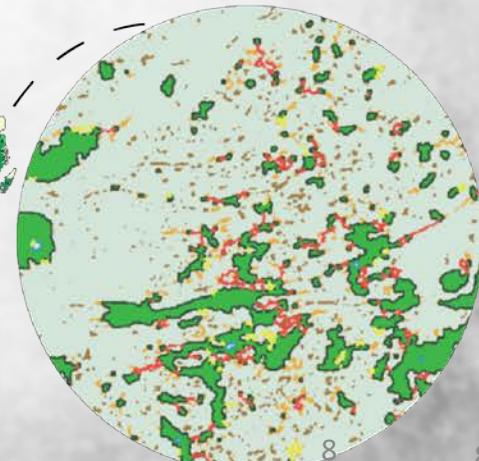
Forest Fragmentation

Many variations of fragmentation can be seen across Mexico. The remanence of a deforested area becoming islet, broken forest bridges attempt to hold on to wild life corridors, and perforated holes show where internal fragmentation is beginning.

Ocozocoautla de
Espinosa, Chiapas



Felipe Carrillo
Puerto, Quintana
Roo



Socioeconomics

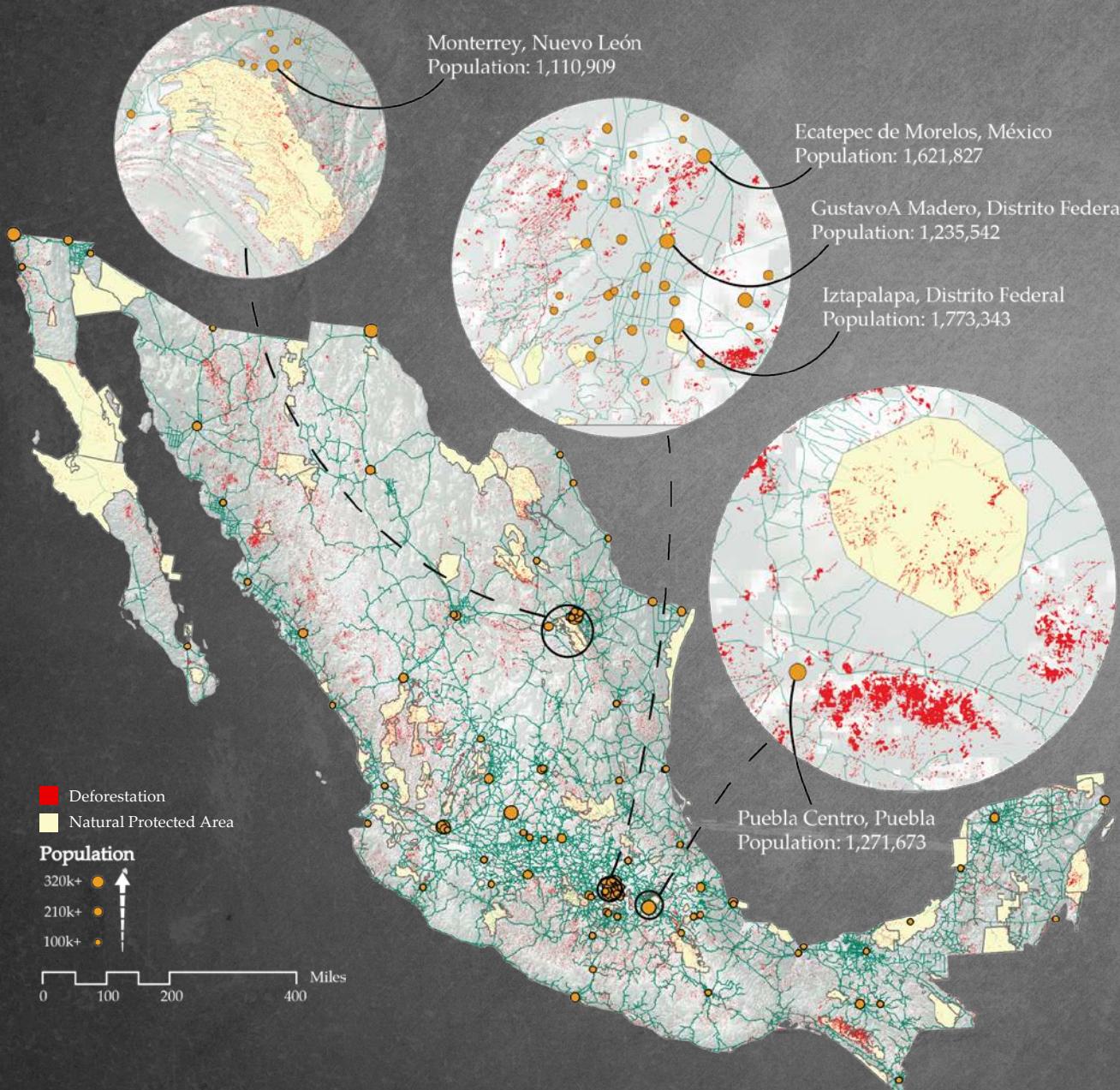
Between 1993 and 2002, 87% of land cover change in biosphere reserves were linked to socioeconomic conditions.⁵

During this time, 54% of NPA were proven effective in reducing the loss of natural vegetation compared to their surrounding areas.⁵

Since, no new studies have evaluated NPAs, yet they continue to be the primary conservation strategy. This section reviews the largest and poorest cities with respect to deforestation and forest fragmentation.



Socioeconomics



Deforestation

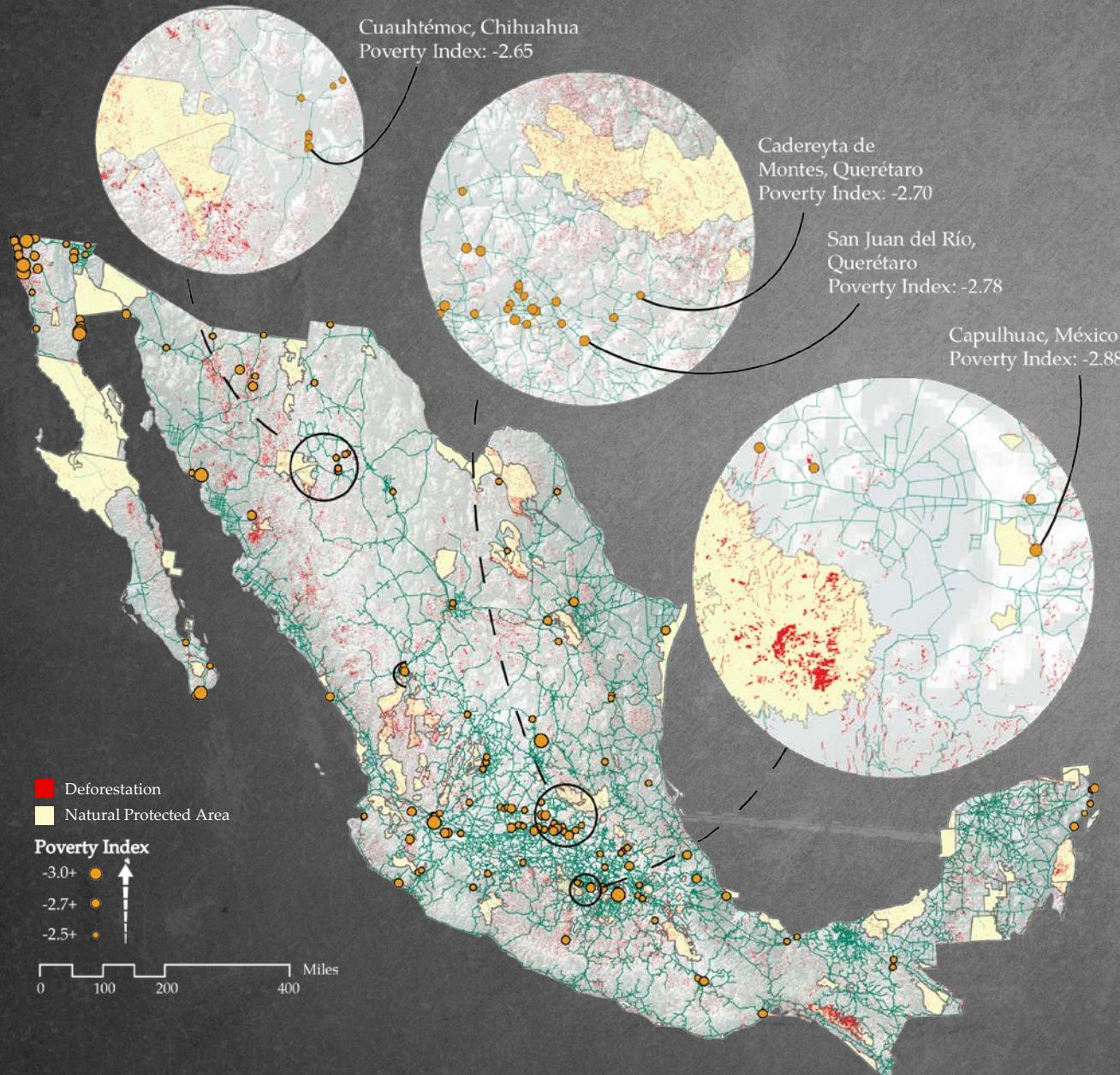
Population over 100k

The left inset shows deforestation occurring more in the NPA than outside. Although its patterns are mildly striated and not concentrated anywhere.

The center inset shows deforestation around the outskirts. It is occurring near cities with large populations, but NPAs are mostly excluded from the majority of deforestation.

The right inset shows a considerable cluster of deforestation near a city with a very high population. It trails from the East side of the city, but the NPA nearby remains relatively unscathed.

Socioeconomics



Deforestation

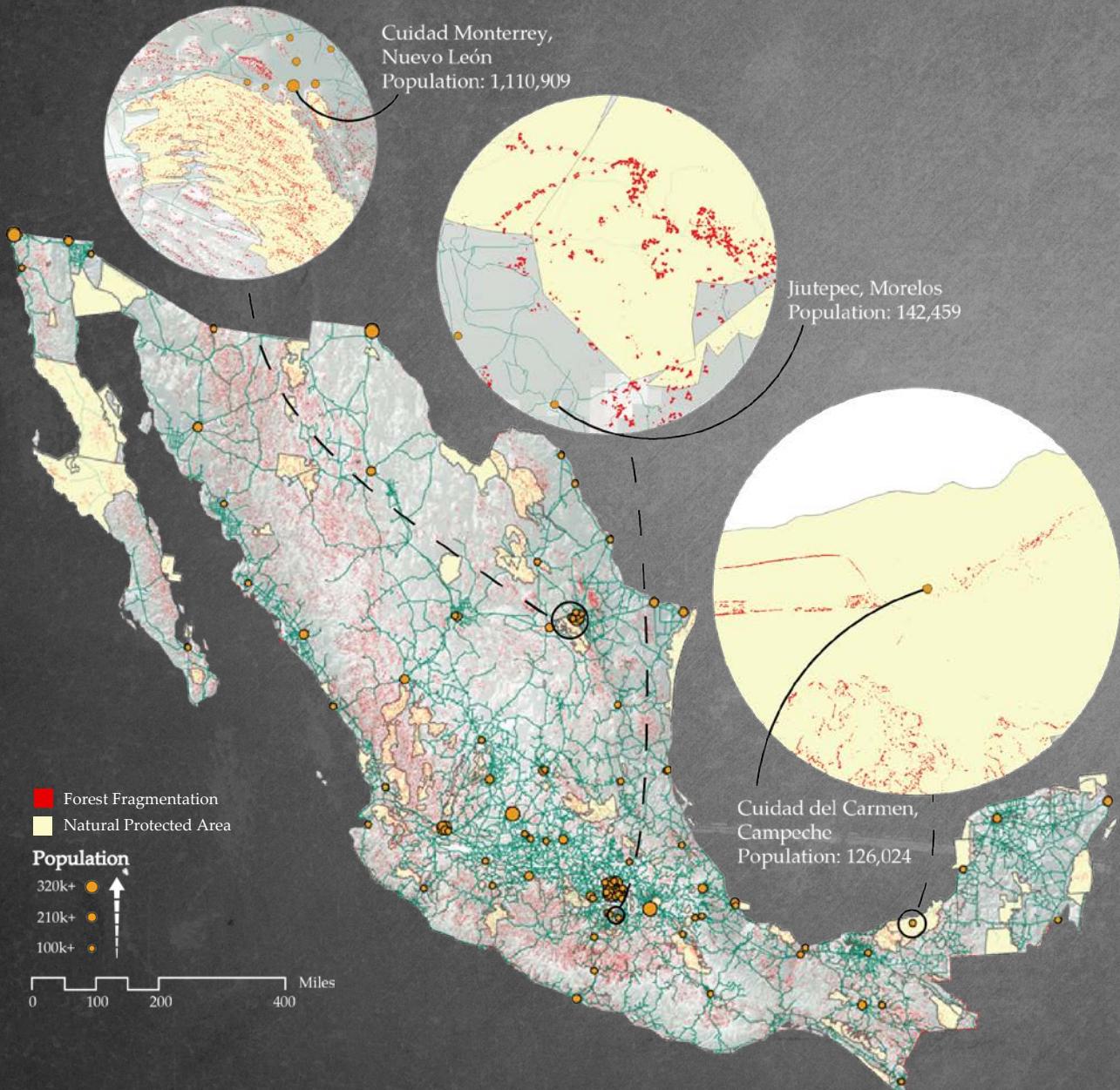
Poorest 200 cities

Deforestation rates are found higher inside NPAs than outside when near high densities of people. Exceptions can be seen in the Northwest and occasionally throughout Mexico.

The center inset shows deforestation peppered throughout the NPA. No clear clustering around roads or any particular area.

The right inset shows deforestation strongly focused in the center of a large NPA. Although the NPA directly west of the largest city shown appears to have experienced relatively no deforestation.

Socioeconomics



Forest Fragmentation

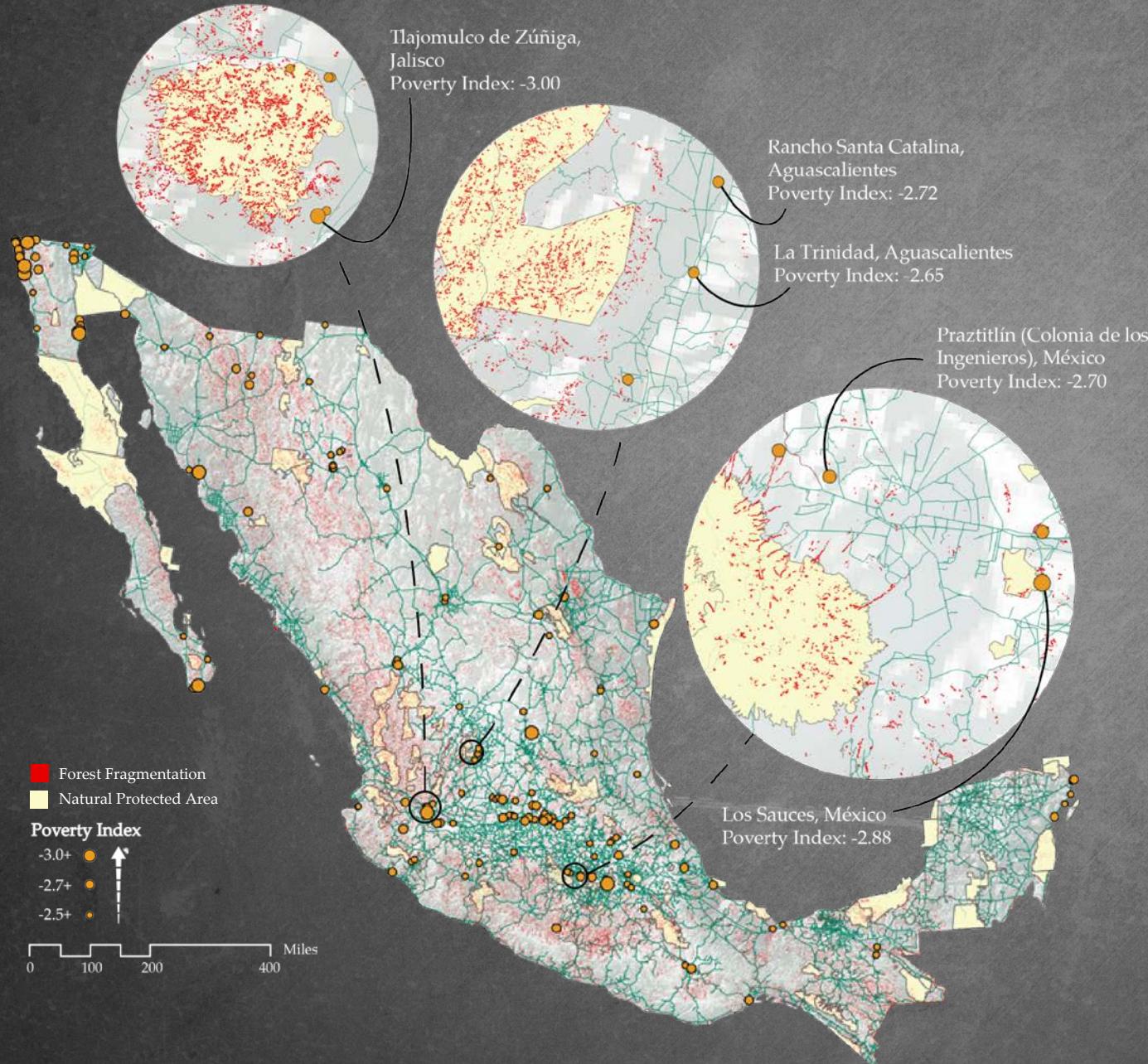
Population over 100k

In the left inset, forest fragmentation appears to radiate from the large population centers and dominate the nearby NPA. The fragmentation dissipates in the NPA further away from the cities.

The center inset shows forest fragmentation following roads through a NPA. The surrounding cities have access to these fragmented areas alluding to anthropogenic disturbance.

The right inset captures a city that exists within the NPA. No paved roads go to this location, but a distinct line of forest fragmentation can be seen drawn from the East and West of the city.

Socioeconomics



Forest Fragmentation

Poorest 200 cities

Forest fragmentation is shown to be prevalent near cities experiencing poverty. The NPAs consistently contain more forest fragmentation than their surrounding areas.

The left inset has a uniformity of fragmentation within its boundaries, whereas outside it becomes more sparse.

The center inset shows forest fragmentation almost exclusively within the borders of the NPA.

It would be hasty to draw conclusions about the right inset, but forest fragmentation can be seen within its boundaries.

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