

Climate and Land Use Change: Synergistic Risks to Health

*APHA Annual Conference
Washington, Nov. 5, 2007*

Jonathan Patz, MD, MPH

**Nelson Institute for Environmental Studies &
Department of Population Health Sciences
University of Wisconsin - Madison**

Copyright 2007, J.A. Patz, patz@wisc.edu



DESPITE THE RECENT WIDENING OF THE BALTIMORE BELTWAY, GRIDLOCK WILL SOON RETURN! TO EASE CONGESTION, PLANNERS ARE WORKING ON THE **BALTIMORE BELTWAY 2025**

KAL 98-3-26
BALTIMORE SUN
CIVIL ENGINEER

FREDERICK

SECURITY MALL REST AREA

LOS ANGELES BELTWAY ← 25 MILES

I-95
ONLY 95 YARDS BETWEEN BELTWAYS

WASHINGTON BELTWAY

THERE'S LESS TRAFFIC

YES! COUGH! AND THERE'S LESS OXYGEN!!

NEWLY WIDENED TO 1472 LANES

STADIUMS

BWI AIRPORT

ANNAPOLIS

TRAFFIC-AT-PEAK BAY (FORMERLY THE CHESAPEAKE BAY)

PENNSYLVANIA

TOWSON ROUNDABOUT

TOWSON

BALTIMORE

INNER HARBOR - EXIT (FORMERLY THE JFX)

MOMMY, WHEN ARE WE GOING TO BE HOME?

WE SPEND 60 HOURS A WEEK IN OUR CAR, HONEY. THIS IS OUR HOME

EASTERN SHORE

NEW YORK BELTWAY (FORMERLY NEW JERSEY)

WHITE MARSH MALL REST AREA

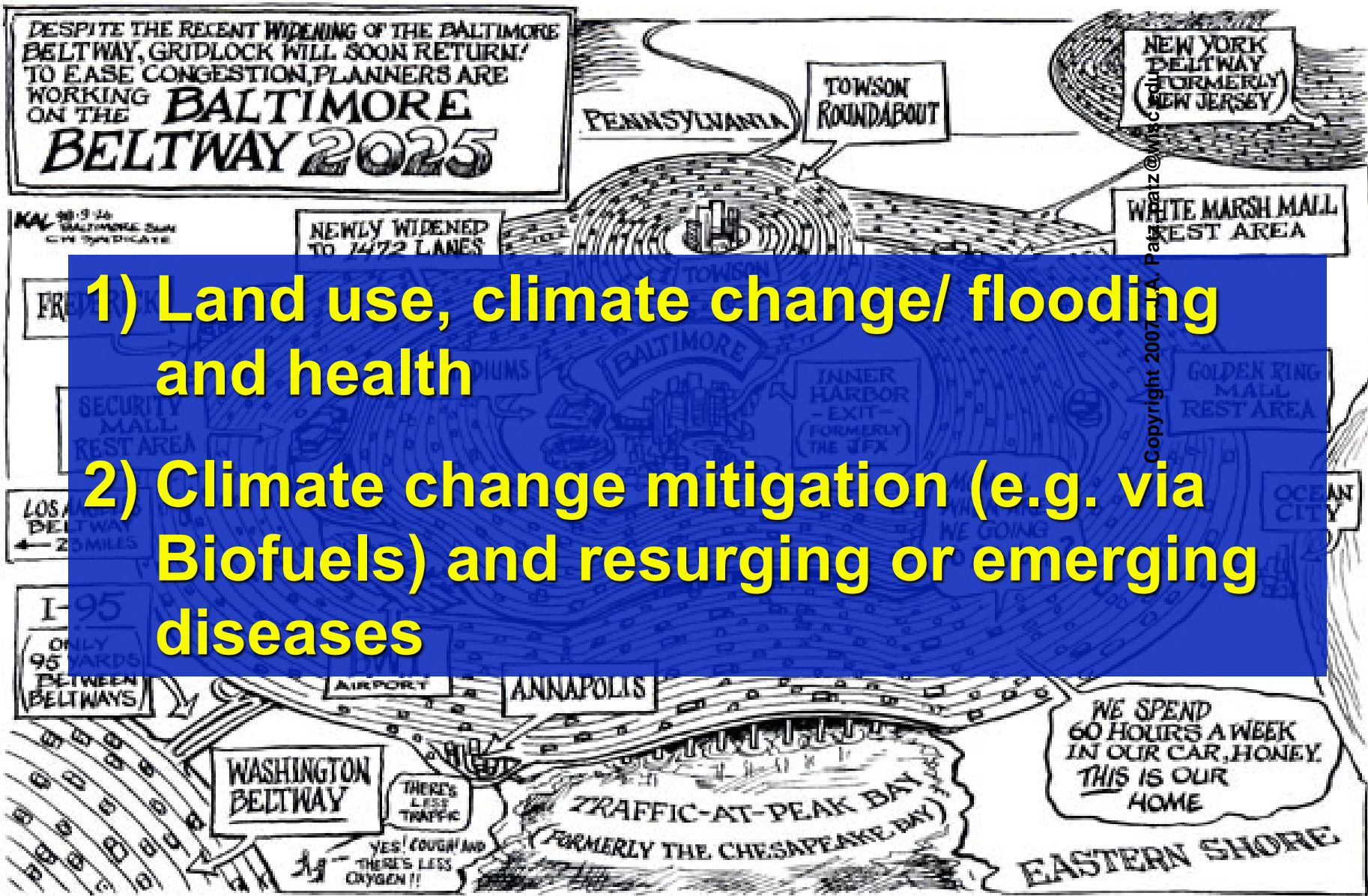
GOLDEN RING MALL REST AREA

OCEAN CITY

Copyright 2007 J.A. Patrizi

September 26, 1998

The Beltway was widened, but commuters hardly noticed.

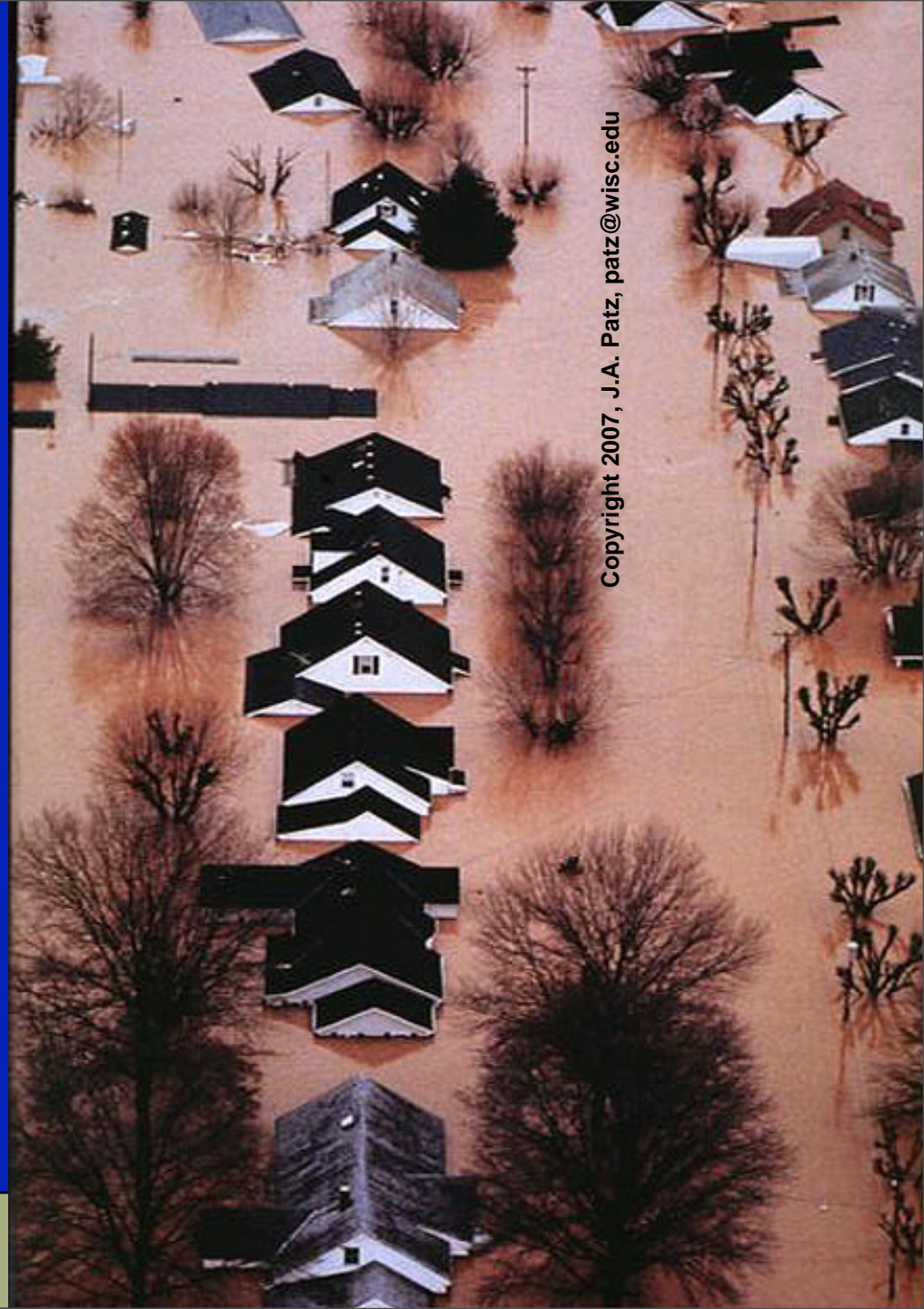


- 1) Land use, climate change/ flooding and health
- 2) Climate change mitigation (e.g. via Biofuels) and resurging or emerging diseases

September 26, 1998

The Beltway was widened, but commuters hardly noticed.

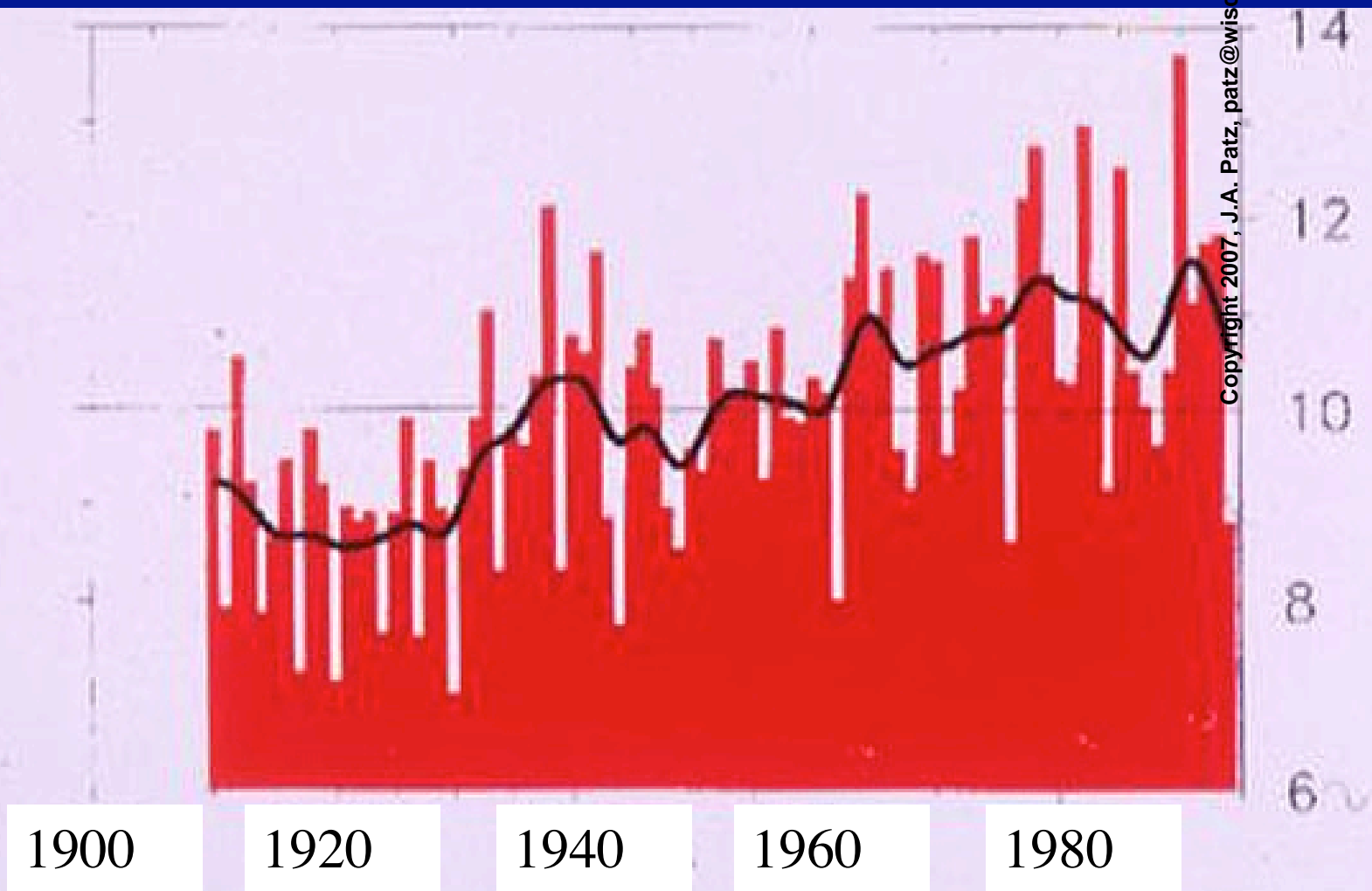
**Climate change:
It's not just about
warming.**



Copyright 2007, J.A. Patz, patz@wisc.edu

Proportion of the USA affected by much above normal annual precipitation from extreme events (>2 inches/day)

Copyright 2007, J.A. Patz, patz@wisc.edu



Source: Karl et al. 1996

annual precipitation derived from extreme daily precipitation events (more than 2 inches)

Extreme Precipitation and Waterborne Disease Outbreaks in the United States, 1948 -1994

Copyright 2007, J.A. Patz, patz@wisc.edu

**Project Sponsor:
US EPA, Office of Research & Development**

PI: J. Patz

Results

- **67%** of waterborne disease outbreaks were preceded by precipitation above the 80th percentile (across a 50 yr. climate record), $p < 0.001$
- **51%** of outbreaks were preceded by precipitation above the 90th percentile, $p < 0.002$
- Surface water-related outbreaks had strongest correlation with extreme precipitation in the month of outbreak; groundwater-related outbreaks lagged 2 months following extreme precipitation.

USA: Combined sewer overflows (CSOs)



Courtesy: Kellogg Schwab

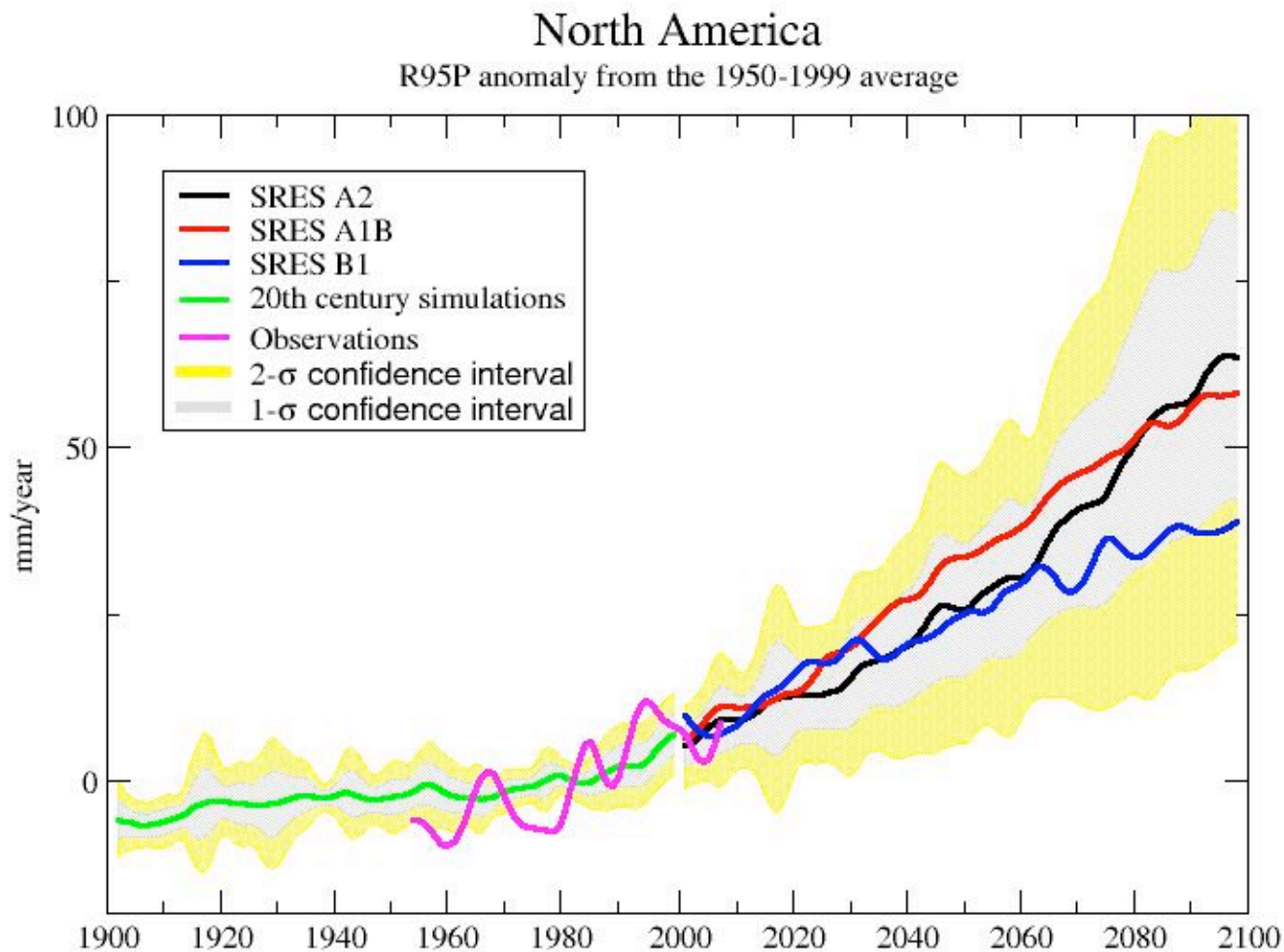


Copyright 2007, J.A. Patz, patz@wisc.edu

**1.2 trillion gal of sewage & stormwater a year
discharged during combined sewer overflows
– would keep Niagara Falls roaring for 18 days**

Center for Water & Health, JHU Bloomberg School of Public Health

Heavy precipitation is projected to increase



Copyright 2007, J.A. Patz, patz@wisc.edu

Figure courtesy of M. Wehner

CLIMATE & LAND USE SYNERGY

Copyright 2007, J.A. Patz, patz@wisc.edu

Hurricanes Mitch & Katrina

~ 9,600 people perished,
widespread water- and vector-
borne diseases followed, and
nearly one million people were
left homeless.

**Areas with extensive deforestation
or degraded hillsides suffered the
greatest morbidity and mortality**
and point to the importance of
vegetation cover and as a buffer
to severe floods, and the long-term
prevention of injuries and
fatalities

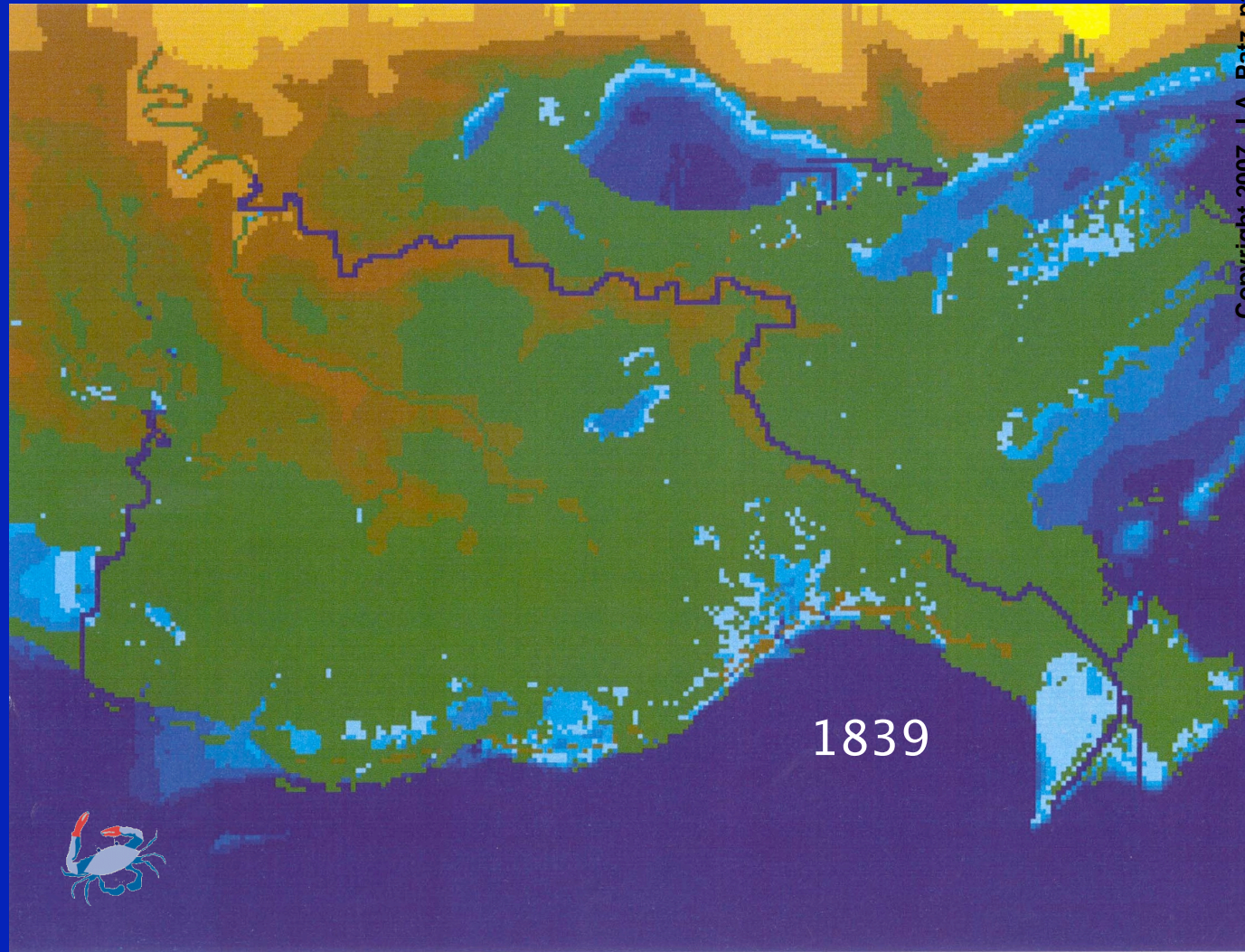


wetland loss in the Mississippi delta (1839 to 2020)

Copyright 2007, J.A. Patz, patz@wisc.edu

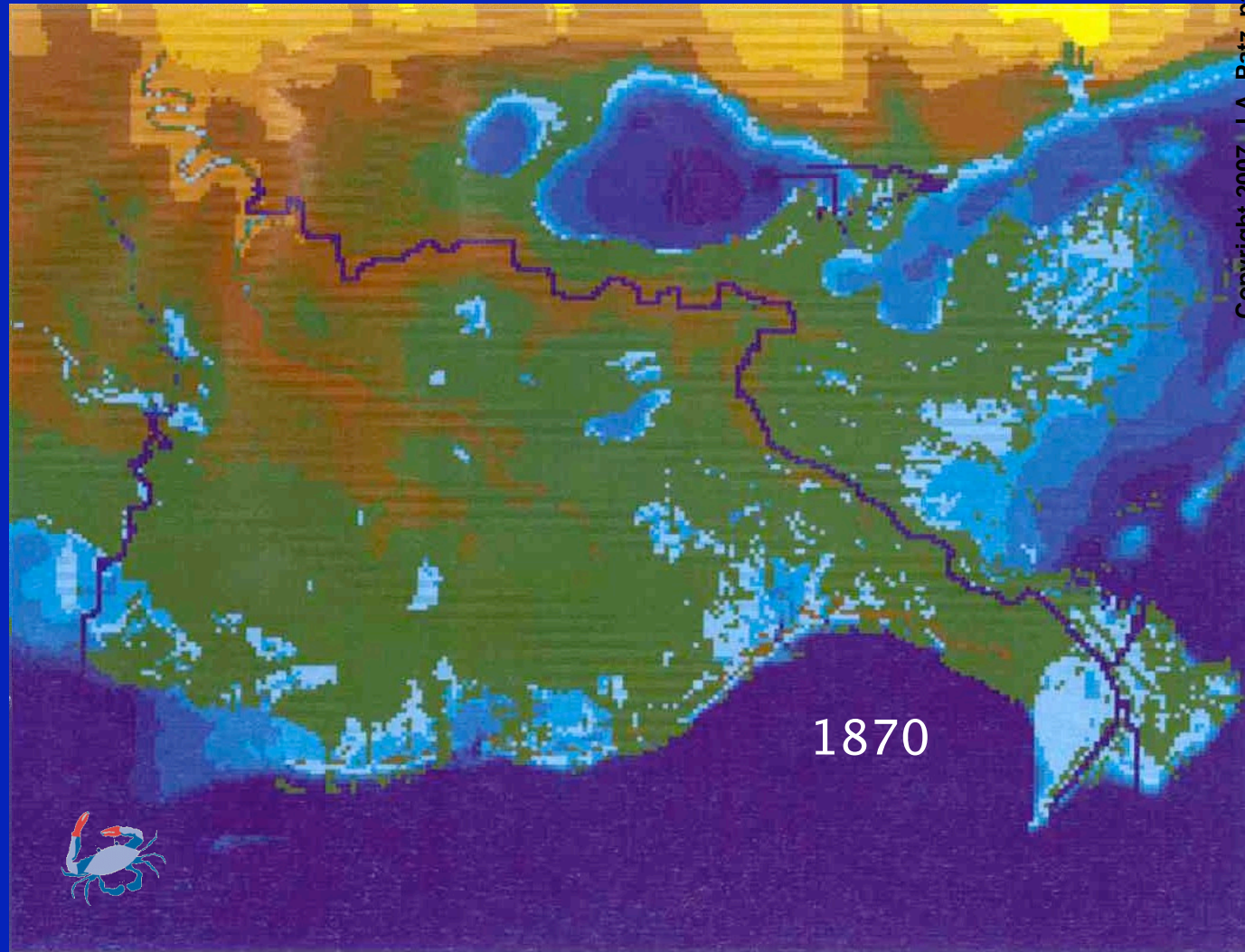


wetland loss in the Mississippi delta (1839 to 2020)



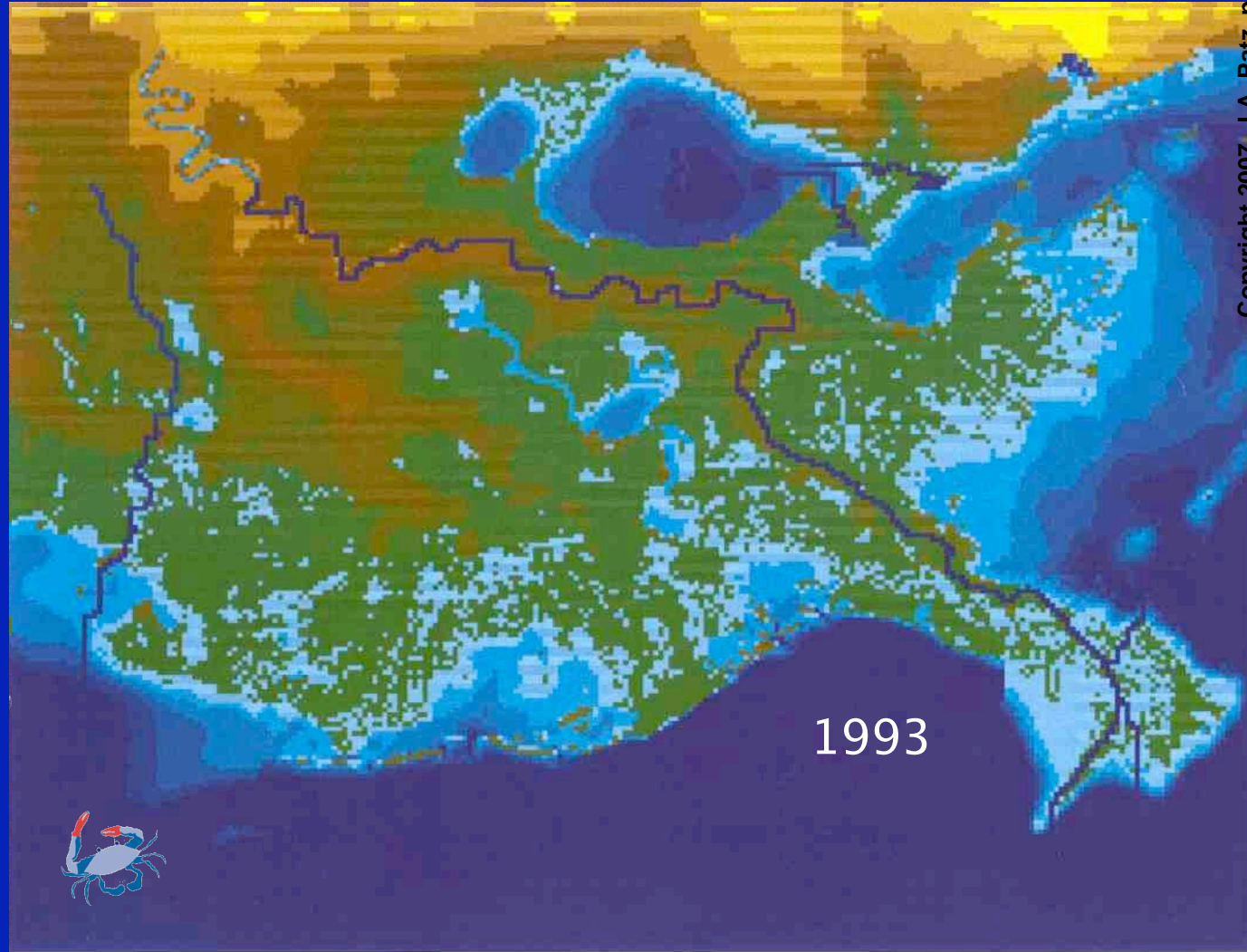
Copyright 2007, J.A. Patz, patz@wisc.edu

wetland loss in the Mississippi delta (1839 to 2020)



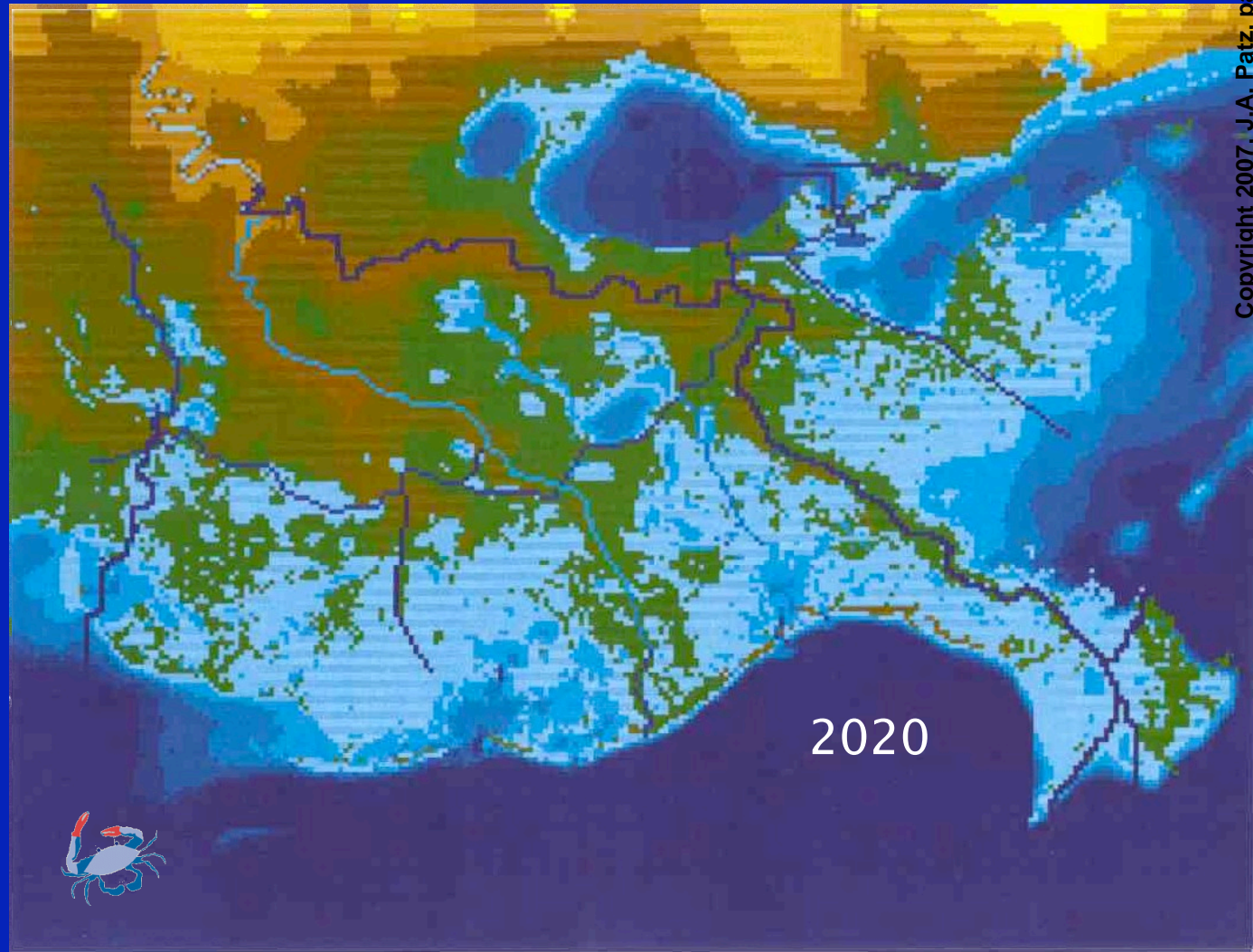
Copyright 2007, J.A. Patz, patz@wisc.edu

wetland loss in the Mississippi delta (1839 to 2020)



Copyright 2007, J.A. Patz, patz@wisc.edu

wetland loss in the Mississippi delta (1839 to 2020)



Copyright 2007, J.A. Patz, patz@wisc.edu

2020

New Orleans after Hurricane Katrina

Copyright 2007, J.A. Patz, patz@wisc.edu

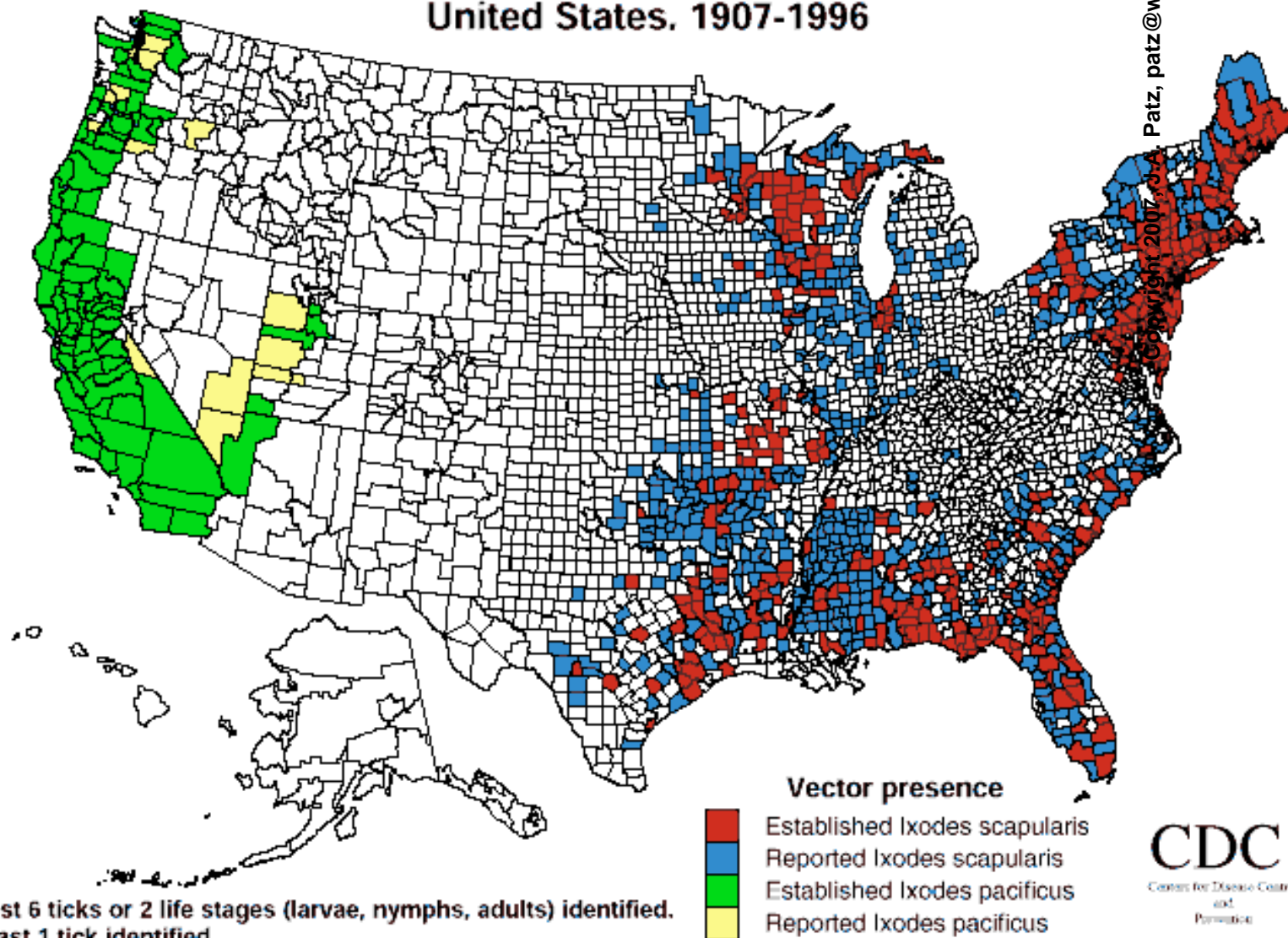




Figure 4 Isolated habitat remnants in the wheat belt of Western Australia. Isolation causes physical changes to habitat remnants, which in turn can lead to changes in species composition and population sizes. Photograph courtesy of CSIRO, Wildlife & Ecology.

Habitat fragmentation, and isolation is a major driver of ecosystem destabilization and species loss...and some diseases.

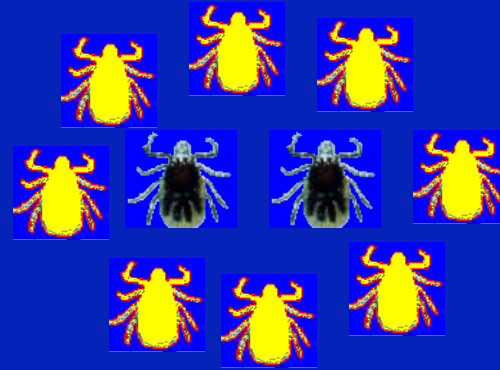
Established* and reported** distribution of the Lyme disease vectors
Ixodes scapularis (*I. dammini*) and *Ixodes pacificus*, by county,
United States, 1907-1996



*at least 6 ticks or 2 life stages (larvae, nymphs, adults) identified.

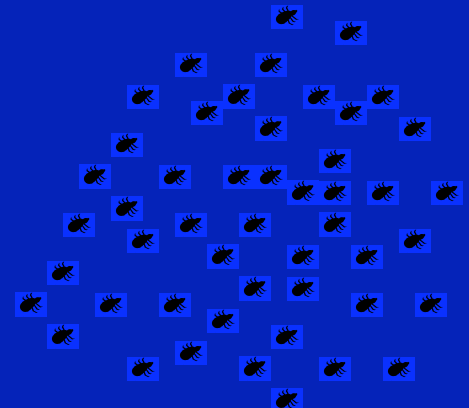
**at least 1 tick identified.

Biodiversity and the **Dilution Effect Hypothesis**



Nymphs

Copyright 2007, J.A. Patz, patz@wisc.edu



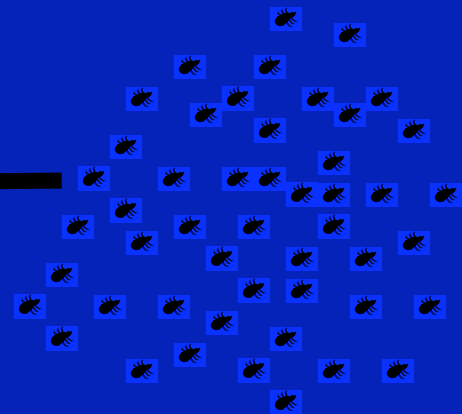
Larvae

Courtesy: Rick Ostfeld



Nymphs

yellow =
infected



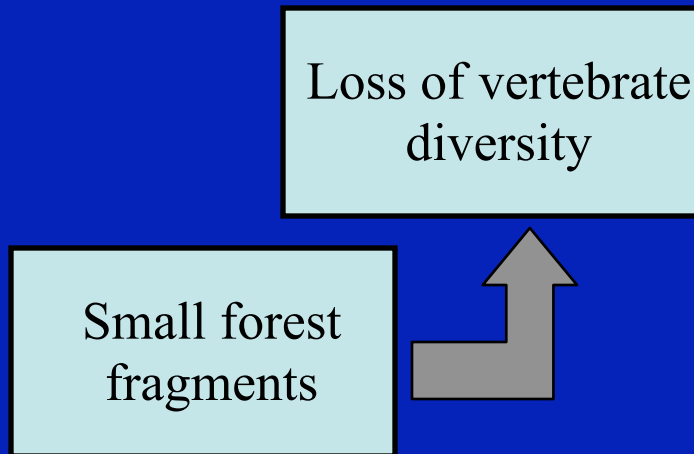
Larvae

Courtesy: R. Ostfeld

Copyright 2007, J.A. Patz, patz@wisc.edu

Small habitat fragments

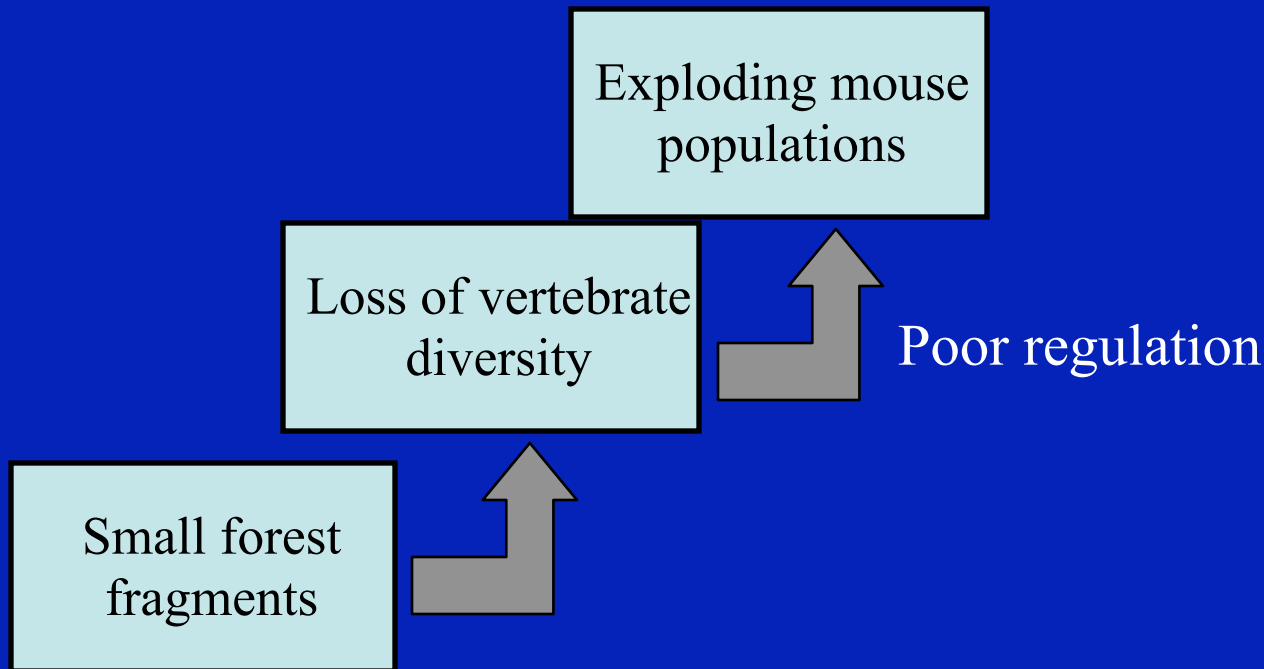
Copyright 2007, J.A. Patz, patz@wisc.edu



Adapted from: R. Ostfeld

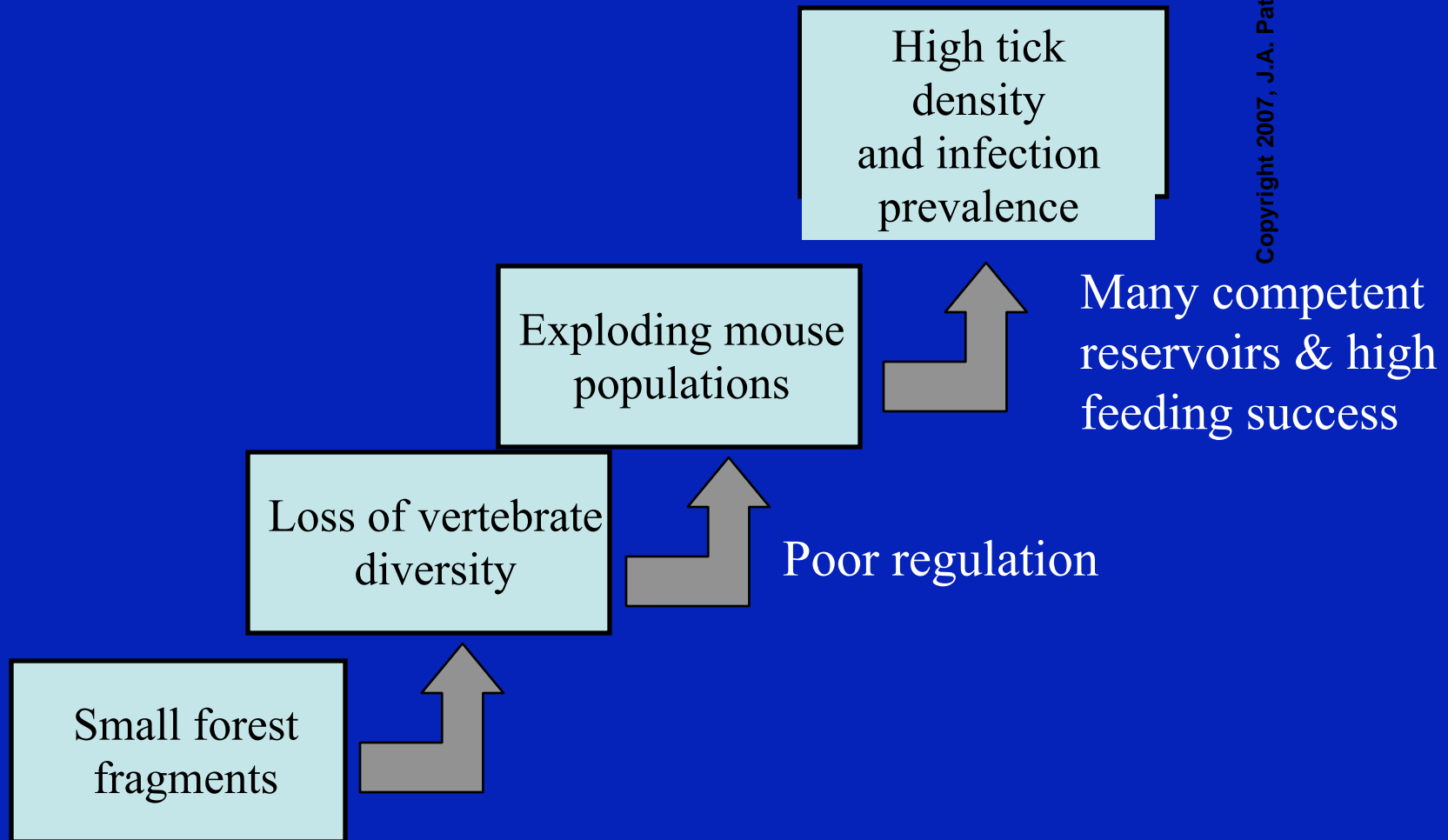
Small habitat fragments

Copyright 2007, J.A. Patz, patz@wisc.edu



Adapted from: R. Ostfeld

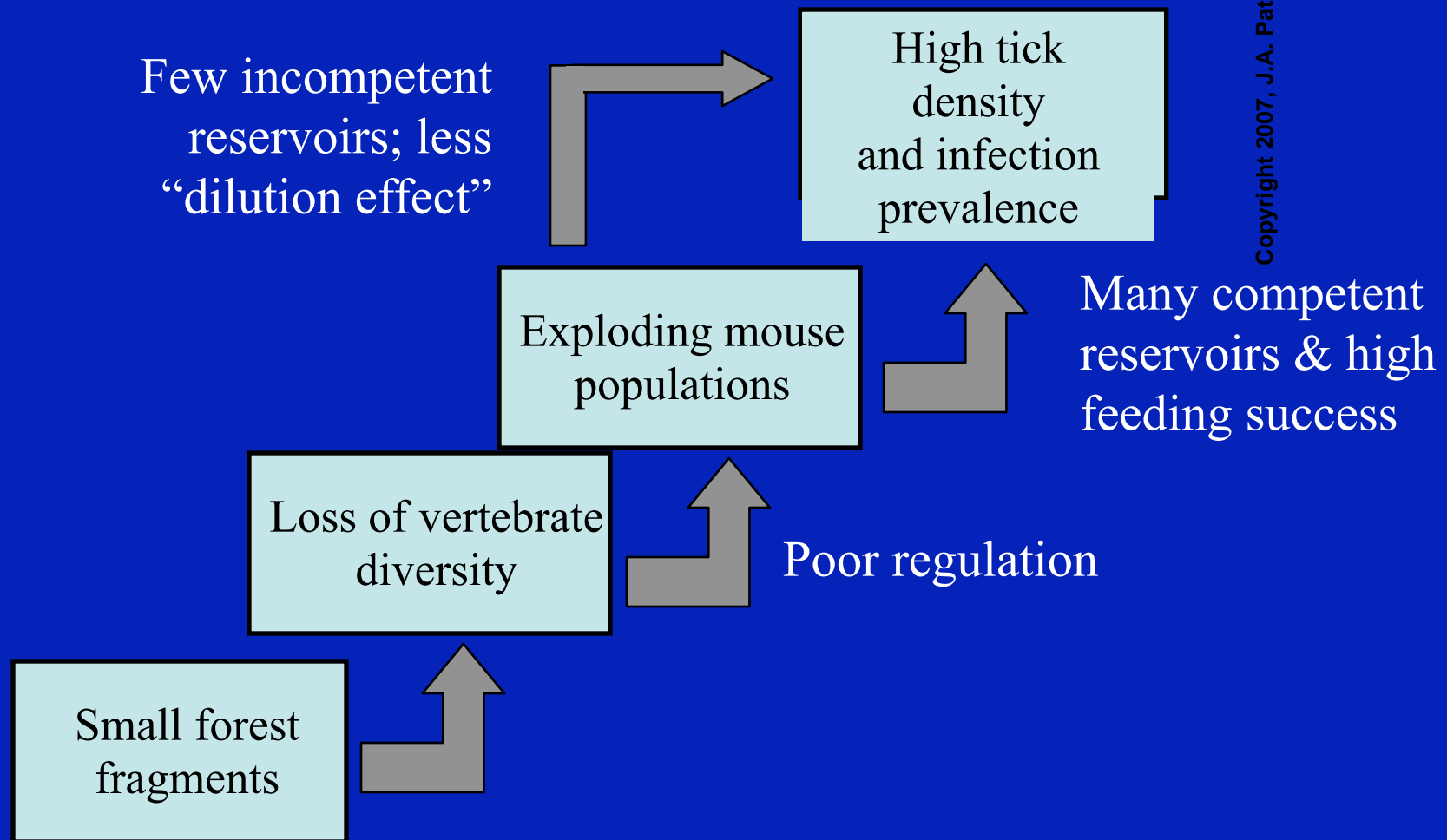
Small habitat fragments



Copyright 2007, J.A. Patz, patz@wisc.edu

Adapted from: R. Ostfeld

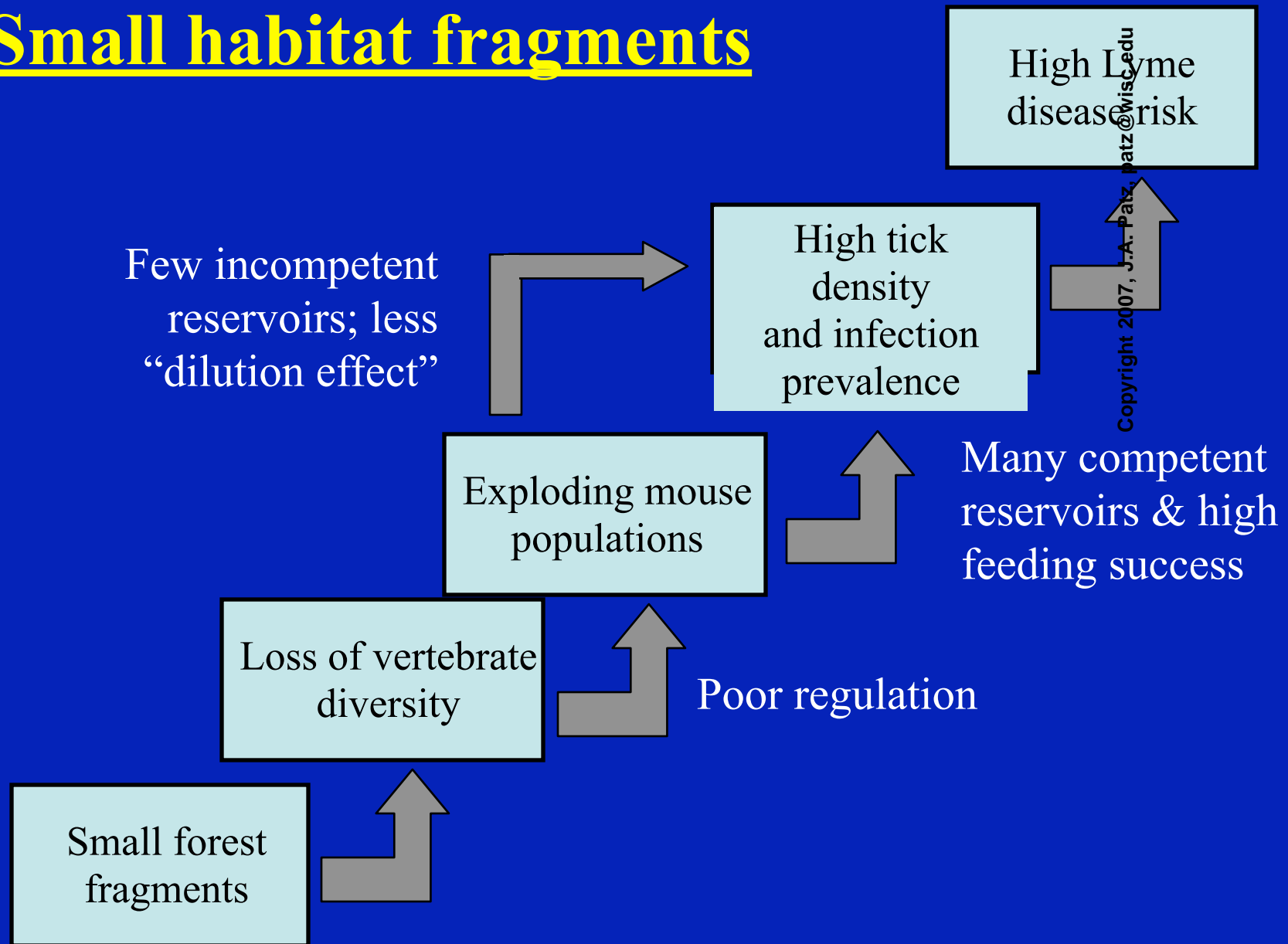
Small habitat fragments



Copyright 2007, J.A. Patz, patz@wisc.edu

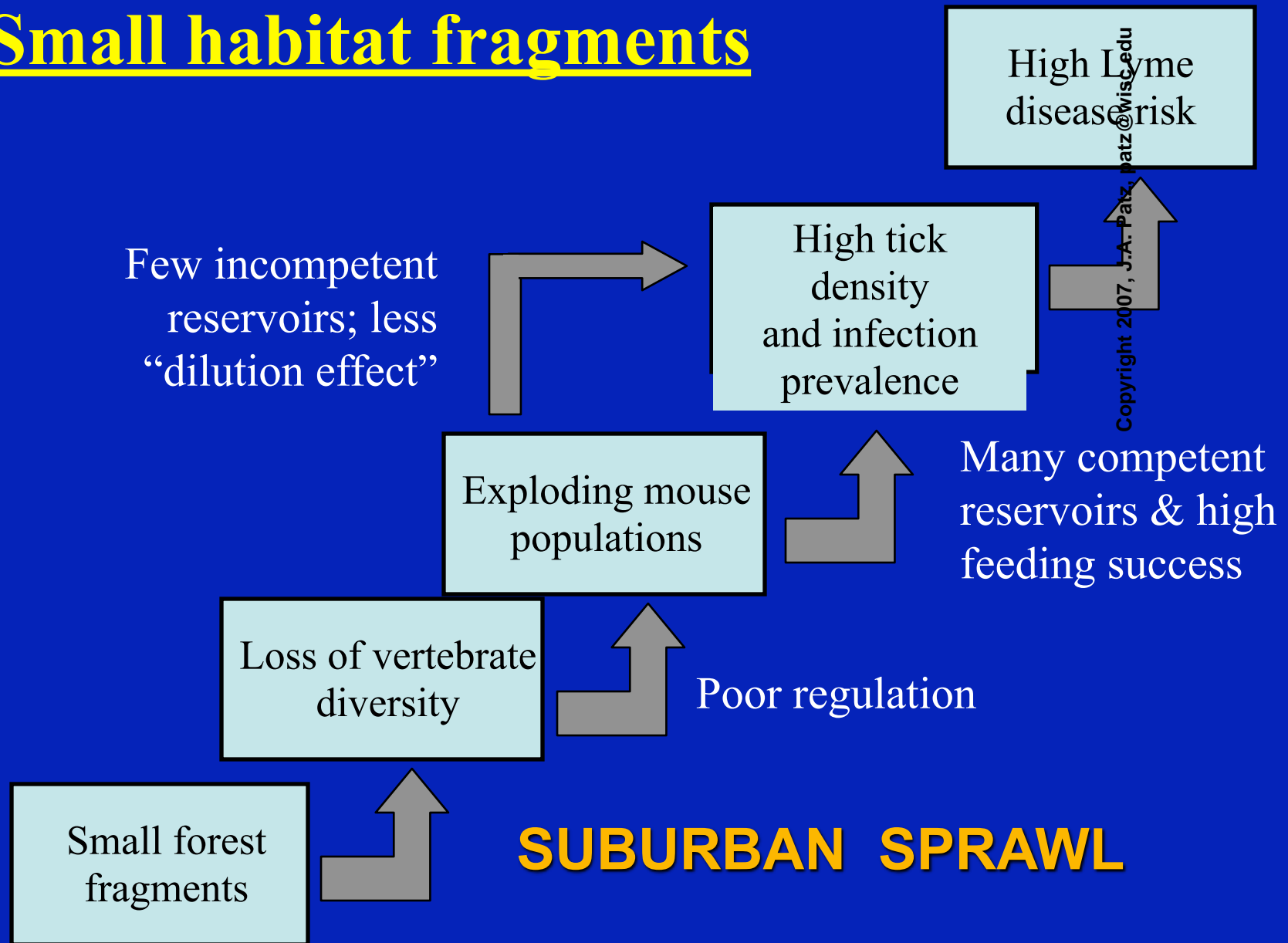
Adapted from: R. Ostfeld

Small habitat fragments



Adapted from: R. Ostfeld

Small habitat fragments



Adapted from: R. Ostfeld

“GROWING FUEL: *The Wrong Way: The Right Way*”

October, 2007, National Geographic



Source: National Geographic

Biofuels and Food Security

- The amount of humanitarian food aid available for extremely impoverished countries will be affected in the short term as **food aid shipments from the USA** are inversely correlated to commodity prices

(Naylor et al. 2007)

- For every percentage increase in the real prices of staple foods, **16 million more people** could become food-insecure

(Runge, 2003)

Biofuels: The End of Biodiversity?

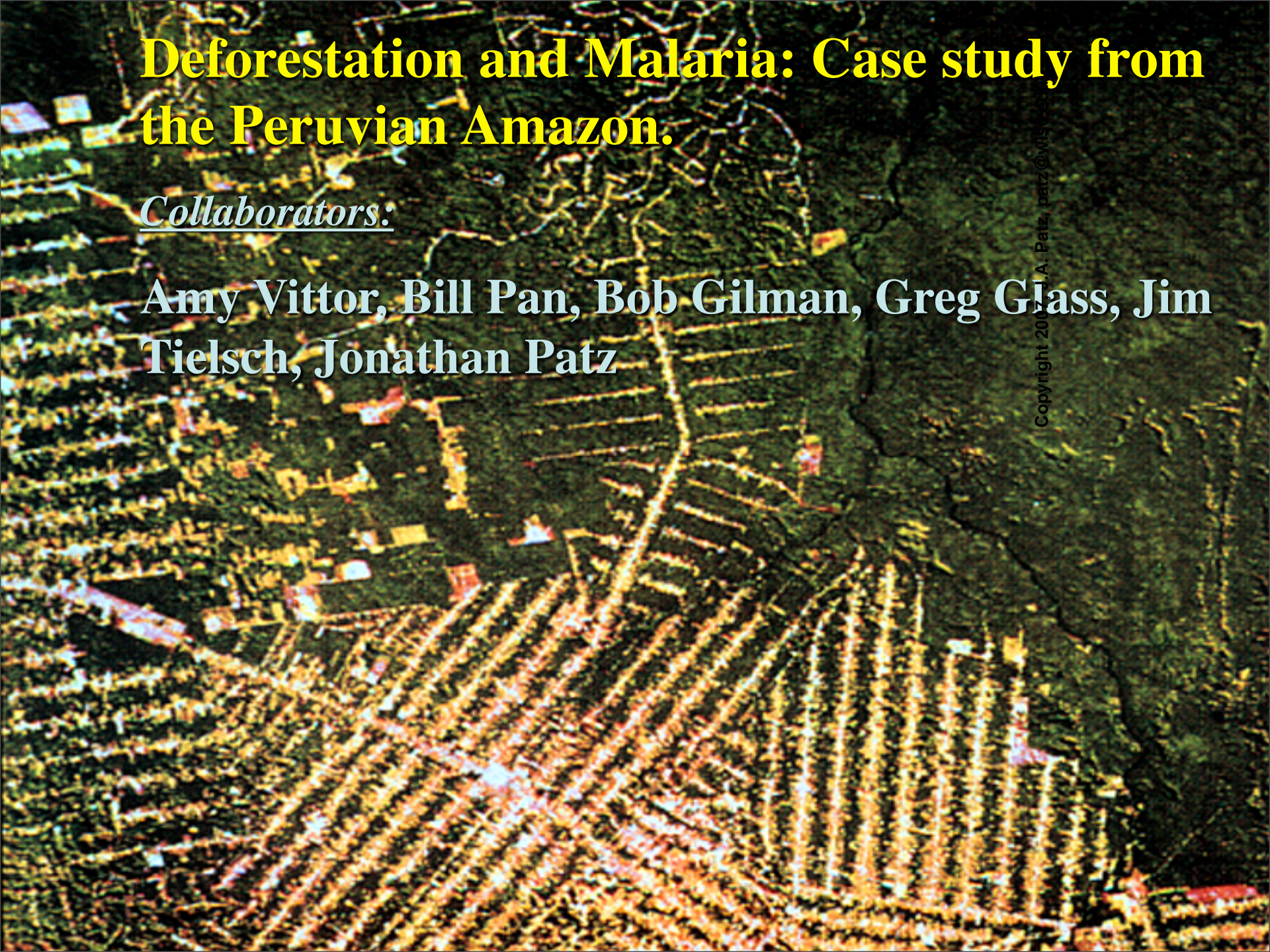
- Rush to rapidly switch energy sources away from oil and increase **reliance on crop-derived ethanol or biodiesel also could have devastating effects on the fate of the world's forests.**
- Vast majority of newly expanding **oil palm** fields have replaced closed forest in parts of Malaysia and Indonesia and increases in **soybean** production in Brazil coincide with more forest conversion.

(Gibbs unpublished data)

Deforestation and Malaria: Case study from the Peruvian Amazon.

Collaborators:

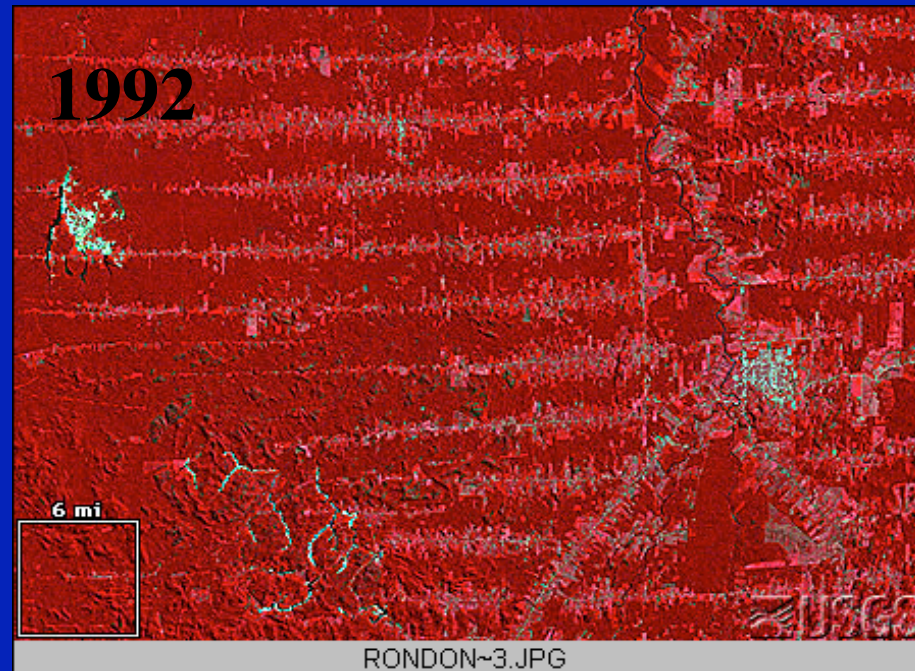
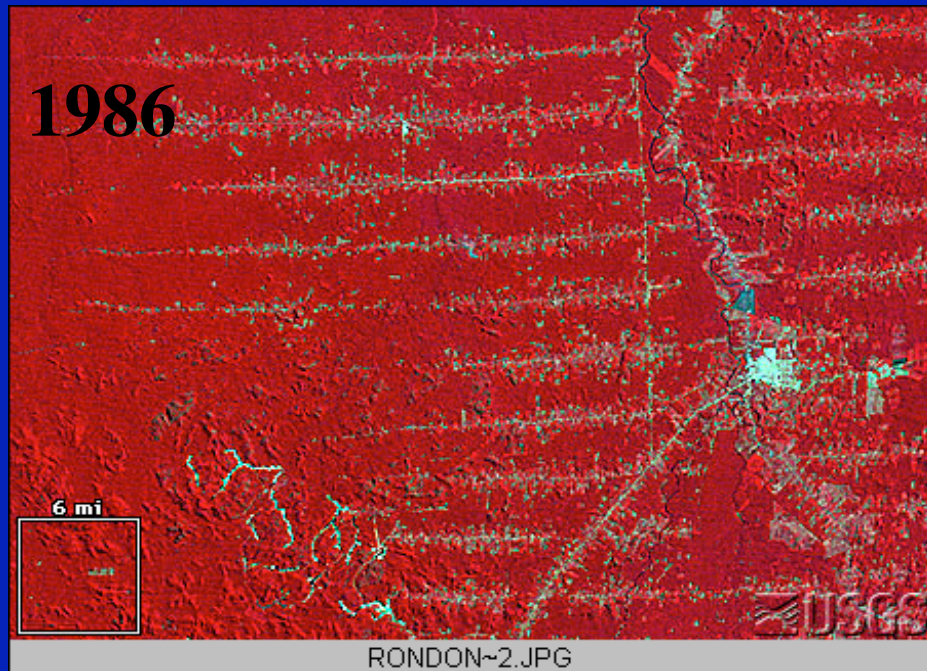
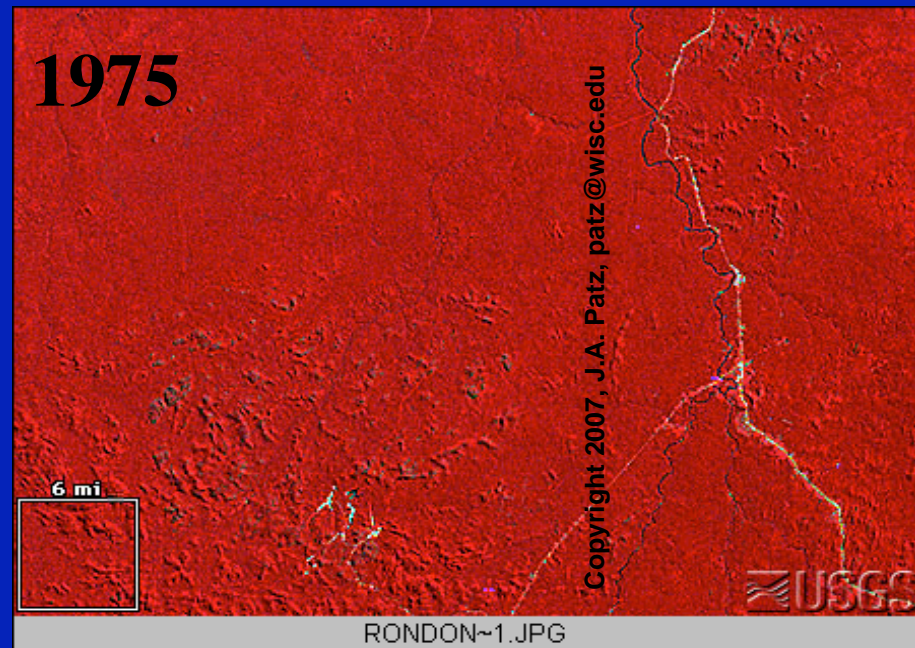
Amy Vittor, Bill Pan, Bob Gilman, Greg Glass, Jim Tielsch, Jonathan Patz



Rondonia, Brazil

“Fishbone pattern” of logging roads

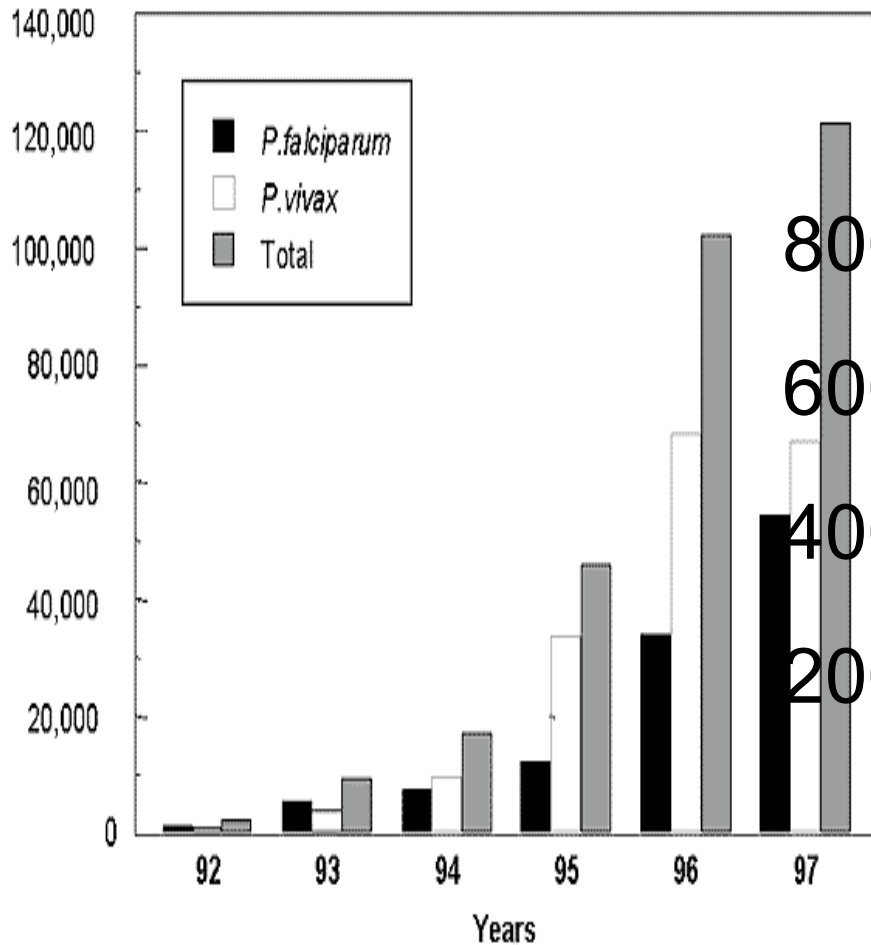
(Reverse color satellite
image)



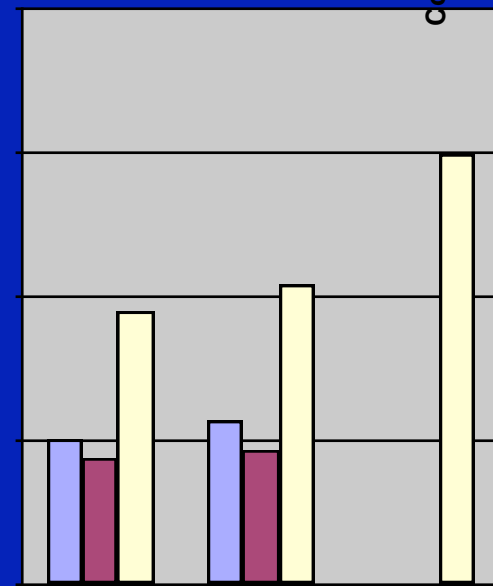
Malaria - Latin America

Copyright 2007, J.A. Patz, patz@wisc.edu

Malaria cases Peruvian Amazon



800000
600000
400000
200000
0



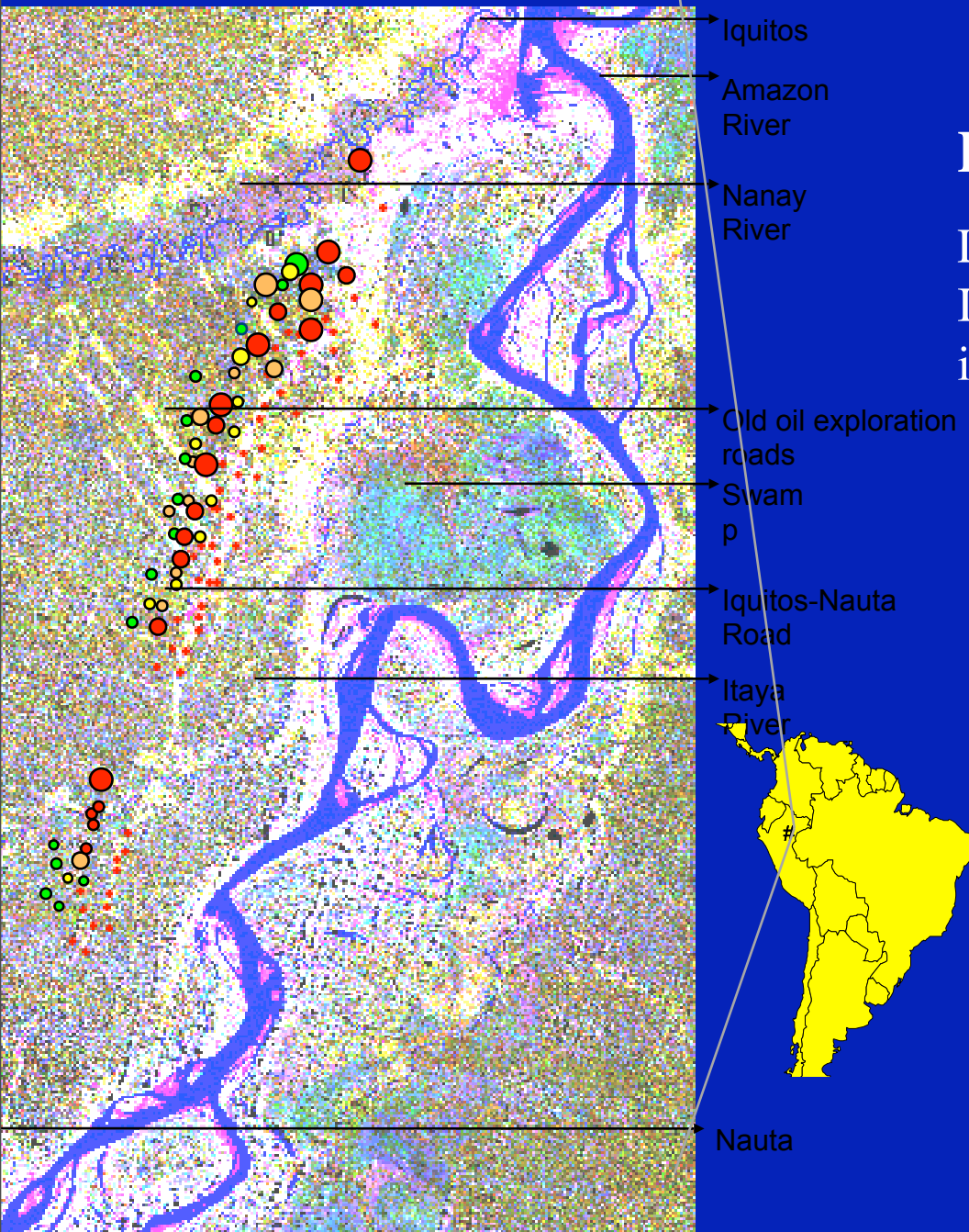
1985 1986 1990

fa
vi
to

Peruvian Amazon study site

Landsat image shows road from Iquitos to Nauta. 56 sampling sites indicated per key below:

Copyright 2007, J.A. Patz-Cruz@msc.edu



Scale: 1:800,000

- 5.0 – 22.9 mean *A. darlingii*/6-hrs/person
- high deforestation (54%), low forest (3%)
- 0.5 – 4.9 mean *A. darlingii*/6-hrs/person
- medium deforestation (25%), medium forest (20%)
- 0 – 0.4 mean *A. darlingii*/6-hrs/person
- low deforestation (5%), medium forest (35%)
- low deforestation (6%), high forest (76%)

Anopheles mosquitoes

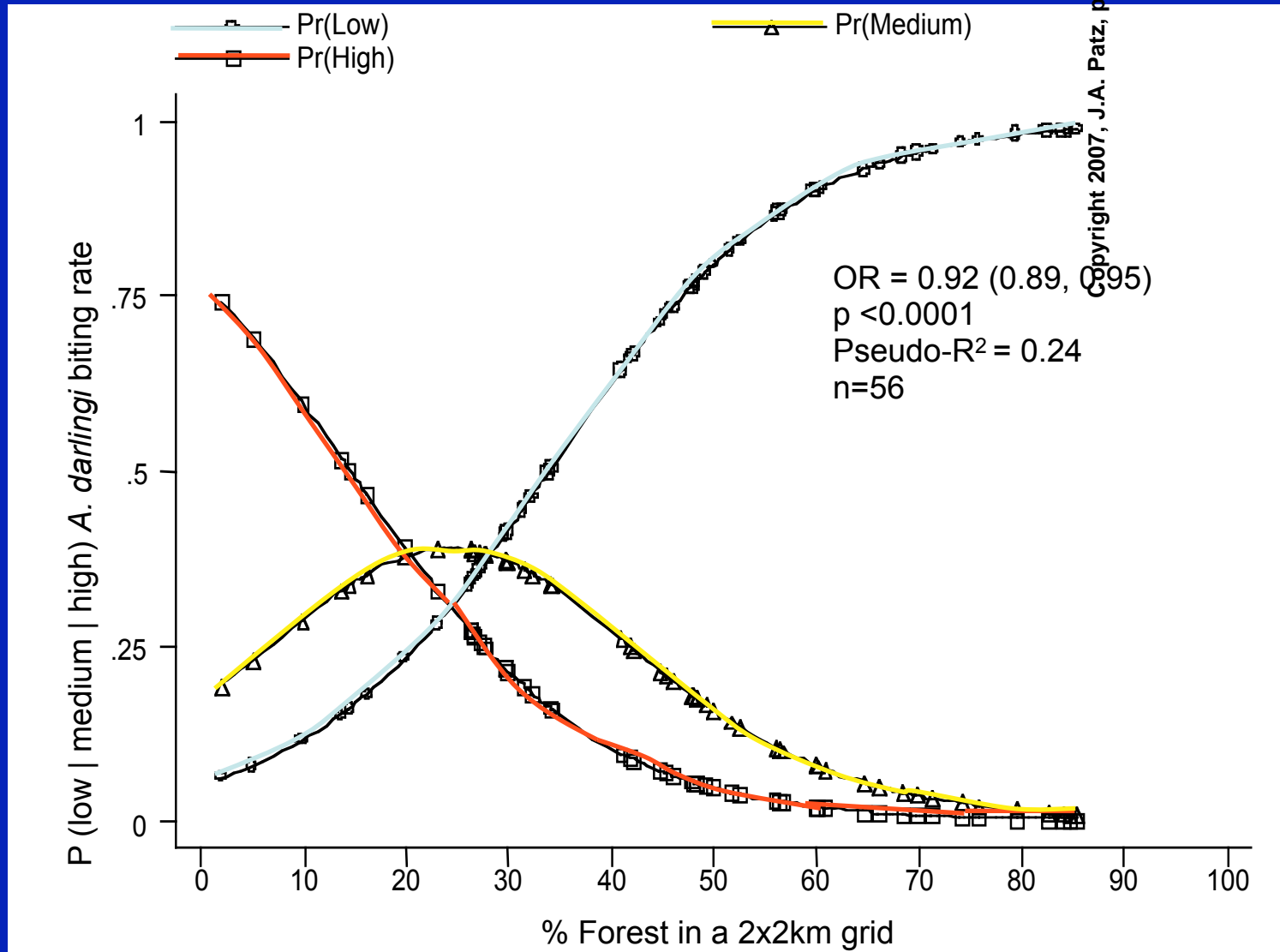
~ 422 species of *Anopheles*, 60 to 70 of which can act as malaria vectors

Therefore, many *Anopheles* species are harmless to humans, incapable of allowing *Plasmodium* to develop into sporozoites that reside in the salivary glands.

Some species will harbor *P. vivax* sporozoites, but not *P. falciparum* sporozoites.

Mosquito biting rates v. forest cover

Vittor et al. 2006



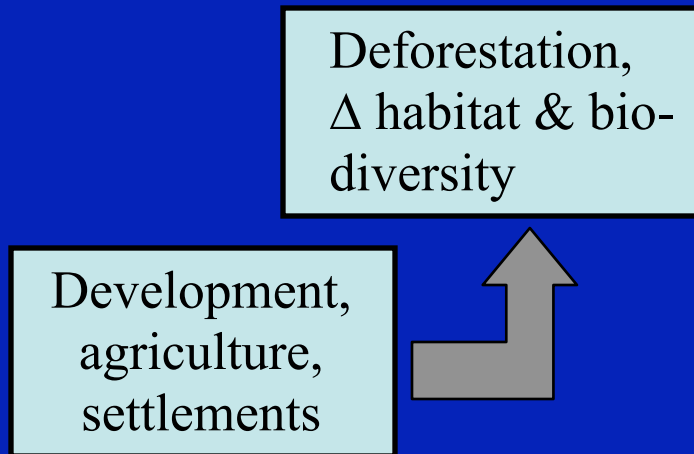
Deforestation's effect on Malaria risk?

Copyright 2007, J.A. Patz, patz@wisc.edu

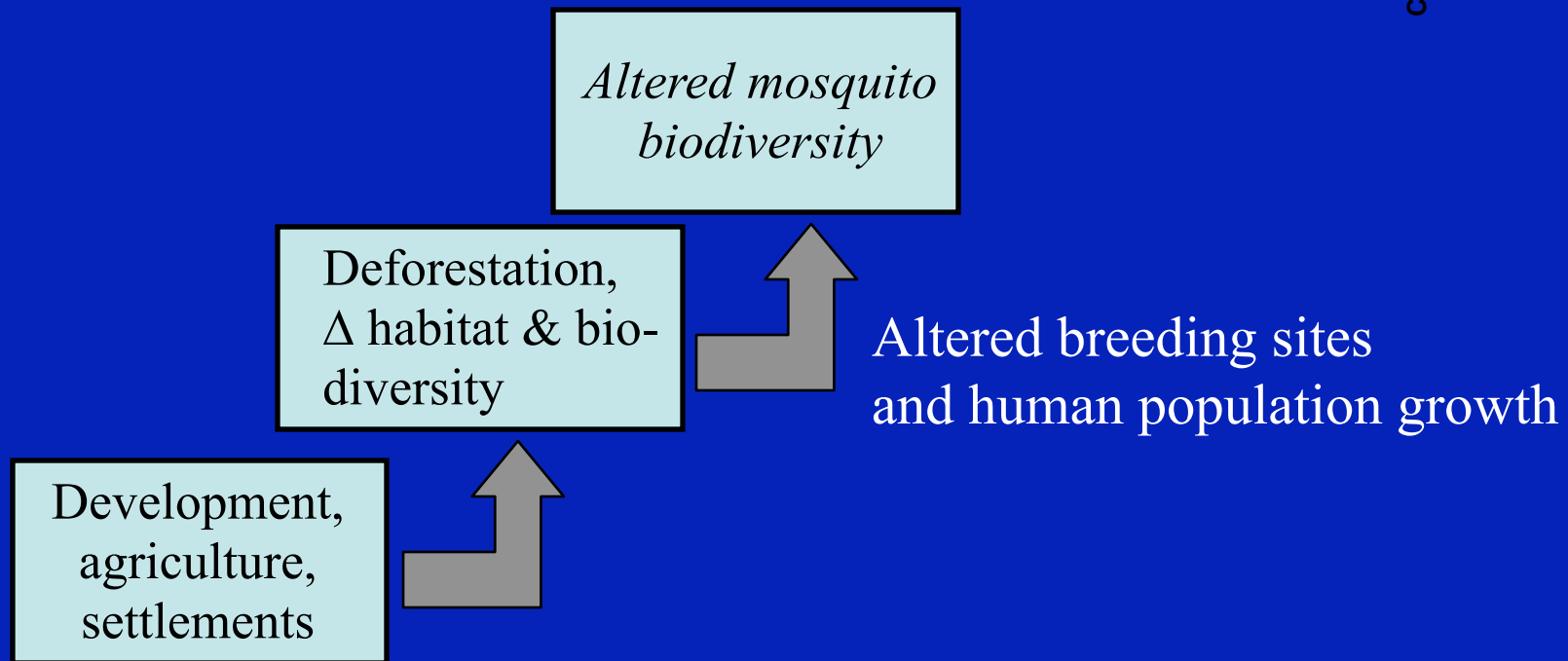


Deforestation's effect on Malaria risk?

Copyright 2007, J.A. Patz, patz@wisc.edu

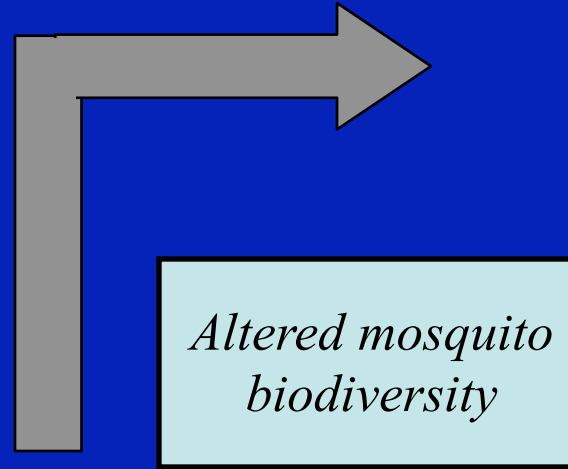


Deforestation's effect on Malaria risk?

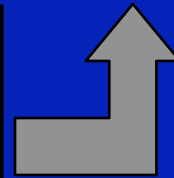


Deforestation's effect on Malaria risk?

Fish ponds and
road culverts

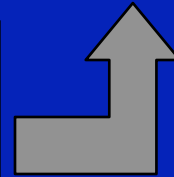


Deforestation,
 Δ habitat & bio-
diversity

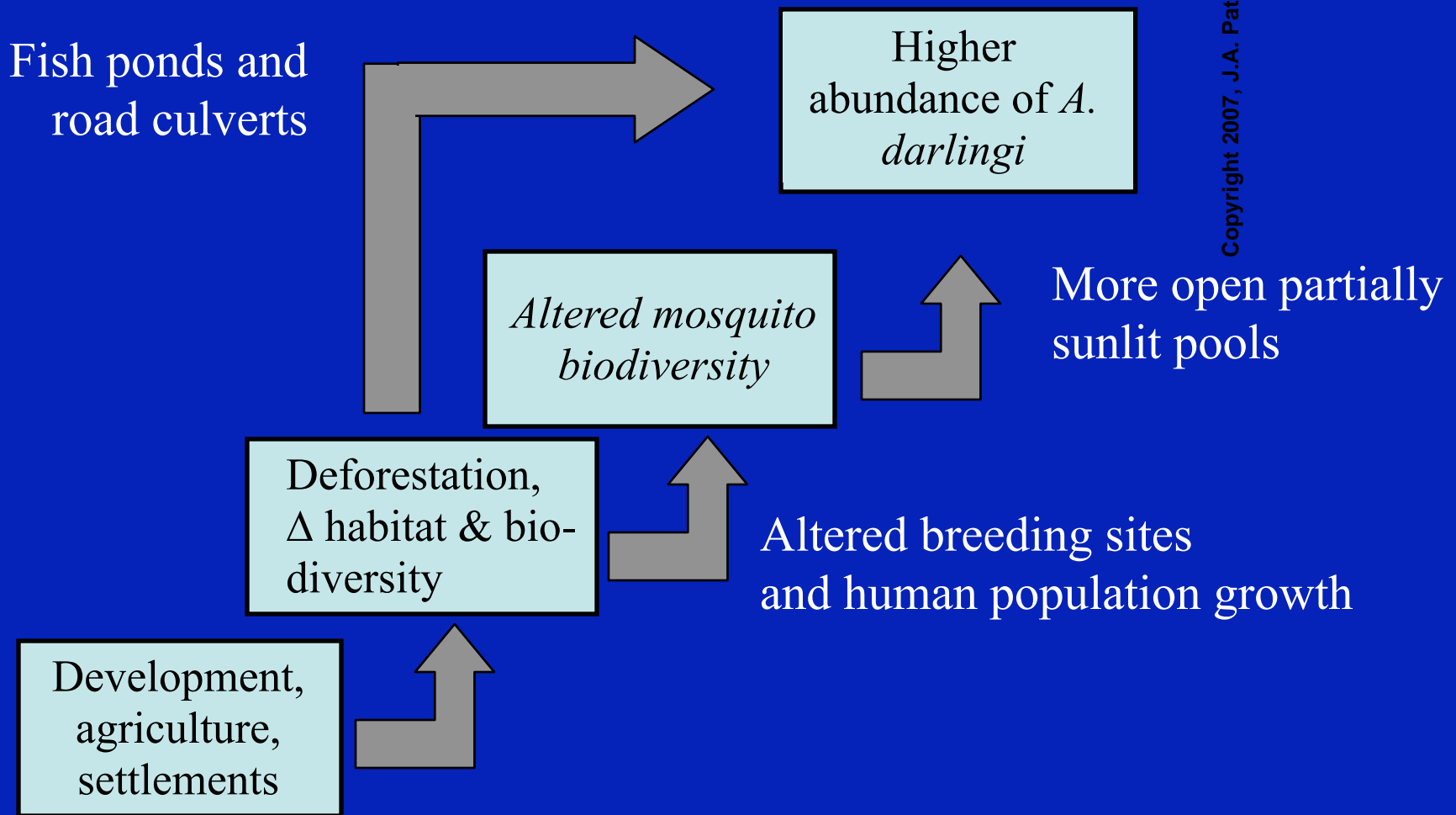


Altered breeding sites
and human population growth

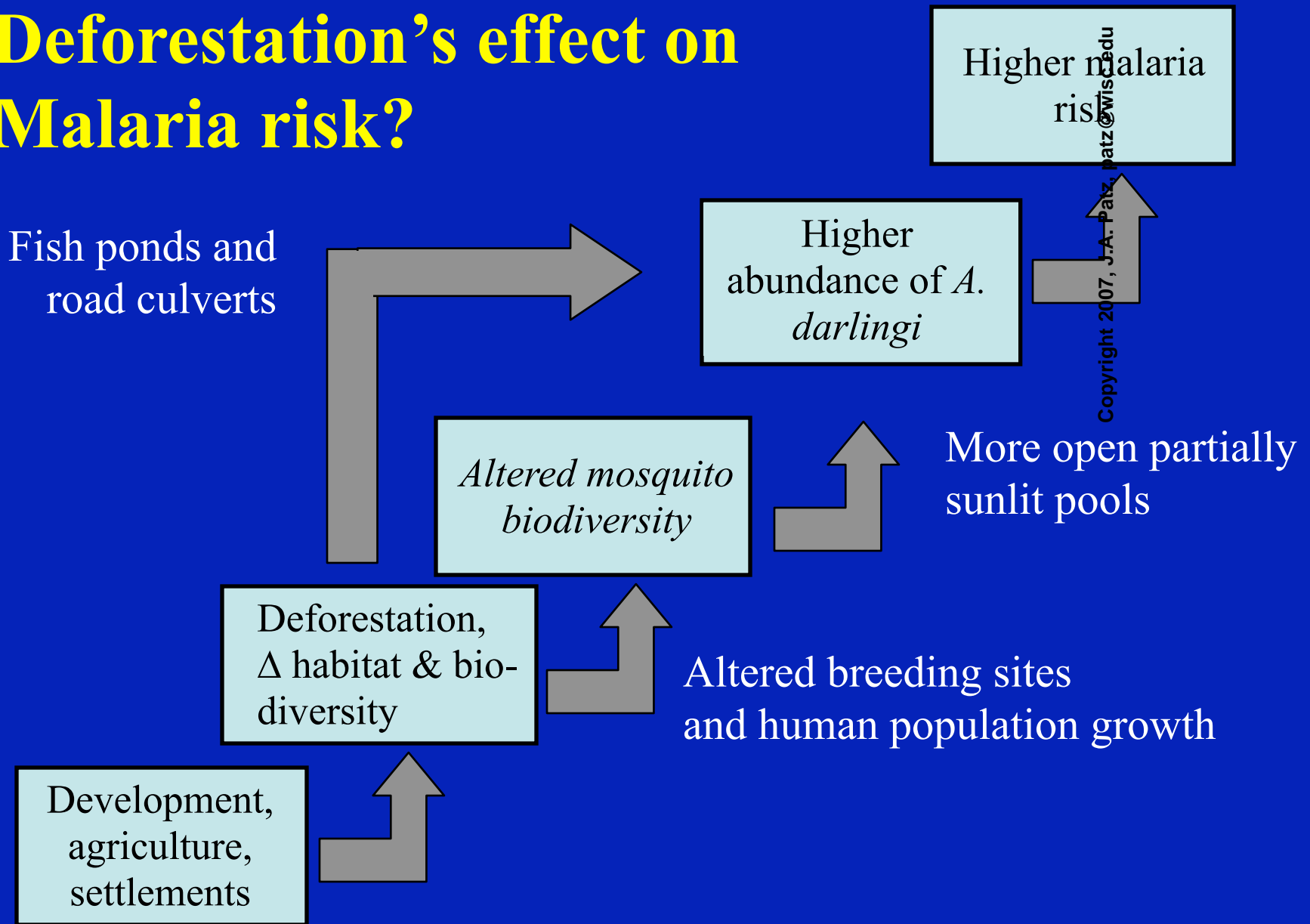
Development,
agriculture,
settlements



Deforestation's effect on Malaria risk?



Deforestation's effect on Malaria risk?



Conclusion

1. Unplanned land use change will modify (for better or worse) the hazardous exposures presented by climate change
2. First do no harm: if switch to biofuels, conduct full health impacts

Information for middleschool teachers
students, and the general public

ECOHEALTH101.ORG

Copyright 2007, J.A. Patz, patz@wisc.edu



PBS HOME

PROGRAMS A-Z

TV SCHEDULES

SUPPORT PBS

SHOP PBS

SEARCH PBS

Search

TEACHERS

STUDENTS

GLOSSARY

SITE MAP

NEWS PAGE



TOPICS

Taking Our Temperature
Hole in the 'Zone
Unbalancing Act
What's Left to Eat?
Our Small World
Questions & Answers

ECO HEALTH

ENVIRONMENTAL CHANGE AND OUR HEALTH

Earth has more people than ever before. New technologies have improved the quality of life for many. But our quest for a better life is also changing the face of the planet – and putting our health at risk.



Information for middleschool teachers
students, and the general public

ECOHEALTH101.ORG

Copyright 2007, J.A. Patz, patz@wisc.edu



PBS HOME

PROGRAMS A-Z

TV SCHEDULES

SUPPORT PBS

SHOP PBS

SEARCH PBS

Search

TEACHERS

STUDENTS

GLOSSARY

SITE MAP

NEWS PAGE



TOPICS

Taking Our Temperature
Hole in the 'Zone
Unbalancing Act
What's Left to Eat?
Our Small World
Questions & Answers

ECO HEALTH 
ENVIRONMENTAL CHANGE AND OUR HEALTH

<-- CLIMATE CHANGE

have improved the quality of
life for many. But our quest for
a better life is also changing the
face of the planet – and putting
our health at risk.



Information for middleschool teachers
students, and the general public

ECOHEALTH101.ORG

Copyright 2007, J.A. Patz, patz@wisc.edu



PBS HOME

PROGRAMS A-Z

TV SCHEDULES

SUPPORT PBS

SHOP PBS

SEARCH PBS

Search

TEACHERS

STUDENTS

GLOSSARY

SITE MAP

NEWS PAGE



TOPICS

Taking Our Temperature
Hole in the 'Zone
Unbalancing Act
What's Left to Eat?
Our Small World
Questions & Answers

ECO HEALTH 
ENVIRONMENTAL CHANGE AND OUR HEALTH

<-- CLIMATE CHANGE

<--LAND USE CHANGE

a better life is also changing the
face of the planet – and putting
our health at risk.



Information for middleschool teachers
students, and the general public

ECOHEALTH101.ORG

Copyright 2007, J.A. Patz, patz@wisc.edu



PBS HOME

PROGRAMS A-Z

TV SCHEDULES

SUPPORT PBS

SHOP PBS

SEARCH PBS

Search

TEACHERS

STUDENTS

GLOSSARY

SITE MAP

NEWS PAGE



TOPICS

Taking Our Temperature
Hole in the 'Zone
Unbalancing Act
What's Left to Eat?
Our Small World
Questions & Answers

ECO HEALTH 
ENVIRONMENTAL CHANGE AND OUR HEALTH

<-- CLIMATE CHANGE

<--LAND USE CHANGE

a better life is also changing the
face of the planet – and putting
our health at risk.



THANK YOU !