Forest species and carbon changes in the West African Sahel, 1954-2002, using aerial photographs and IKONOS

Patrick Gonzalez (The Nature Conservancy)
Hamady Sy (Université de Nouakchott)
Compton J. Tucker (NASA)

High Spatial Resolution Commercial Imagery Workshop, U.S. Geological Survey
May 21, 2003

Image NASA

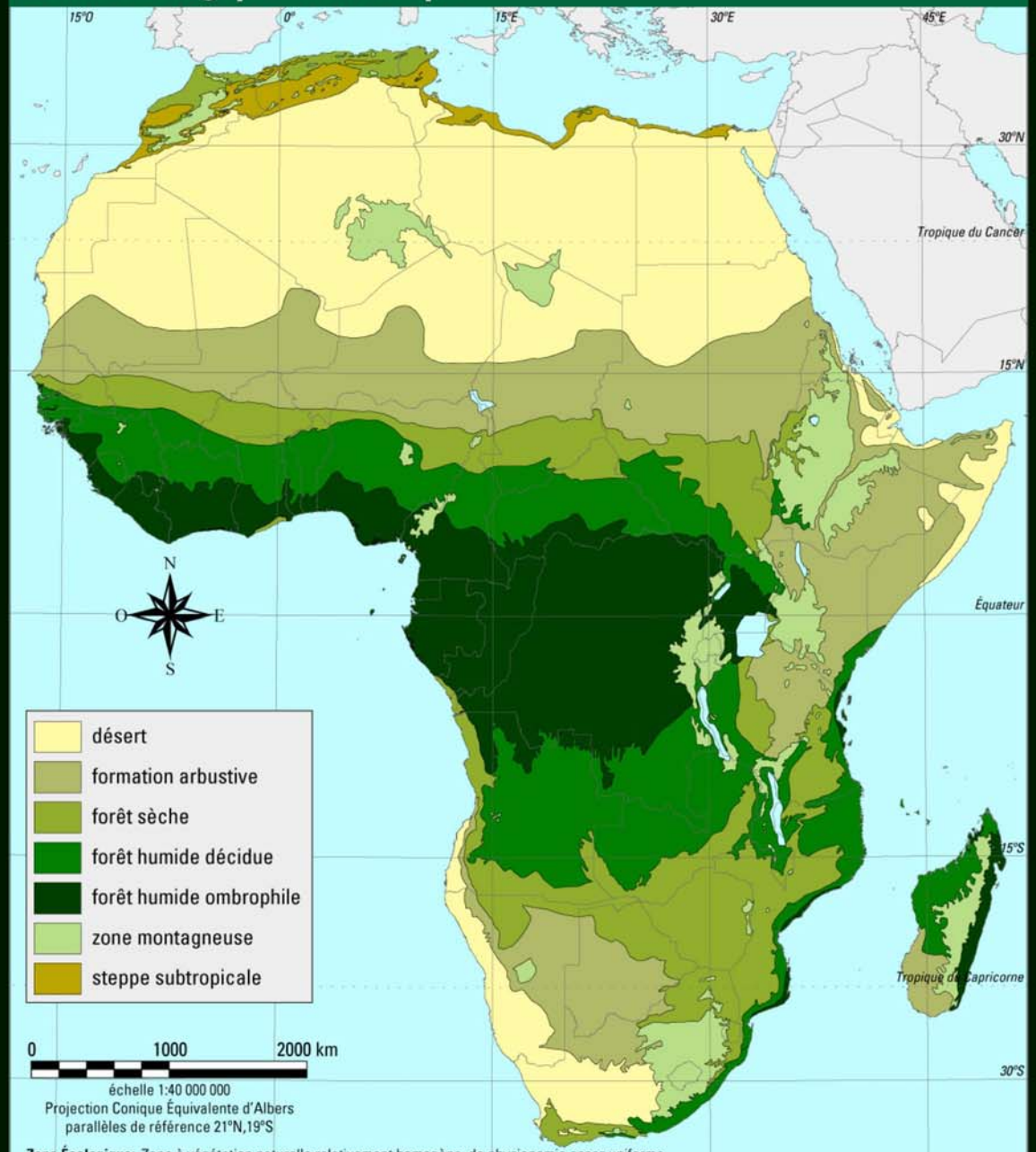
The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

Forest species and carbon changes in the West African Sahel, 1954-2002, using aerial photographs and IKONOS

Research in progress:

- Document impacts of climate change and desertification
- Compare density of trees of height > 3 m to 1954 and 1989 aerial photos
- Compare 1954, 1989, and 2002 vegetation carbon per ha
- Compare ca. 1960 and 2000 forest species richness
- Ground-truth objects on IKONOS images with inventory of actual trees and shrubs in 12 one-hectare quadrats
- Determine size and species profile of IKONOS objects

Zones Écologiques de l'Afrique



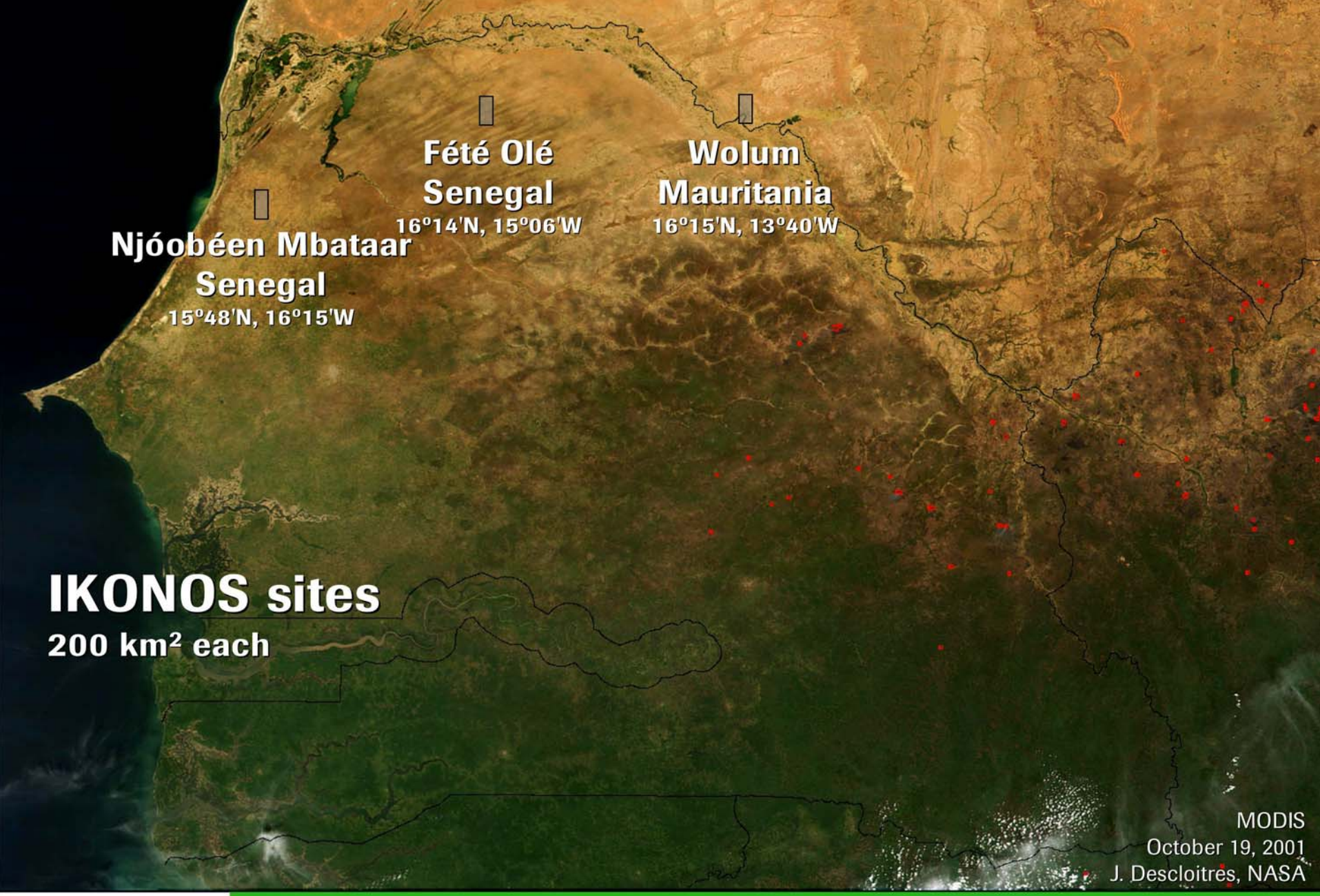
Zone Écologique: Zone à végétation naturelle relativement homogène, de physionomie assez uniforme.

Données: Köppen, W. 1931. Grundriss der klimakunde. Walter de Gruyter, Berlin, Germany.
White, F. 1983. The vegetation of Africa. United Nations Educational, Scientific, and Cultural Organization (UNESCO), Paris, France.

Analyses: Bailey, R.G. 1998. Ecoregions: The ecosystem geography of the oceans and continents. Springer-Verlag, New York, NY.
Food and Agriculture Organization (FAO). 2001. Global forest resources assessment 2000. FAO, Rome, Italy.

Carte: U.S. Geological Survey (USGS), Earth Resources Observation Systems (EROS) Data Center, 2002.

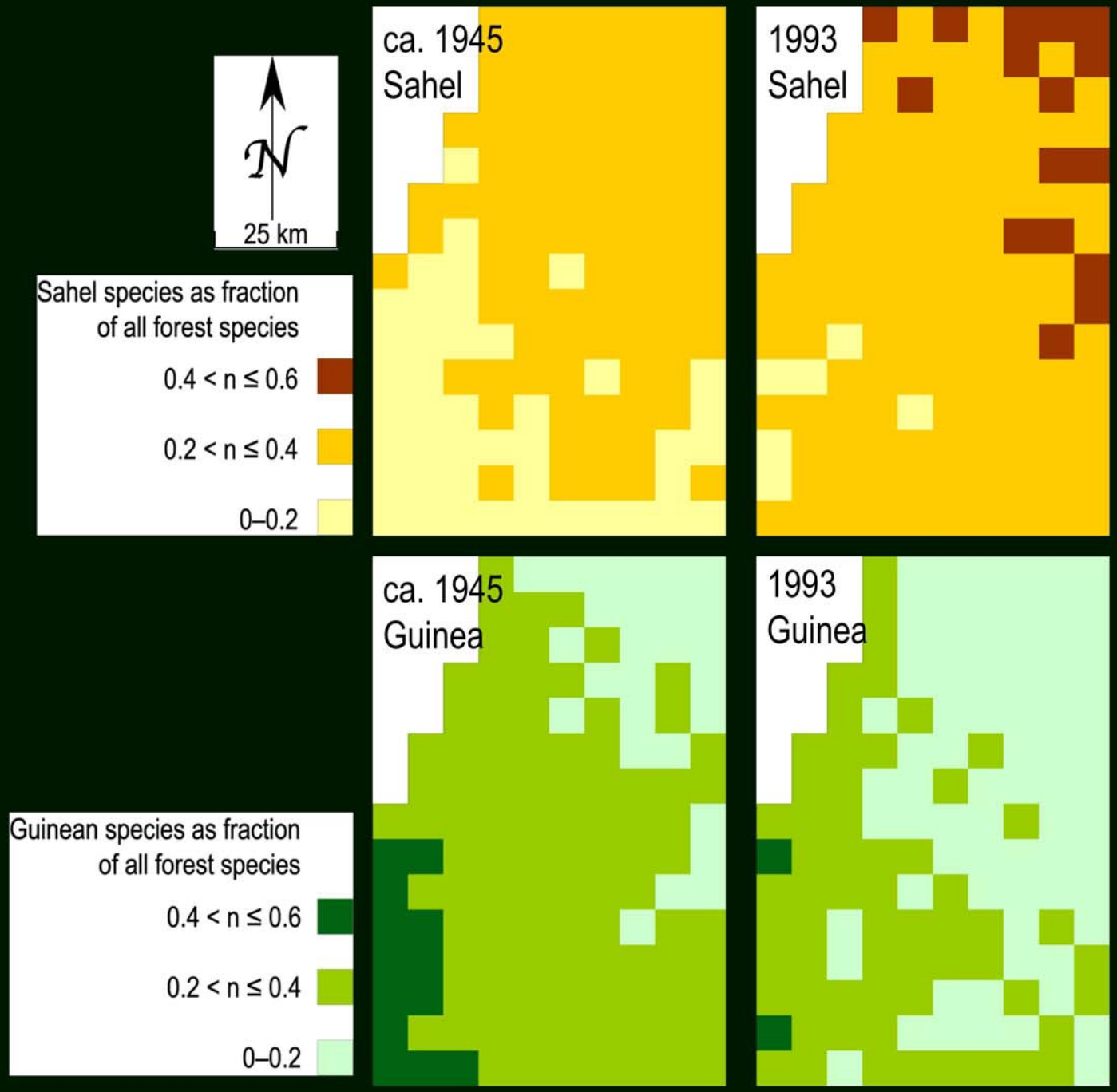
The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

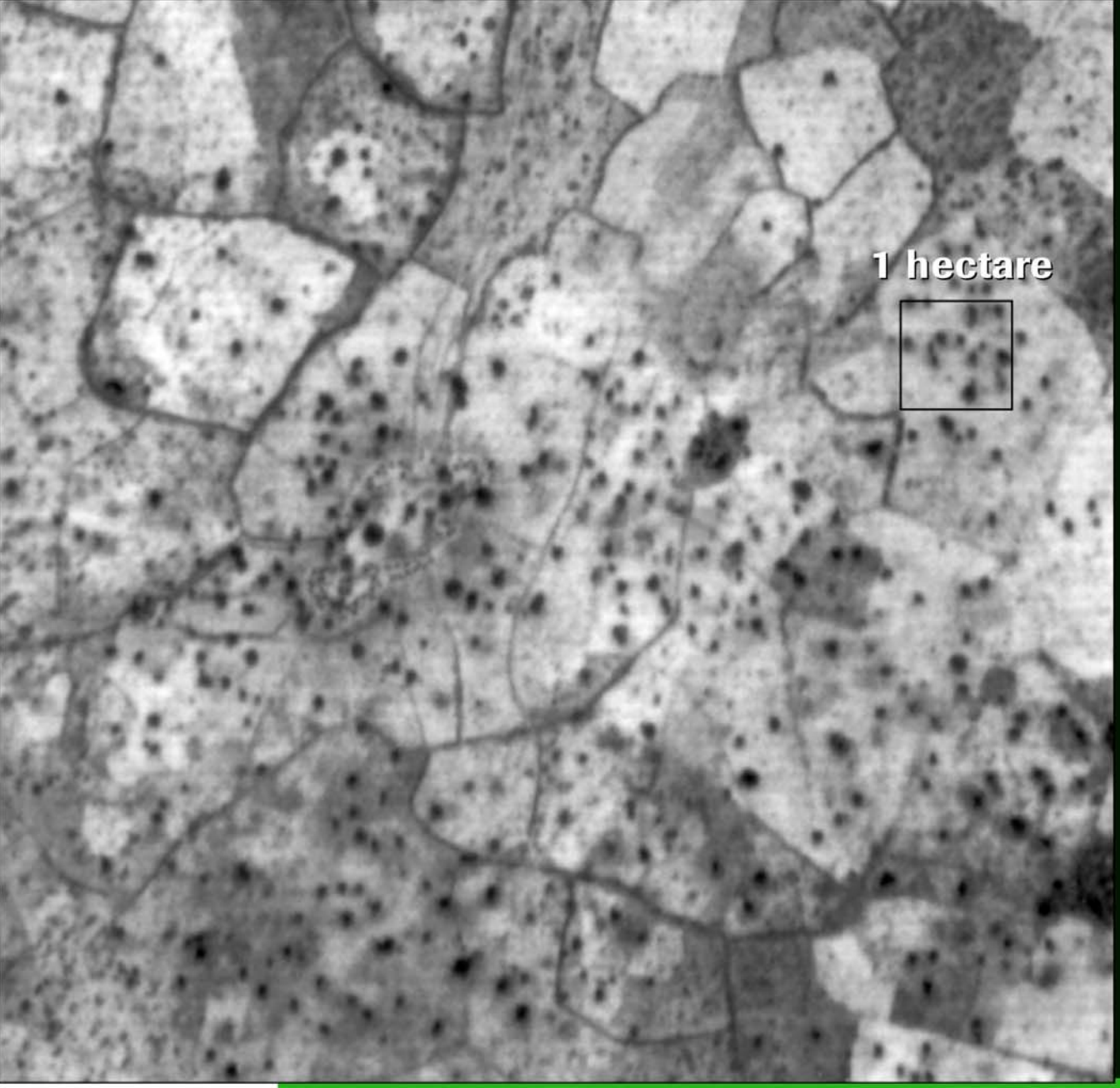


The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

Forest species changes ca.1945–1993 and tree density changes 1954-1989 in Northwest Senegal (Gonzalez 2001)

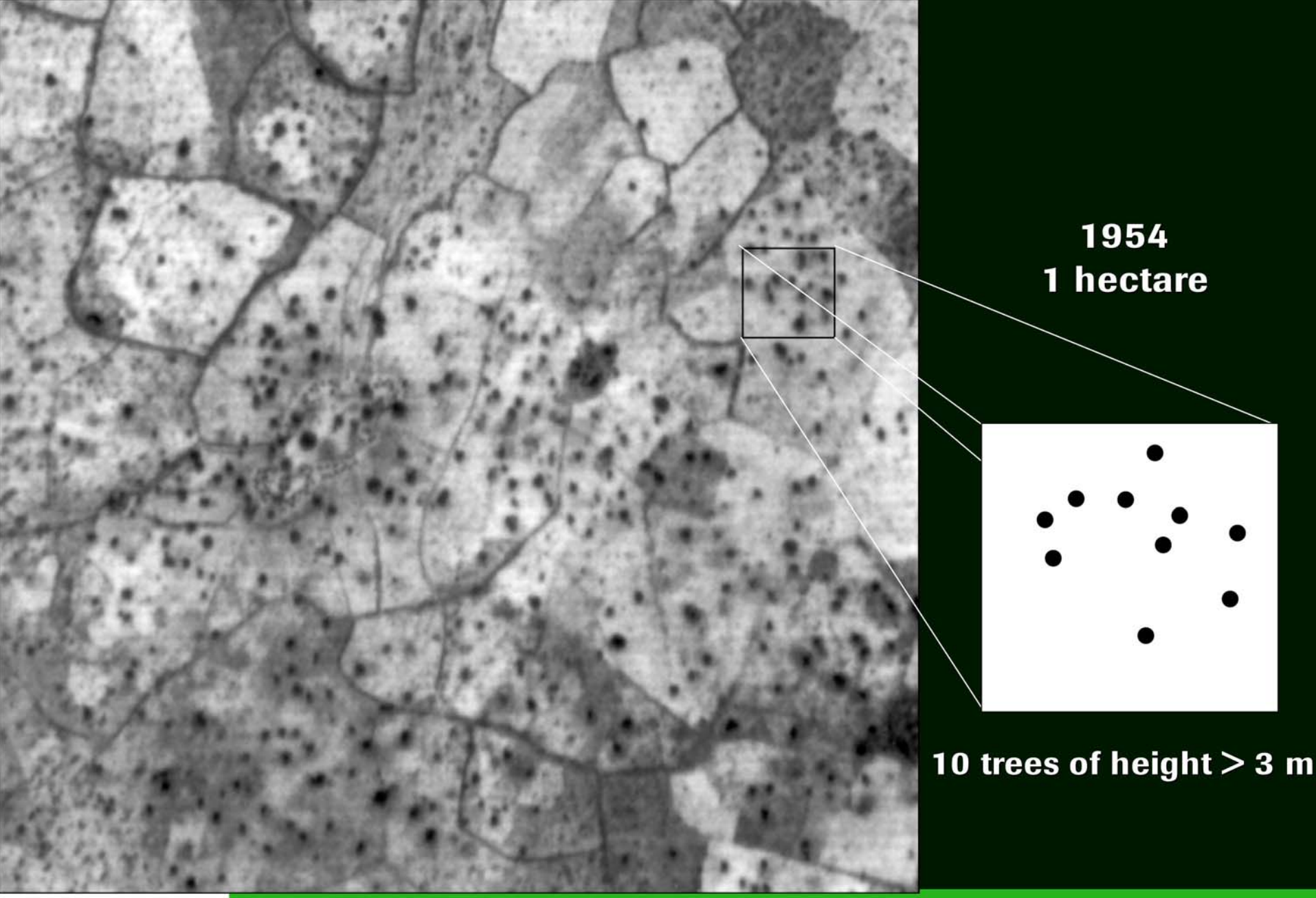
ca. 1945-1993 shift of vegetation zones in Northwest Senegal



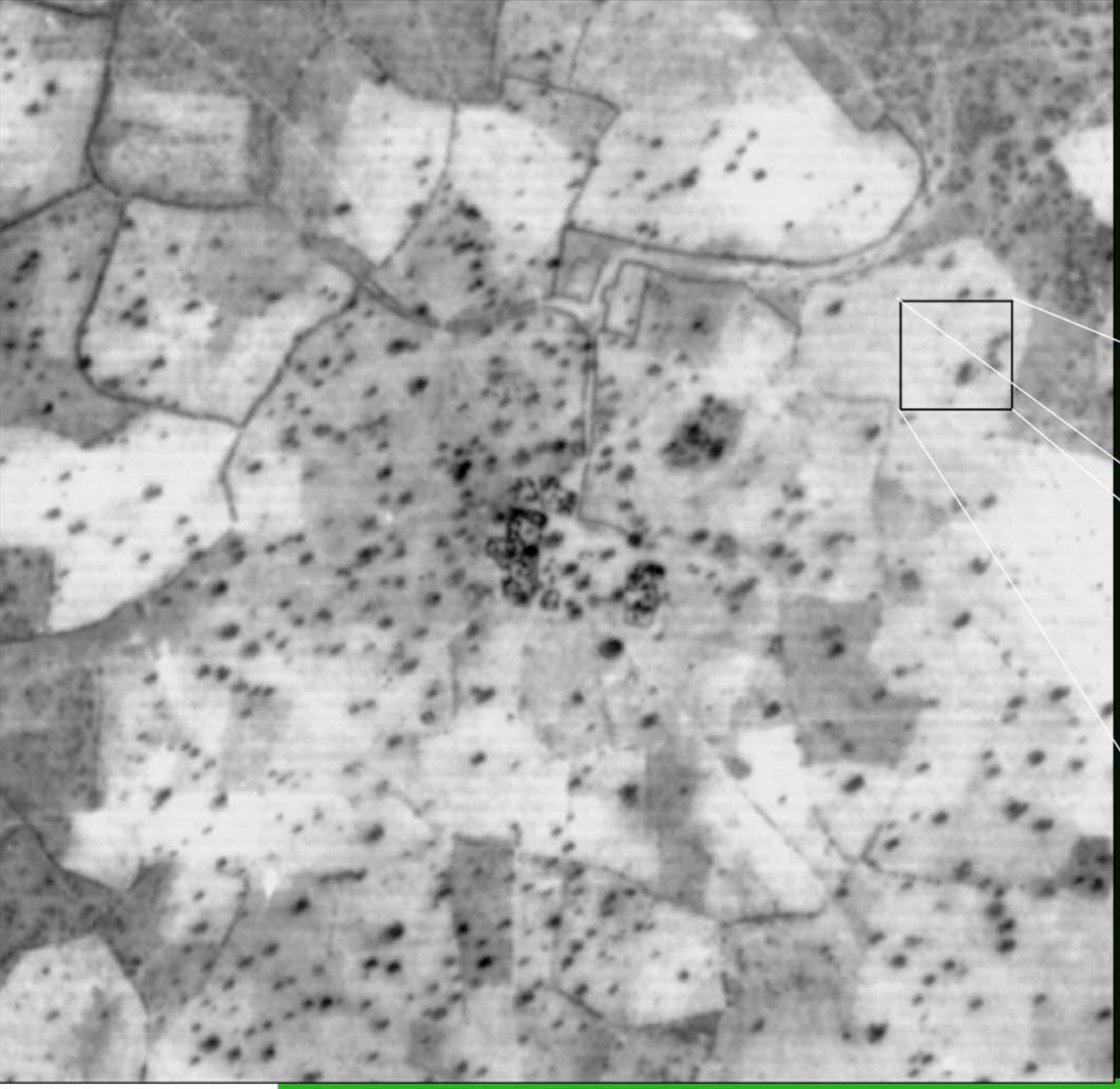


Yamaan Sekk
Senegal
1 km²
February 1954
(IGN)

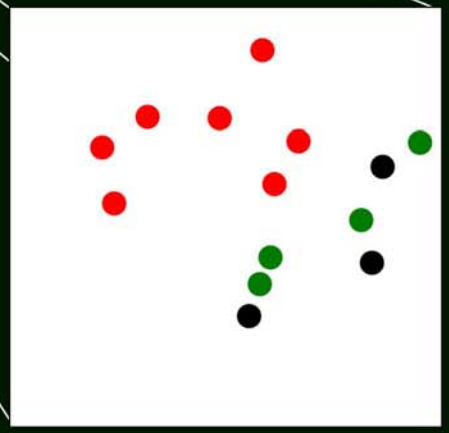
The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH



The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

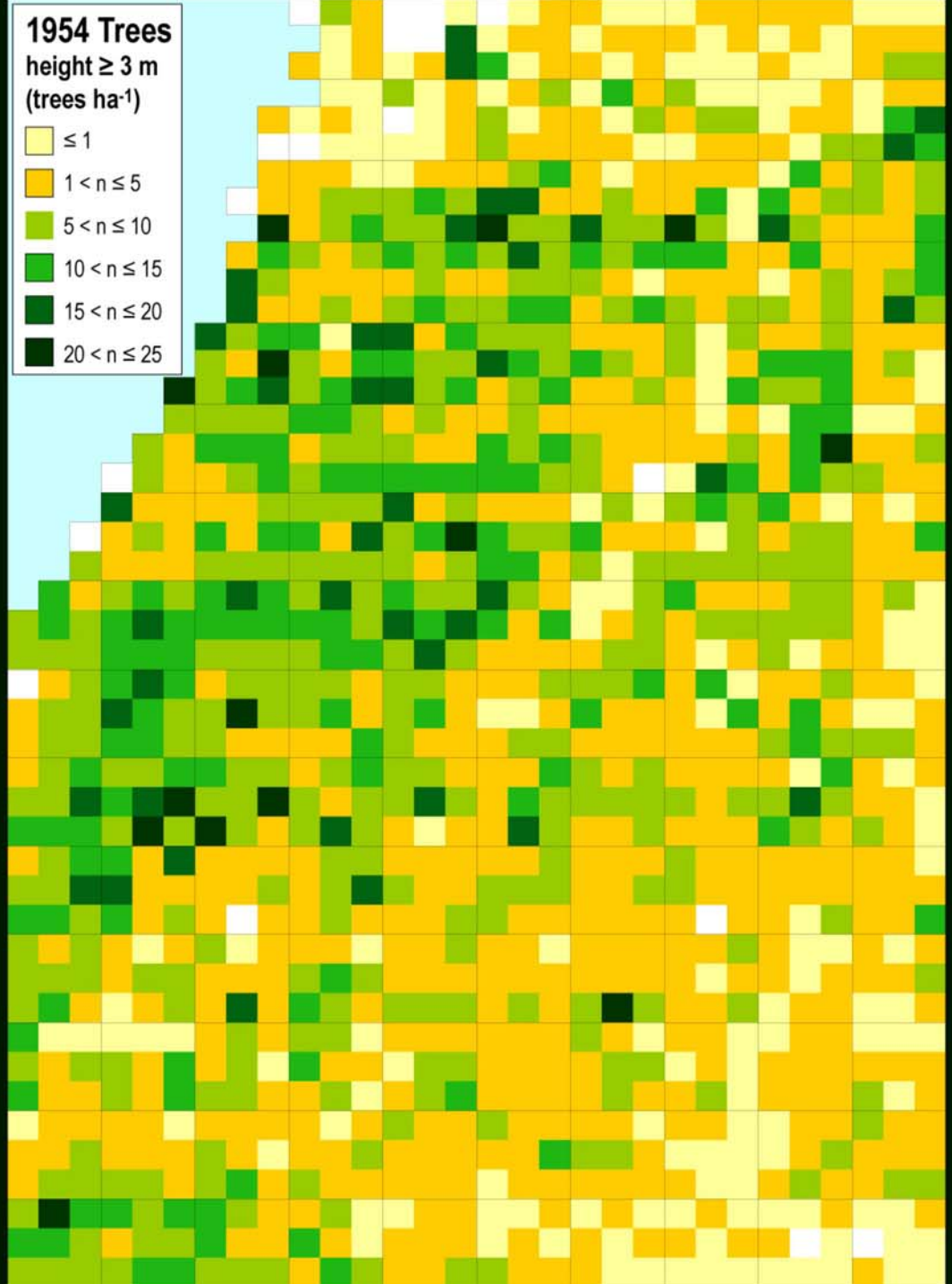


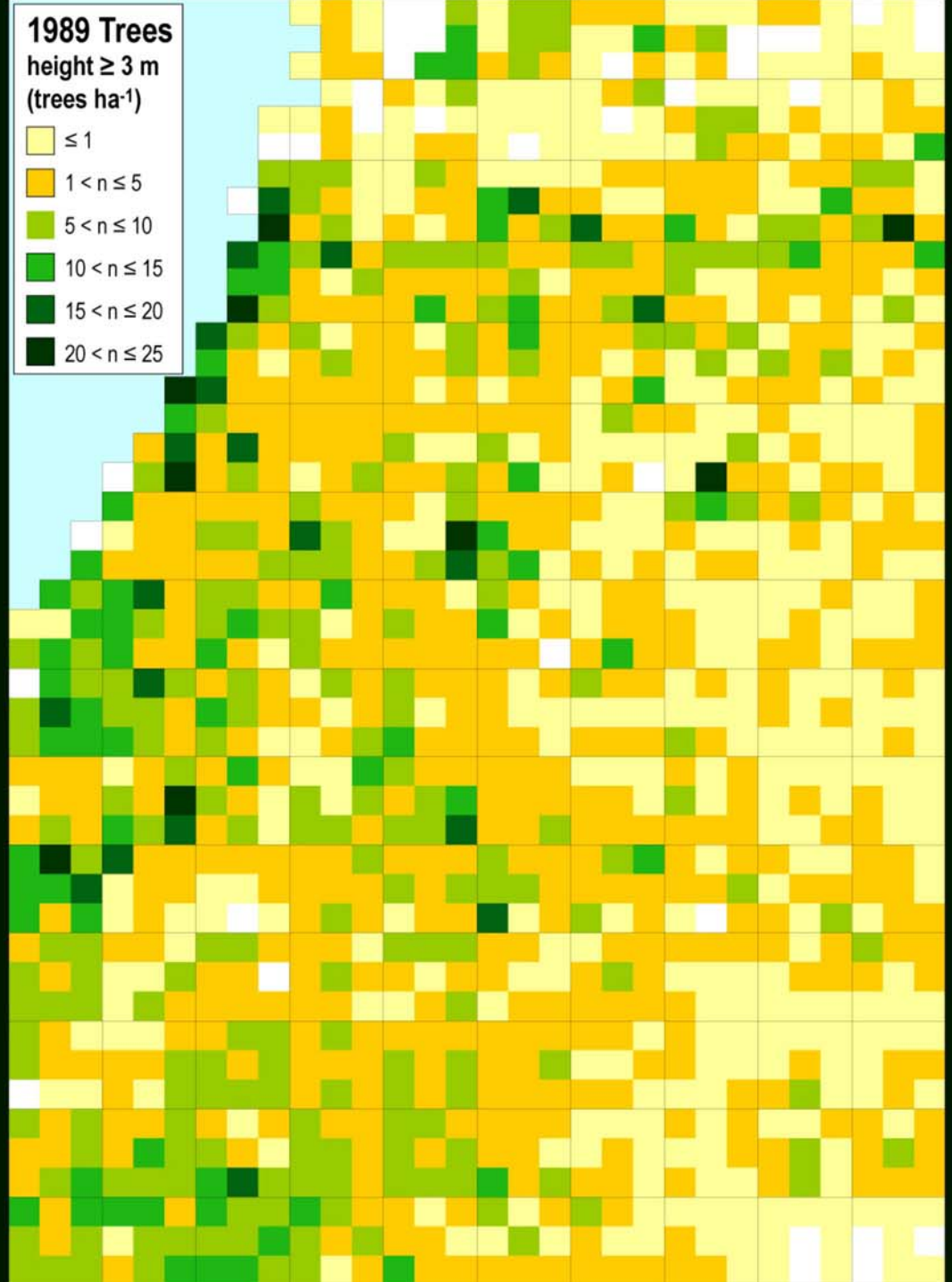
1989
1 hectare

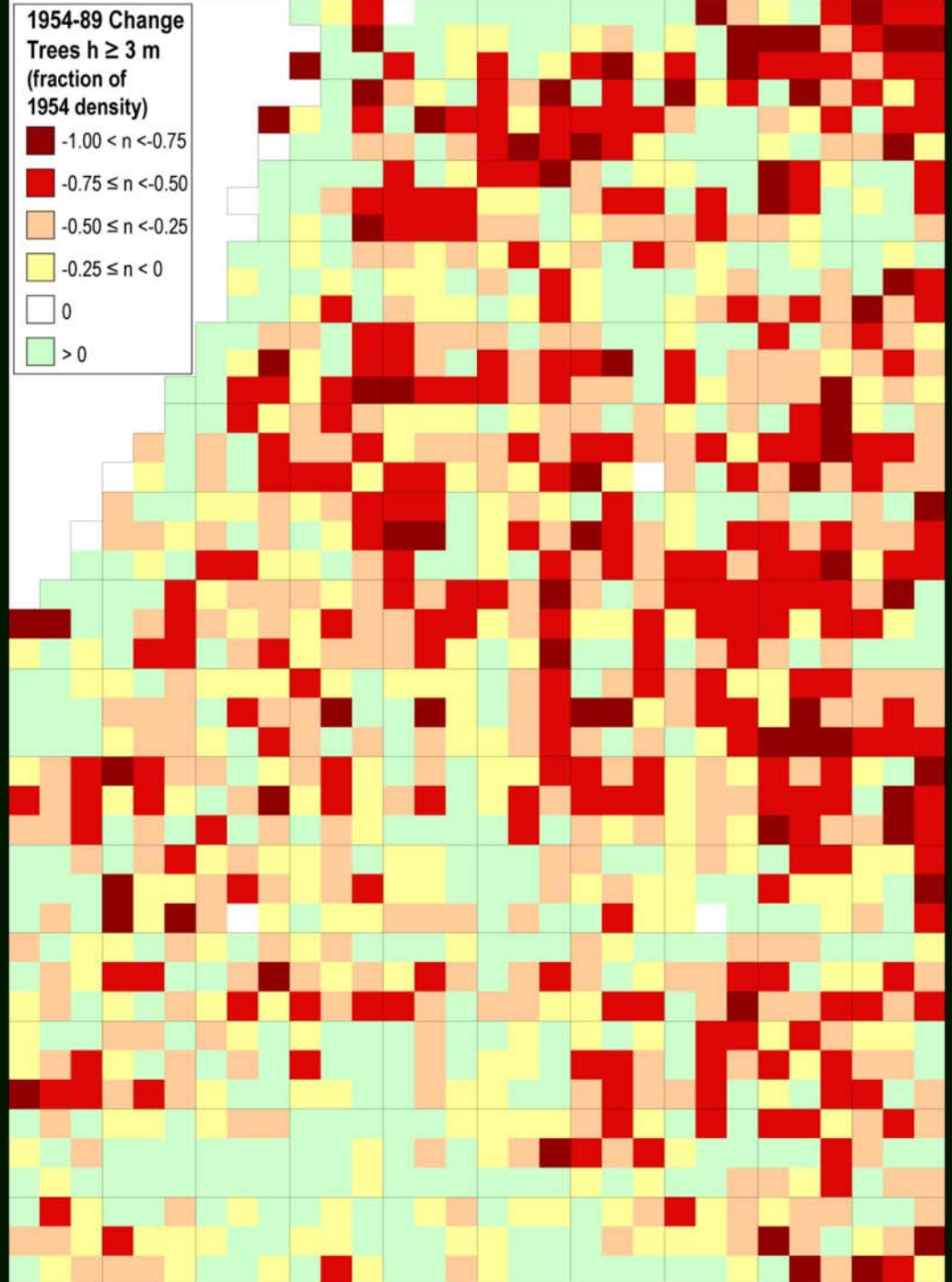


7 trees of height > 3 m
7 trees had died
4 new trees had grown

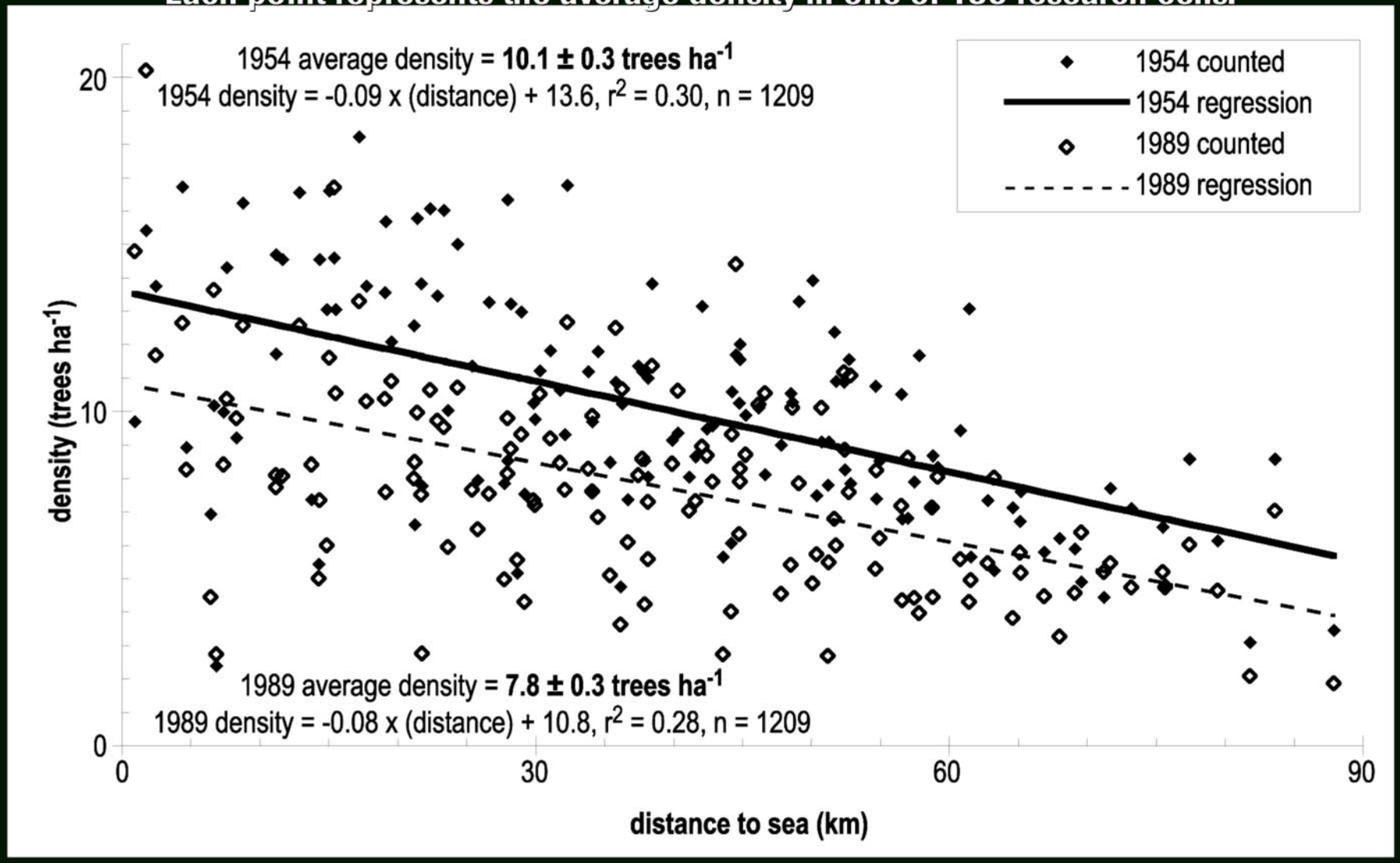
The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH


1954 Trees
height ≥ 3 m
(trees ha-1)
≤ 1
1 < n ≤ 5
5 < n ≤ 10
10 < n ≤ 15
15 < n ≤ 20
20 < n ≤ 25


1989 Trees
height ≥ 3 m
(trees ha-1)
≤ 1
1 < n ≤ 5
5 < n ≤ 10
10 < n ≤ 15
15 < n ≤ 20
20 < n ≤ 25


1954-89 Change
Trees h ≥ 3 m
(fraction of
1954 density)
-1.00 < n <-0.75
-0.75 ≤ n <-0.50
-0.50 ≤ n <-0.25
-0.25 ≤ n < 0
0
> 0

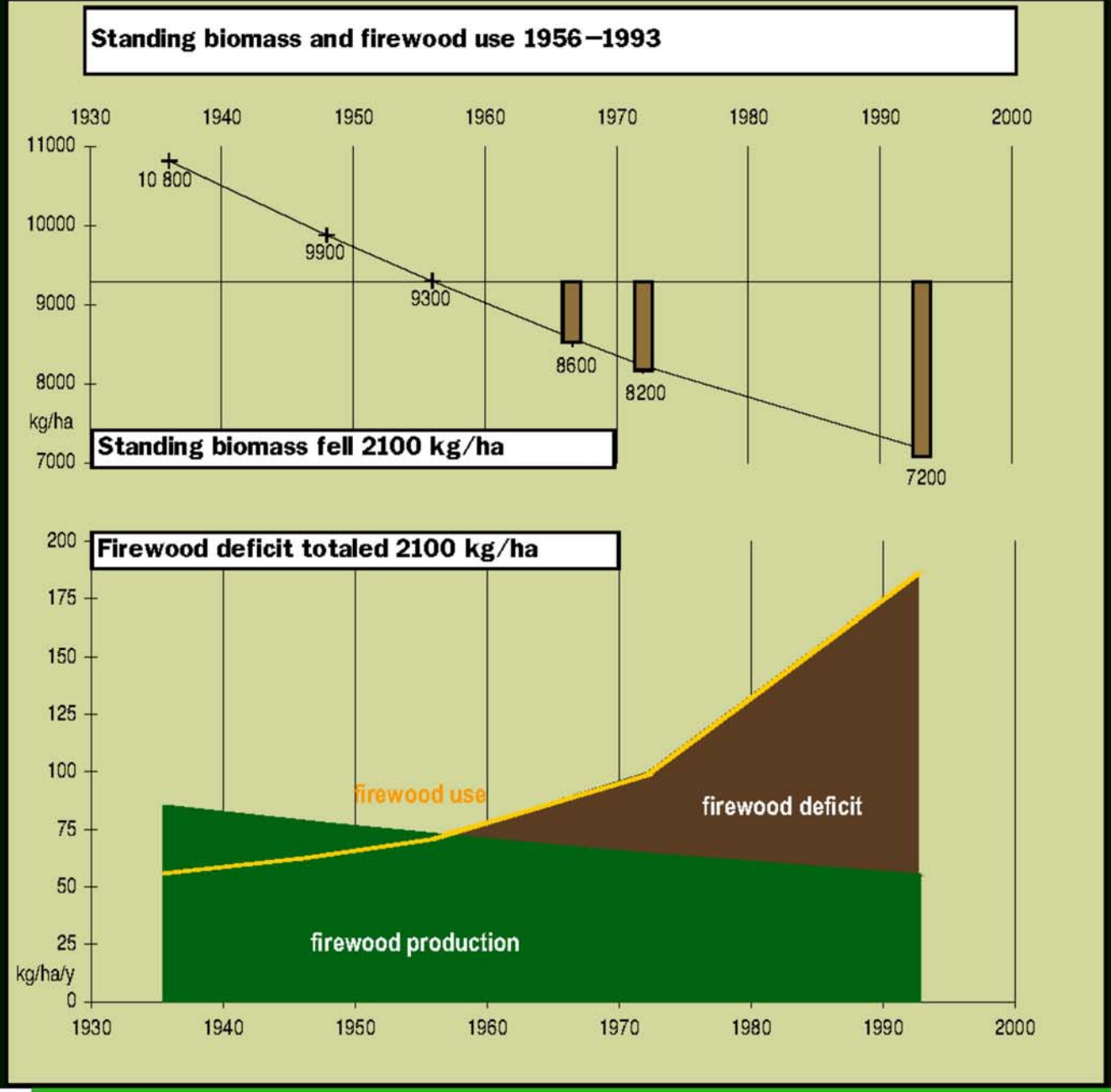
Decrease in the density of trees of height > 3 m, from 1954 to 1989, from aerial photographs.
Each point represents the average density in one of 135 research cells.



The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

Net primary productivity, standing biomass, and vegetative growth 1993

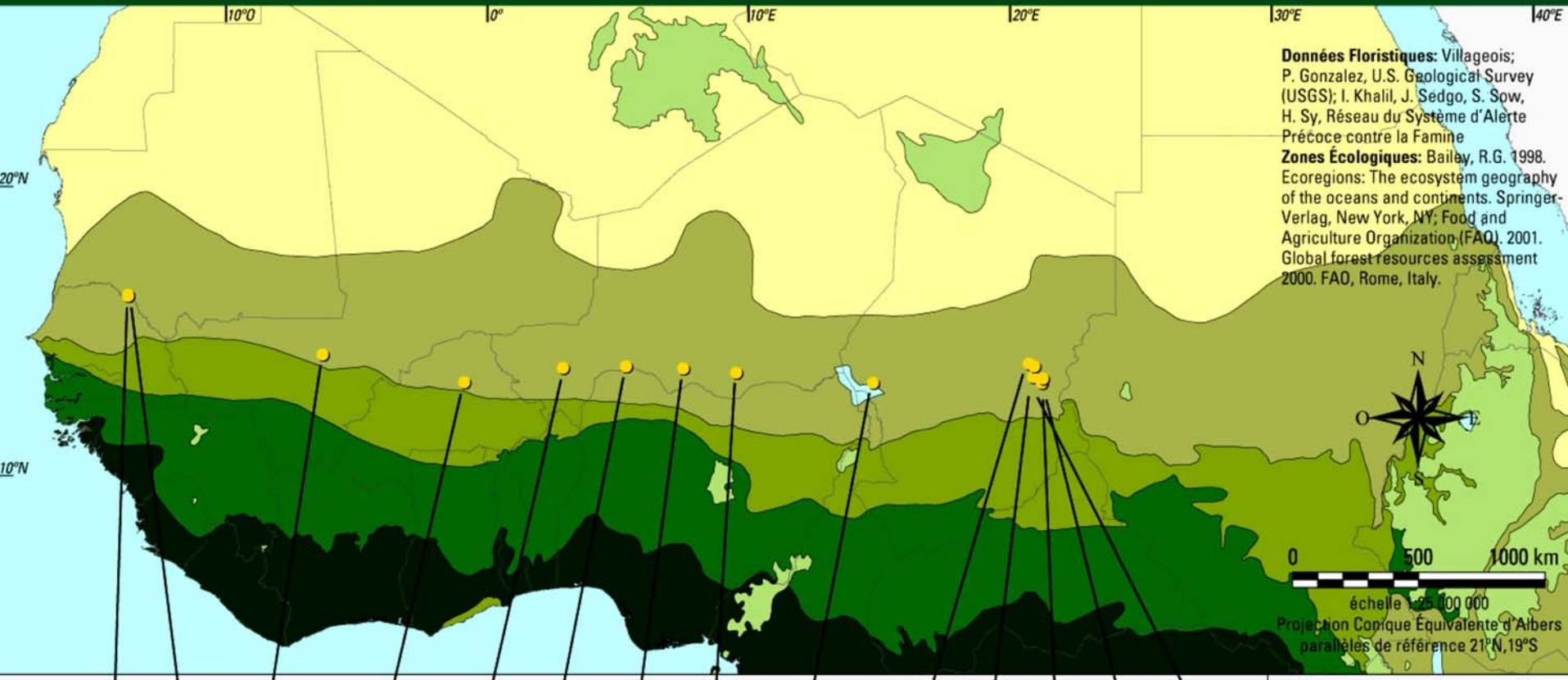
	kg $ha^{-1}y^{-1}$	kg ha^{-1}	y^{-1}
total biomass			
herbaceous	2900	3200	0.91
ligneous	200	12 000	0.02
sum	3100	15 200	0.02
above-ground			
herbaceous	1200	1300	0.89
foliar	80	80	1.00
ligneous	160	7200	0.02
sum	1400	8500	0.16
below-ground			
herbaceous	1700	1900	0.91
ligneous	30	4800	0.006
sum	1800	6700	0.26

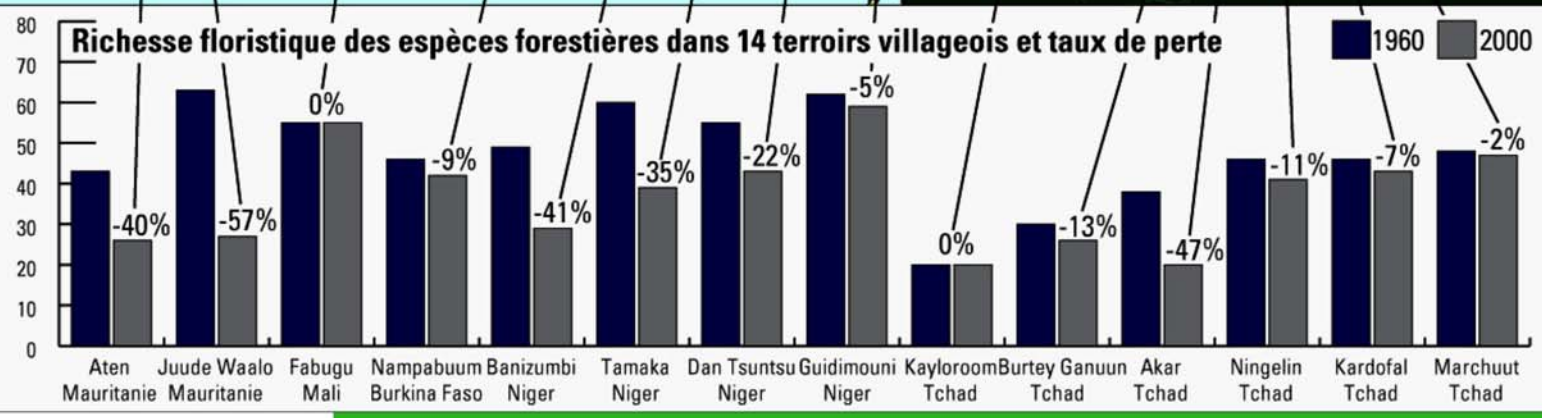


The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

Additional analyses of changes using additional field data across the Sahel, aerial photos, and IKONOS

Changements des espèces forestières dans le Sahel 1960-2000

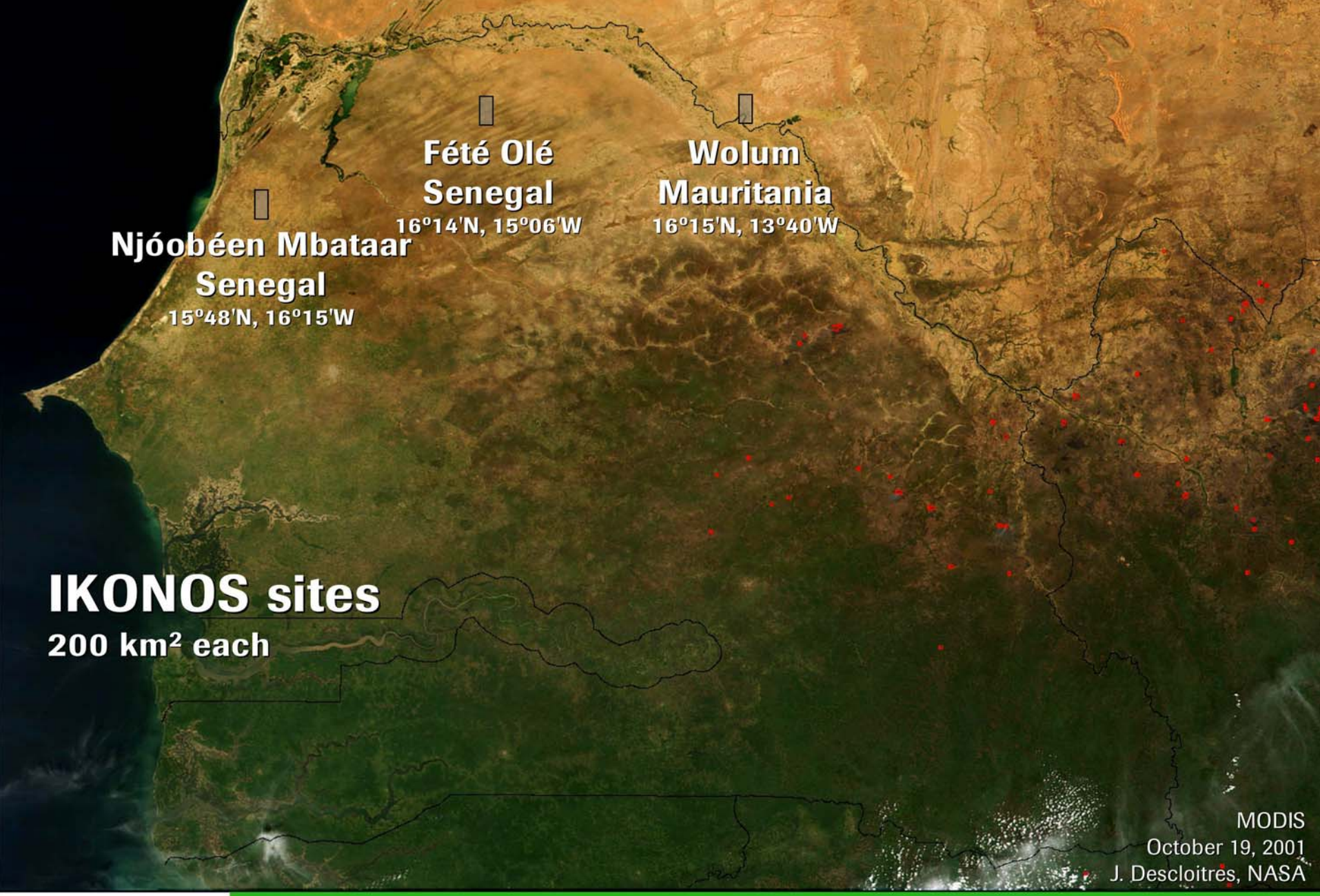




Zones Écologiques

- désert
- formation arbustive
- forêt sèche
- forêt humide décidue
- forêt ombrophile
- zone montagneuse

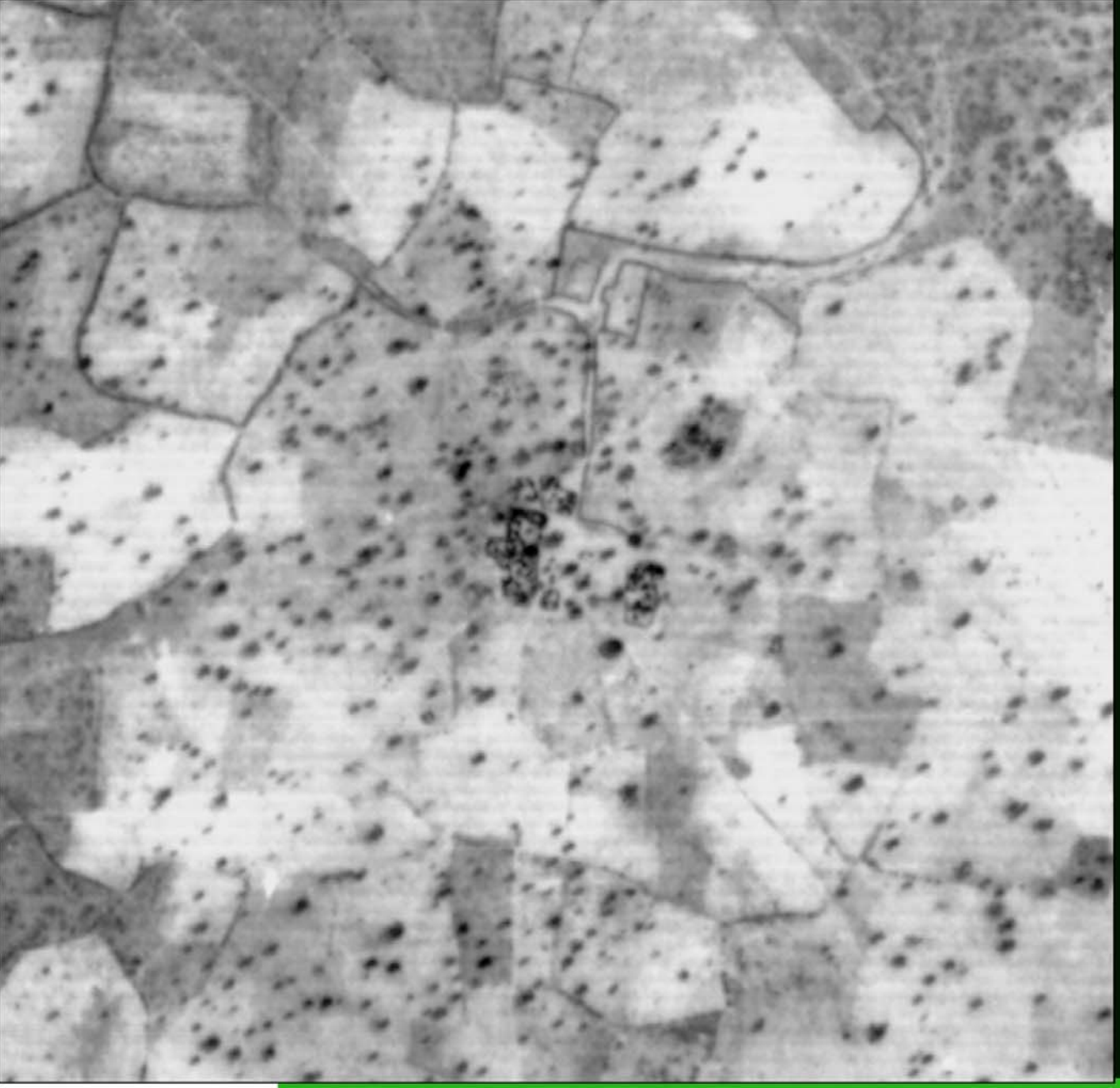
The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH



The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

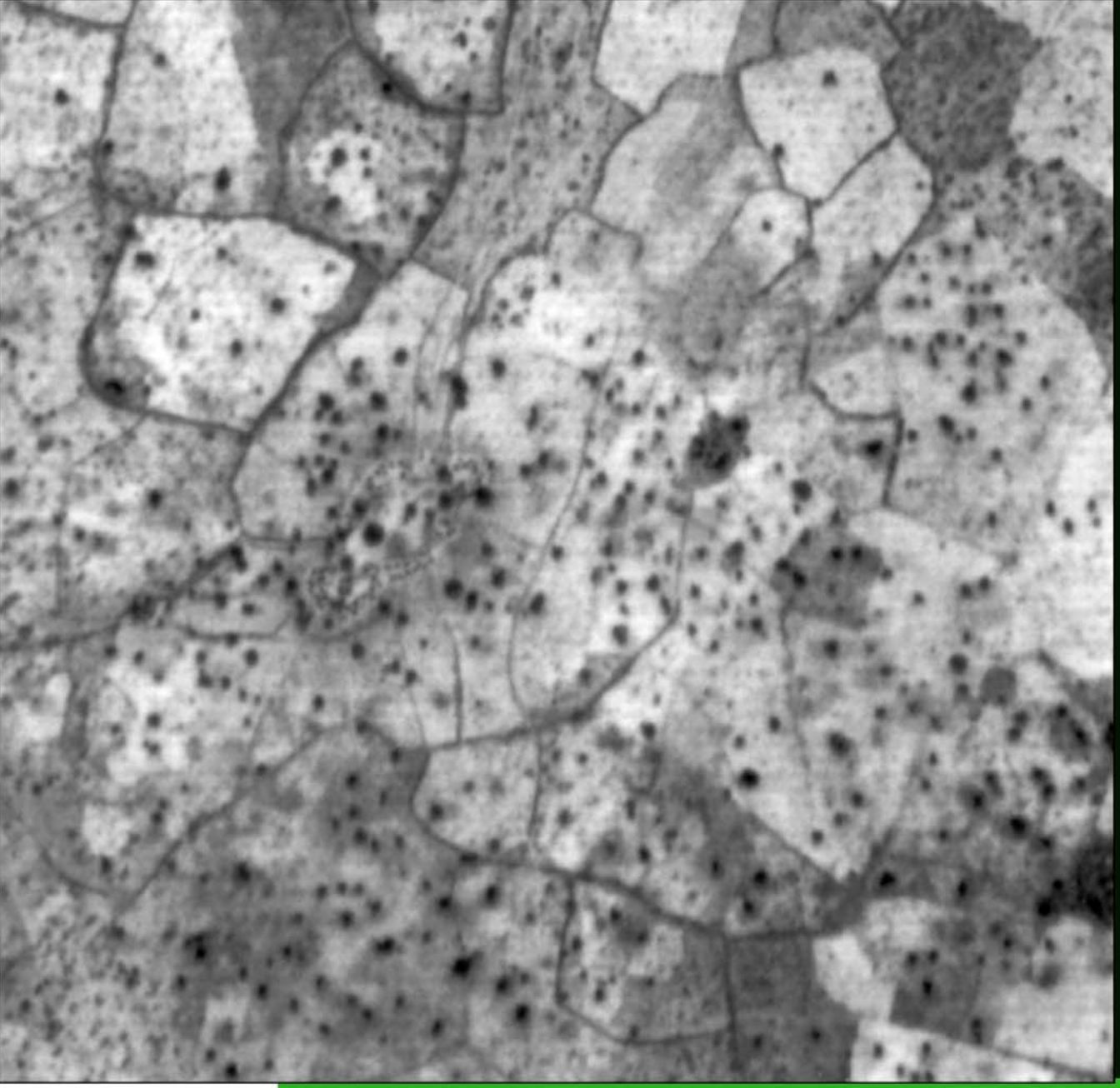
Yamaan Sekk
Senegal
1 km²
February 17, 2002
(Space Imaging)

The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH



Yamaan Sekk
Senegal
1 km²
March 1989
(JICA aerial photo)

The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH



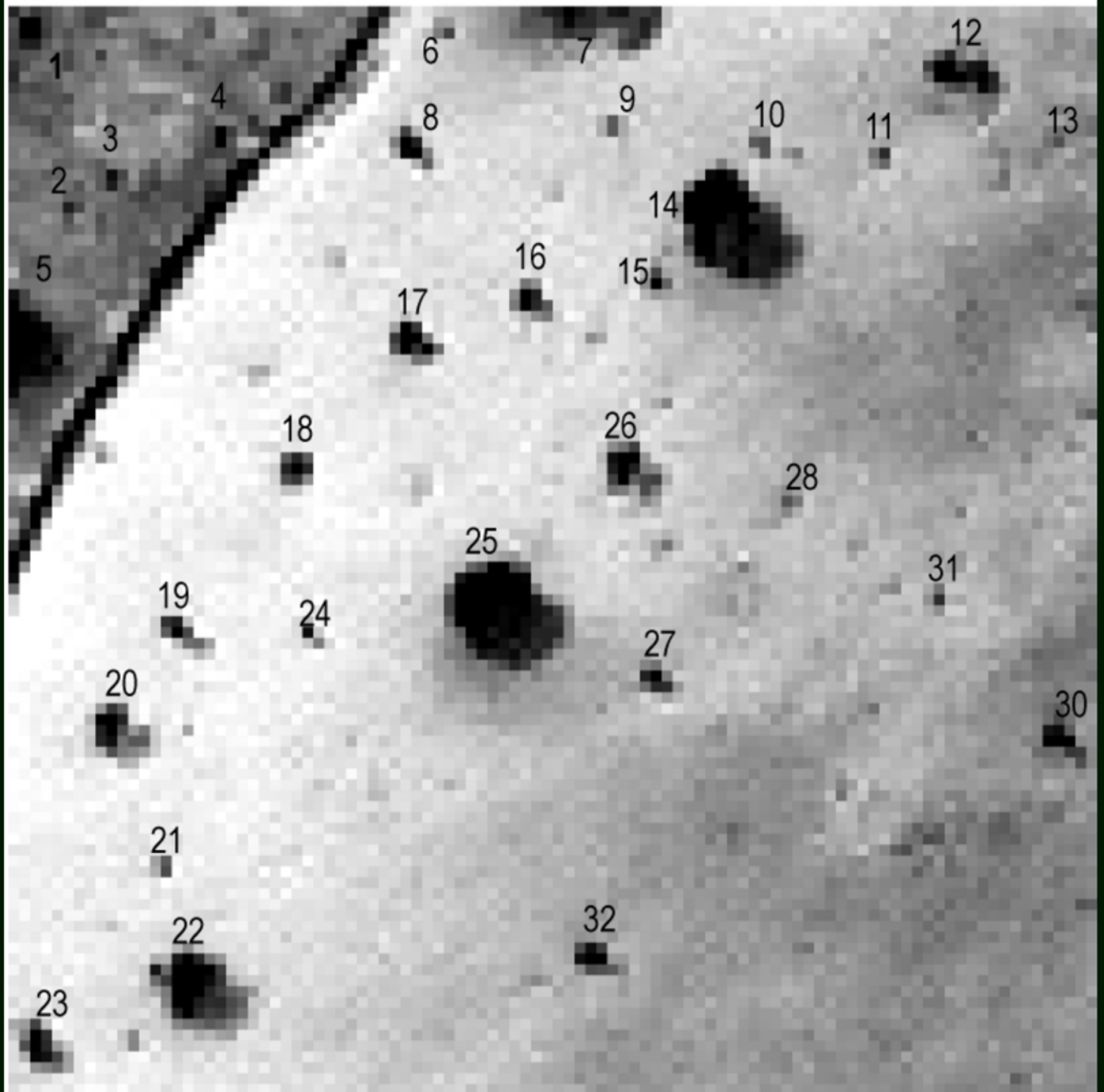
Yamaan Sekk
Senegal
1 km²
February 1954
(IGN aerial photo)

The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

Njóobéen Mbataar,
Senegal
February 2002

15.845419 -16.274422
15º50'44" N 16º16'28" W

Njóobéen Mbataar NW



Njóobéen Mbataar,
Senegal
May 2002

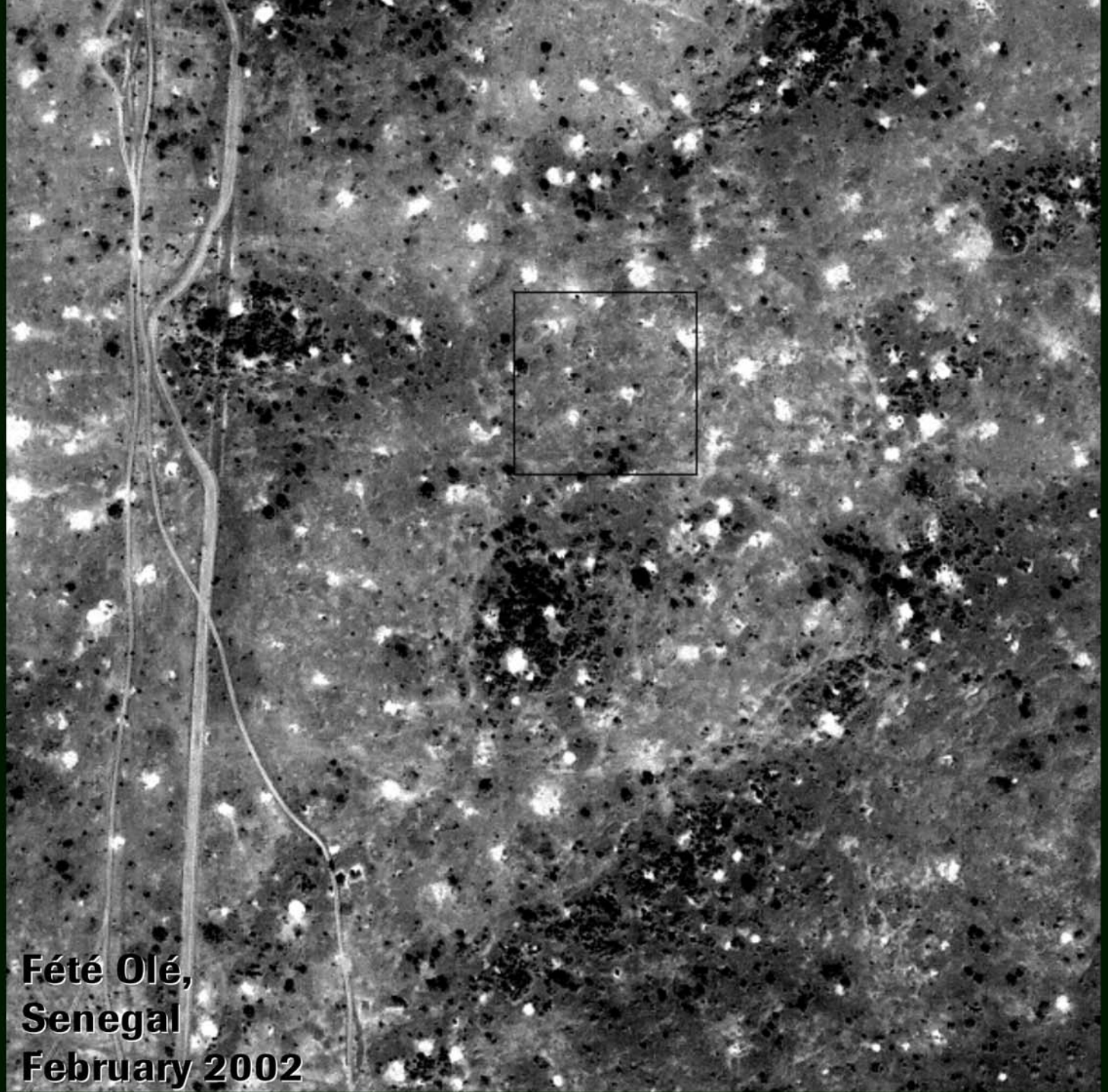
The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

The Nature Conservancy

SAVING THE LAST GREAT PLACES ON EARTH

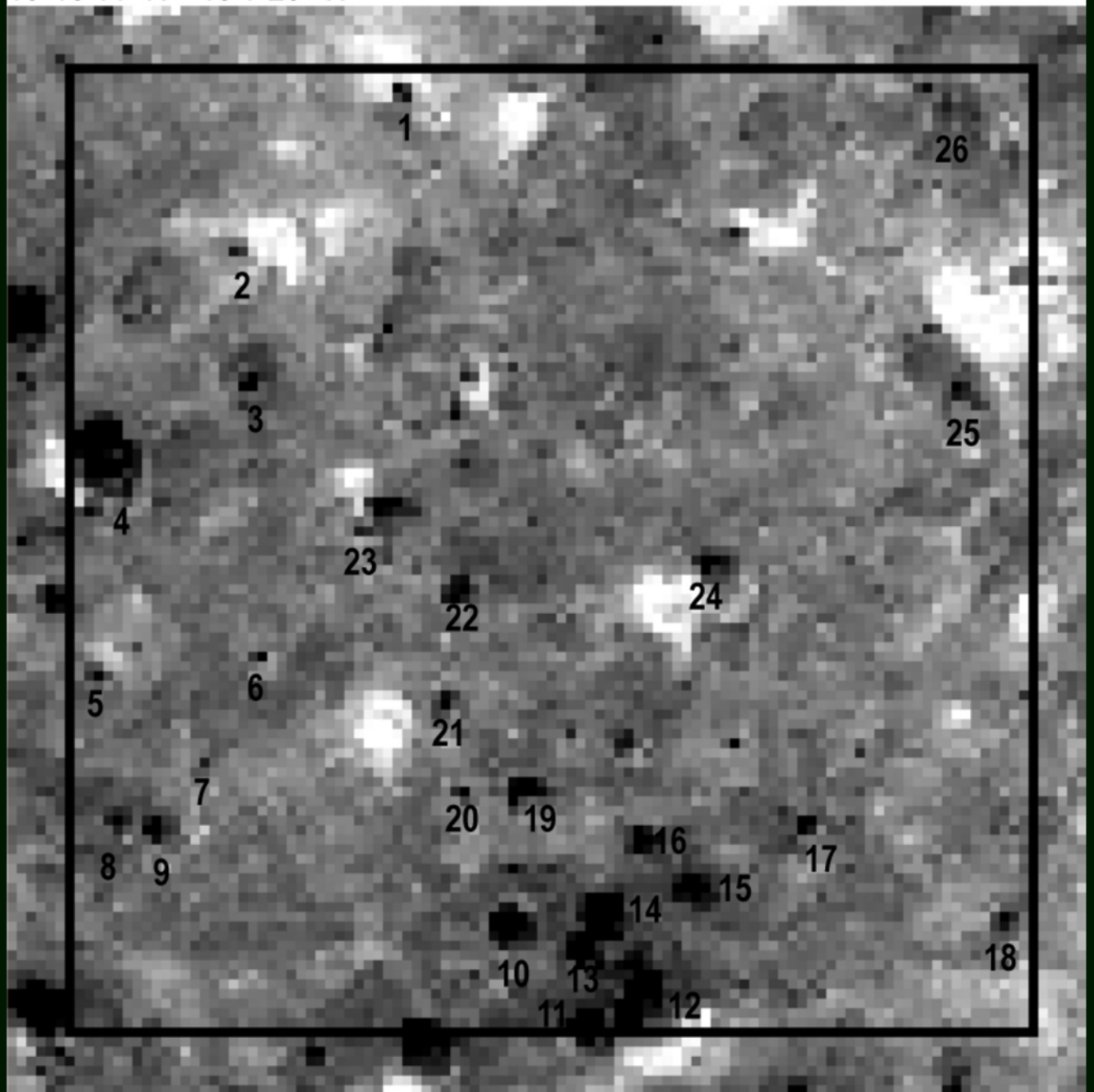
The Nature Conservancy

SAVING THE LAST GREAT PLACES ON EARTH


Fété Olé,
Senegal
February 2002

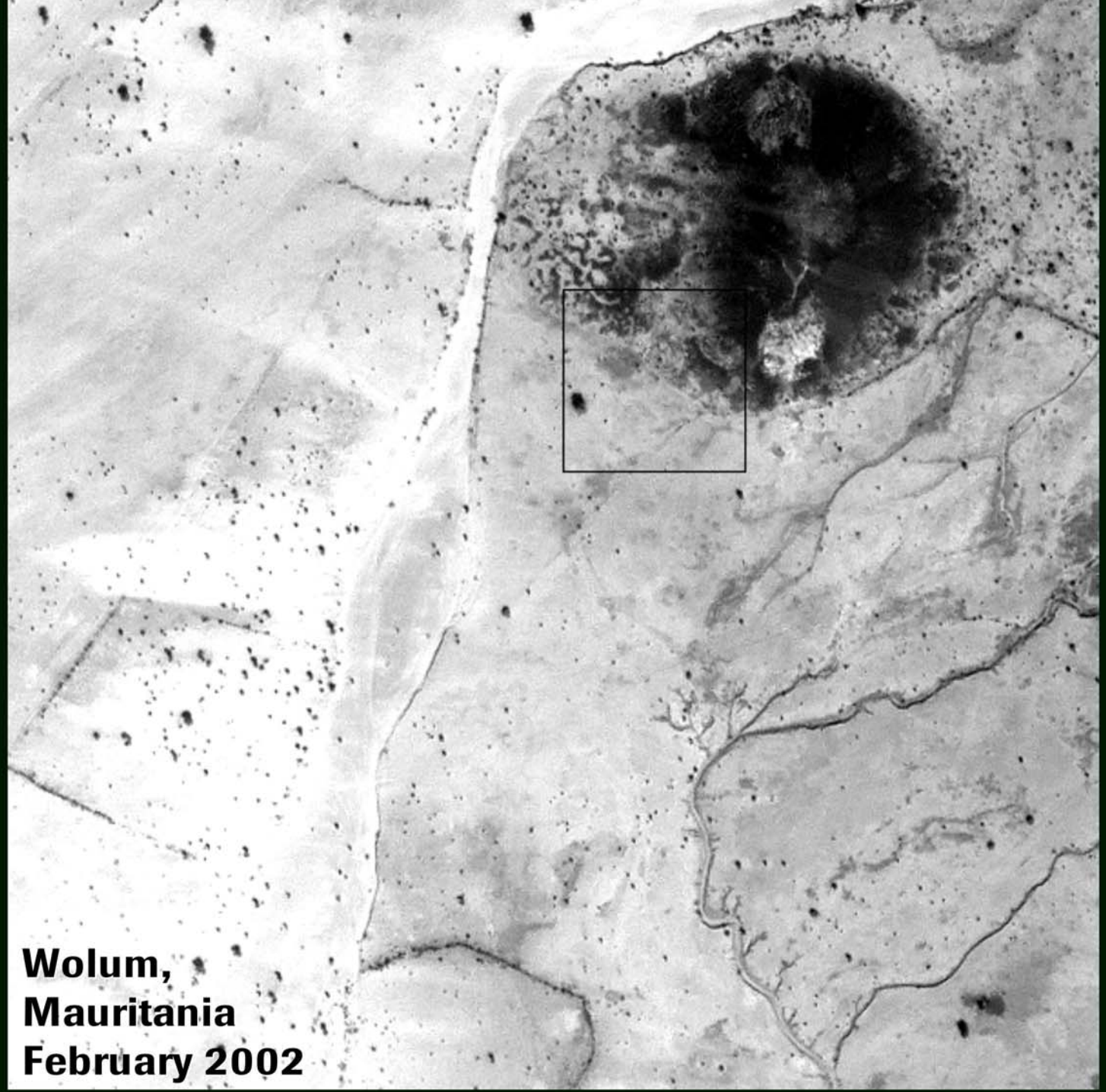
16.278761 -15.123961
16º16'44" N 15º7'26" W

Fete Ole NW



Fété Olé,
Senegal
May 2002

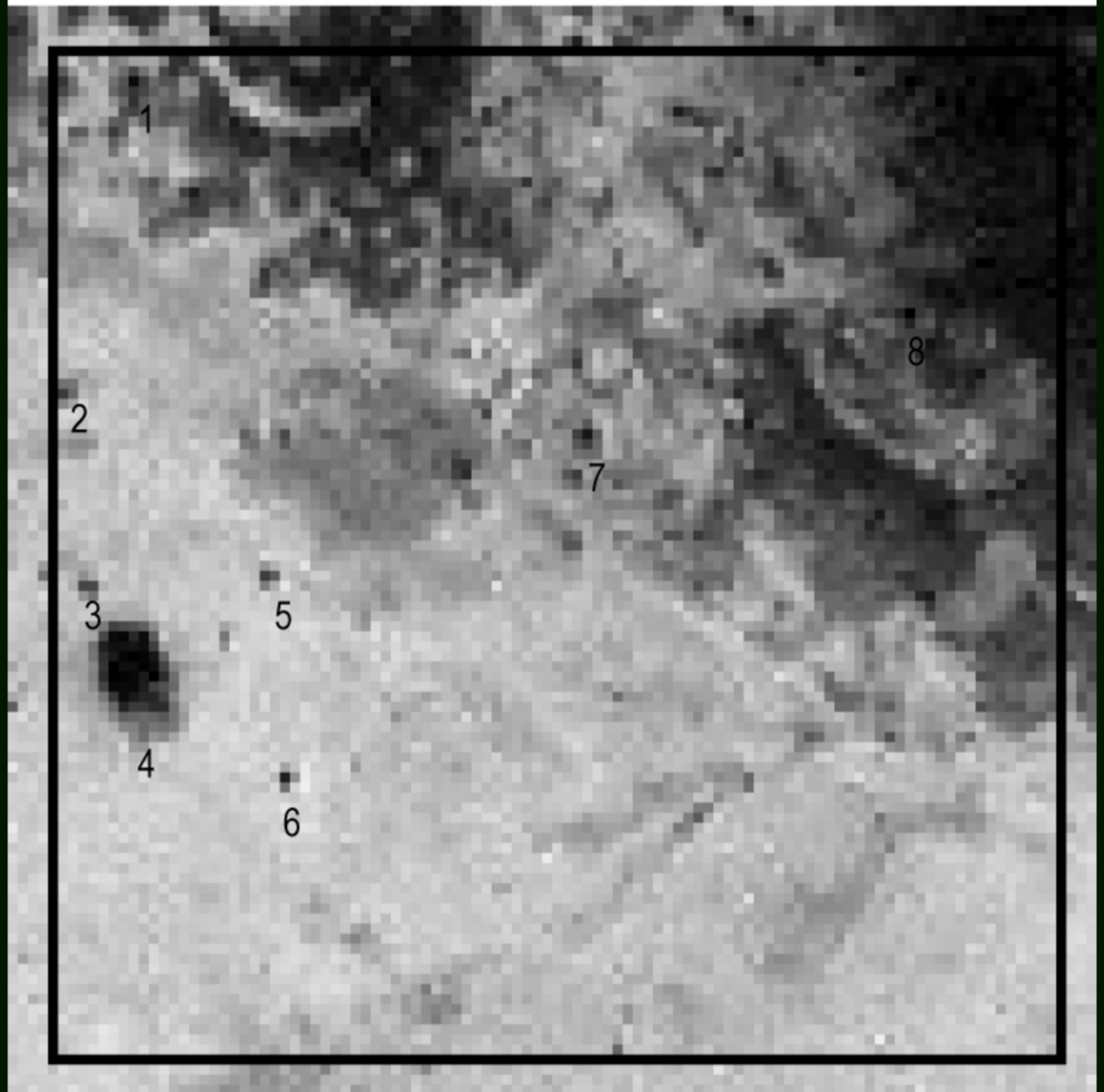
The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH


Wolum,
Mauritania
February 2002

16.20519 -13.643411

16º12'19" N 13º38'36" W

Wolum SE



The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH