A World In Motion

Martin Cetron, M.D.
Global Migration and Emerging Infections

CDC

National Geographic, Feb. 2002

Cholera in New York City, 1892

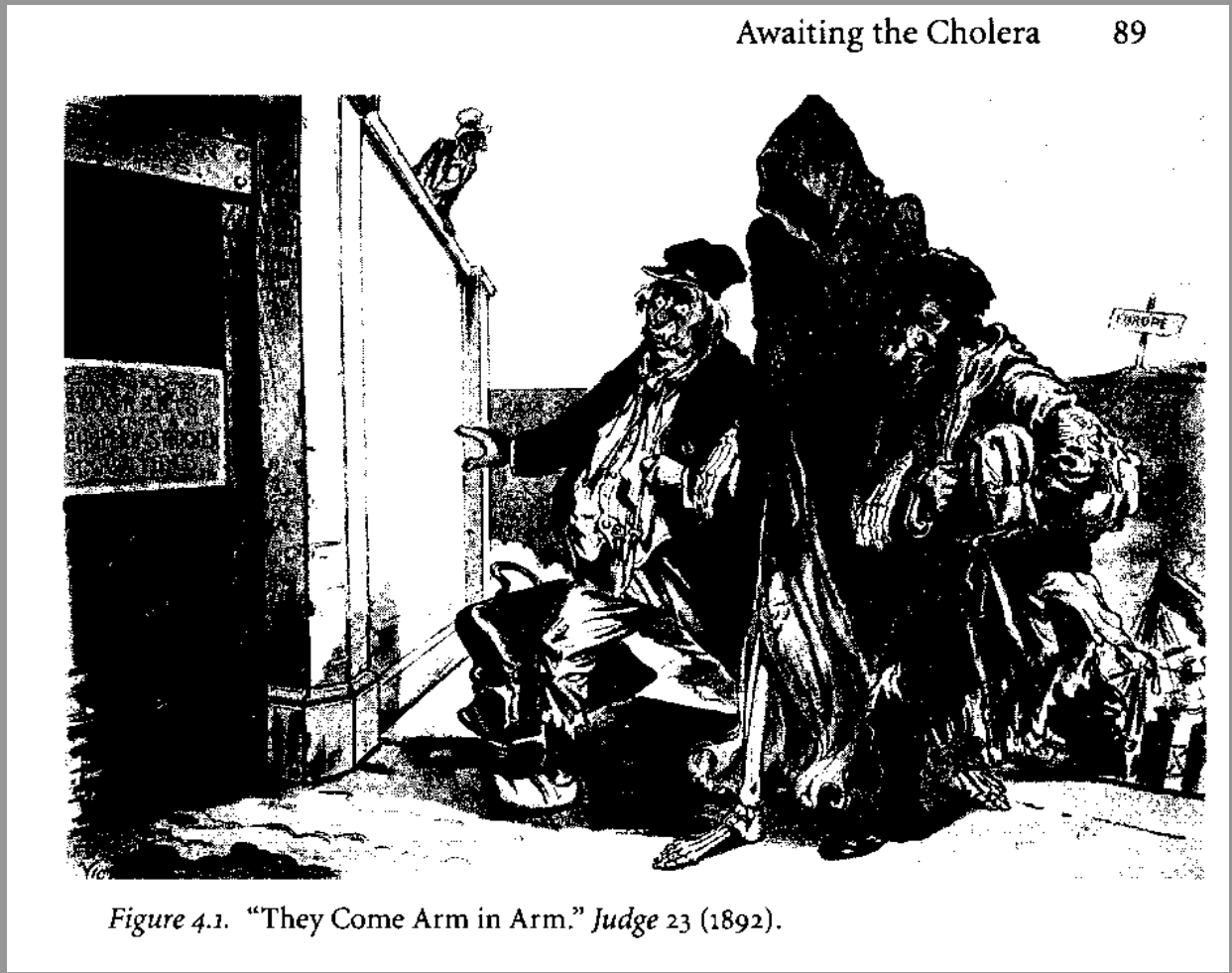

Figure 4.1. "They Come Arm in Arm." *Judge* 23 (1892).

CDC
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Typhus Fever Epidemic, 1892

Figure 1.3. SS *Massilia.* Collection of the Peabody Essex Museum, Salem, Mass.

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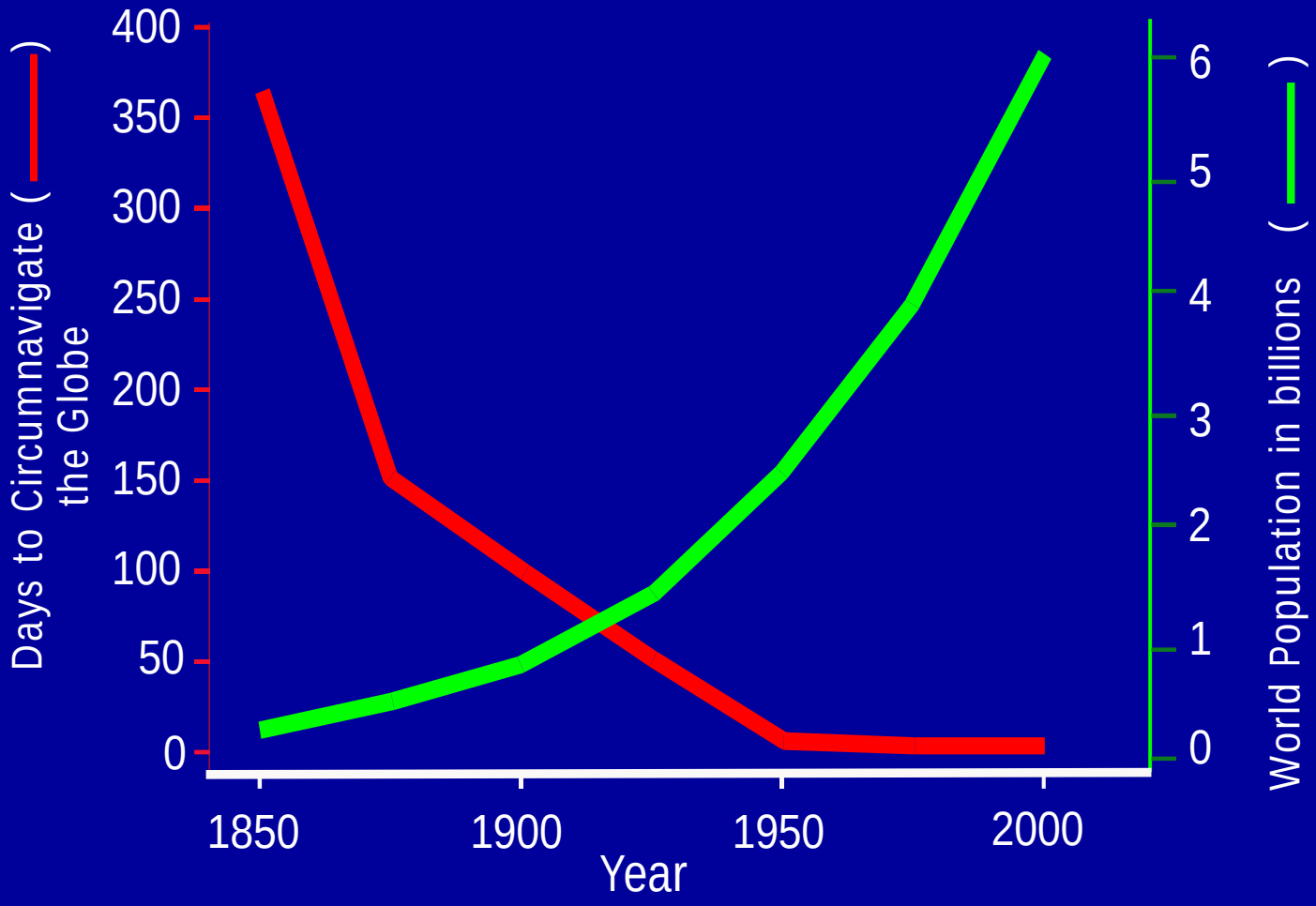
Speed of Global Travel in Relation to World Population Growth



From: Murphy and Nathanson. Semin. Virol. 5, 87, 1994

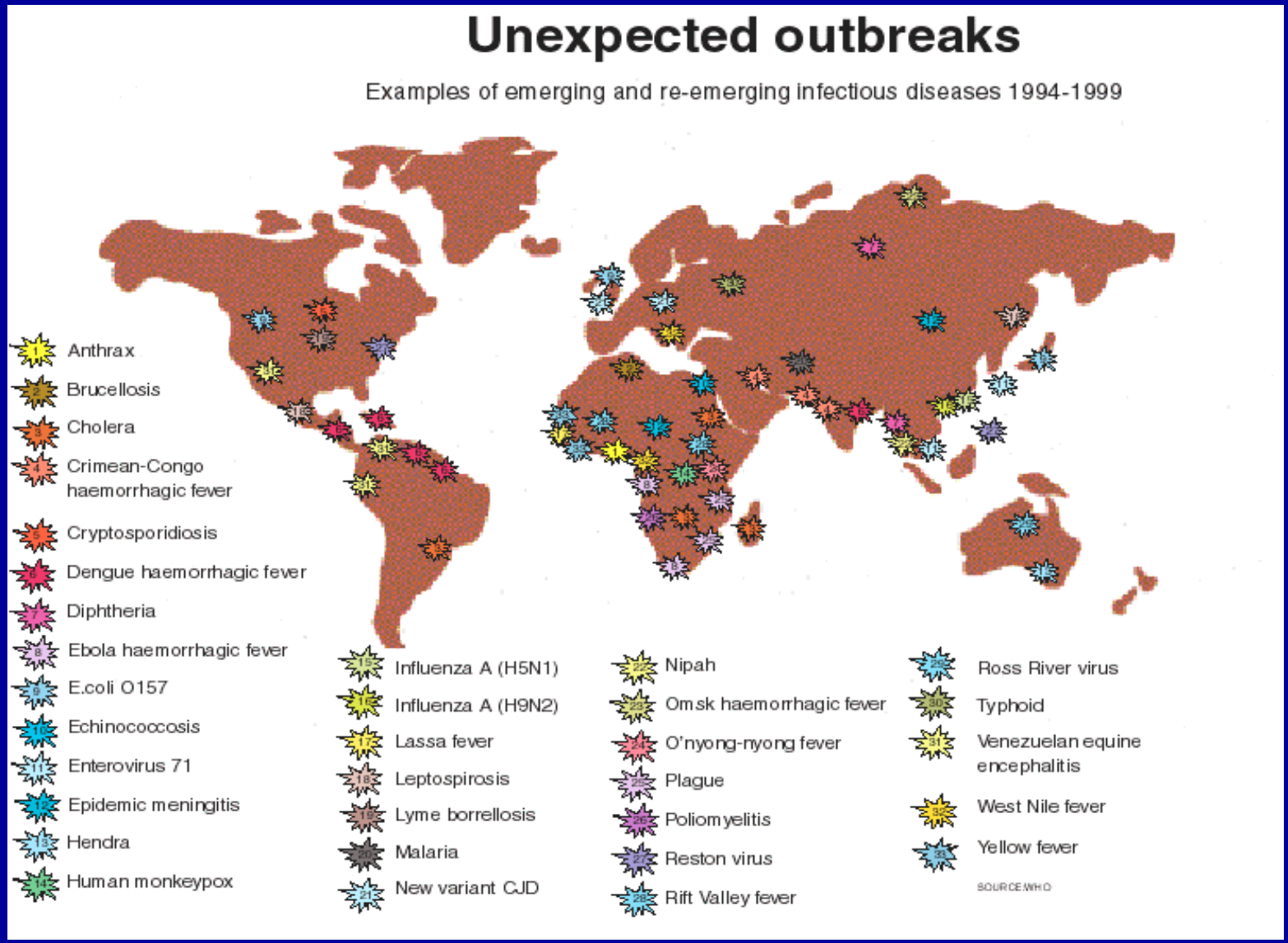
CDC

“ Today, diseases as common as the cold and as rare as Ebola are circling the globe with near telephonic speed, making long-distance connections and intercontinental infections as if by satellite. You needn’t even bother to reach out and touch someone. If you’re homeothermic biomass, you will be reached and touched.”

Natalie Angier

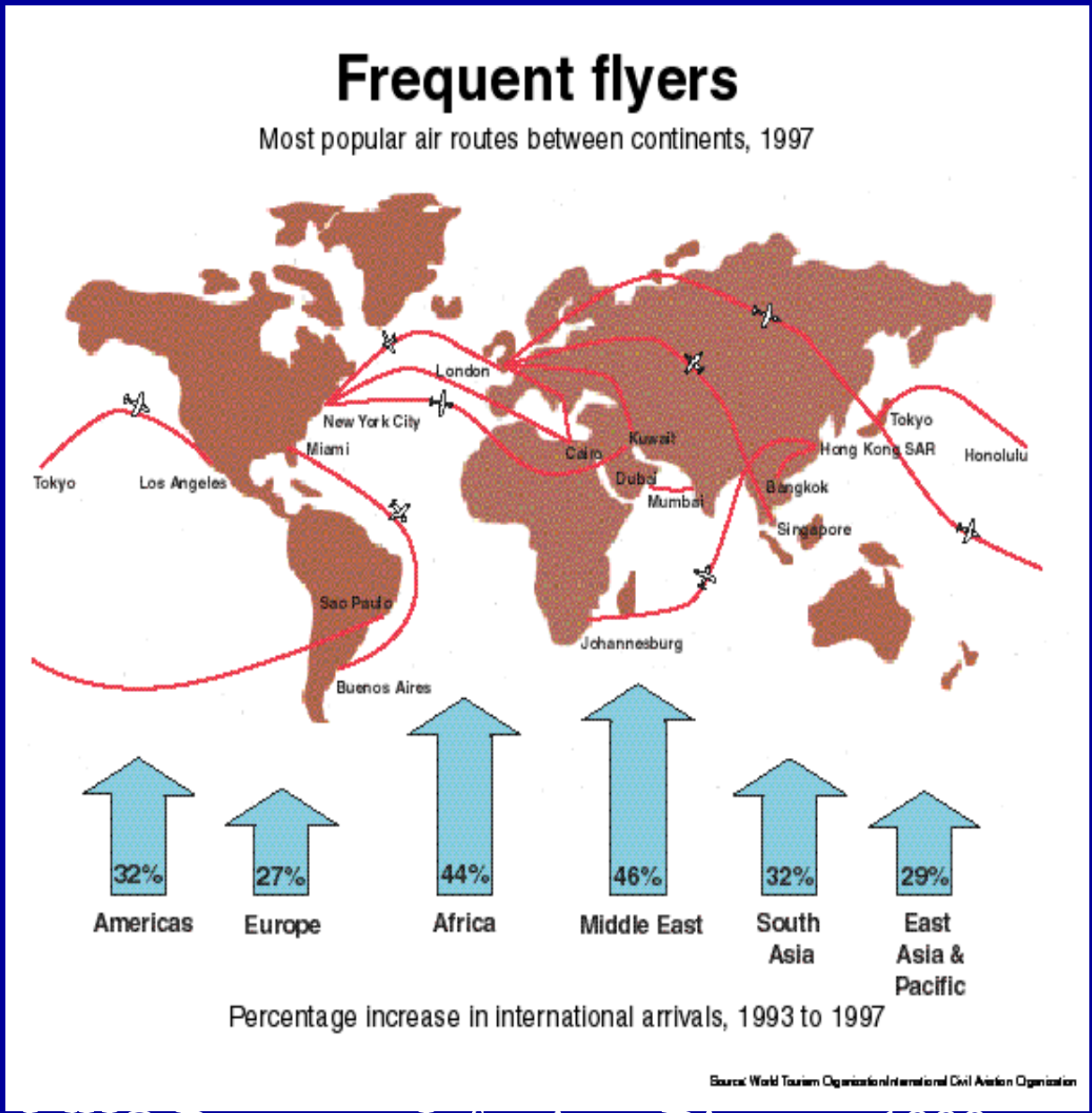
New York Times Magazine

6 May 2001



WHO Report on Infectious Diseases 1999
"Removing Obstacles to Healthy Development"

CDC



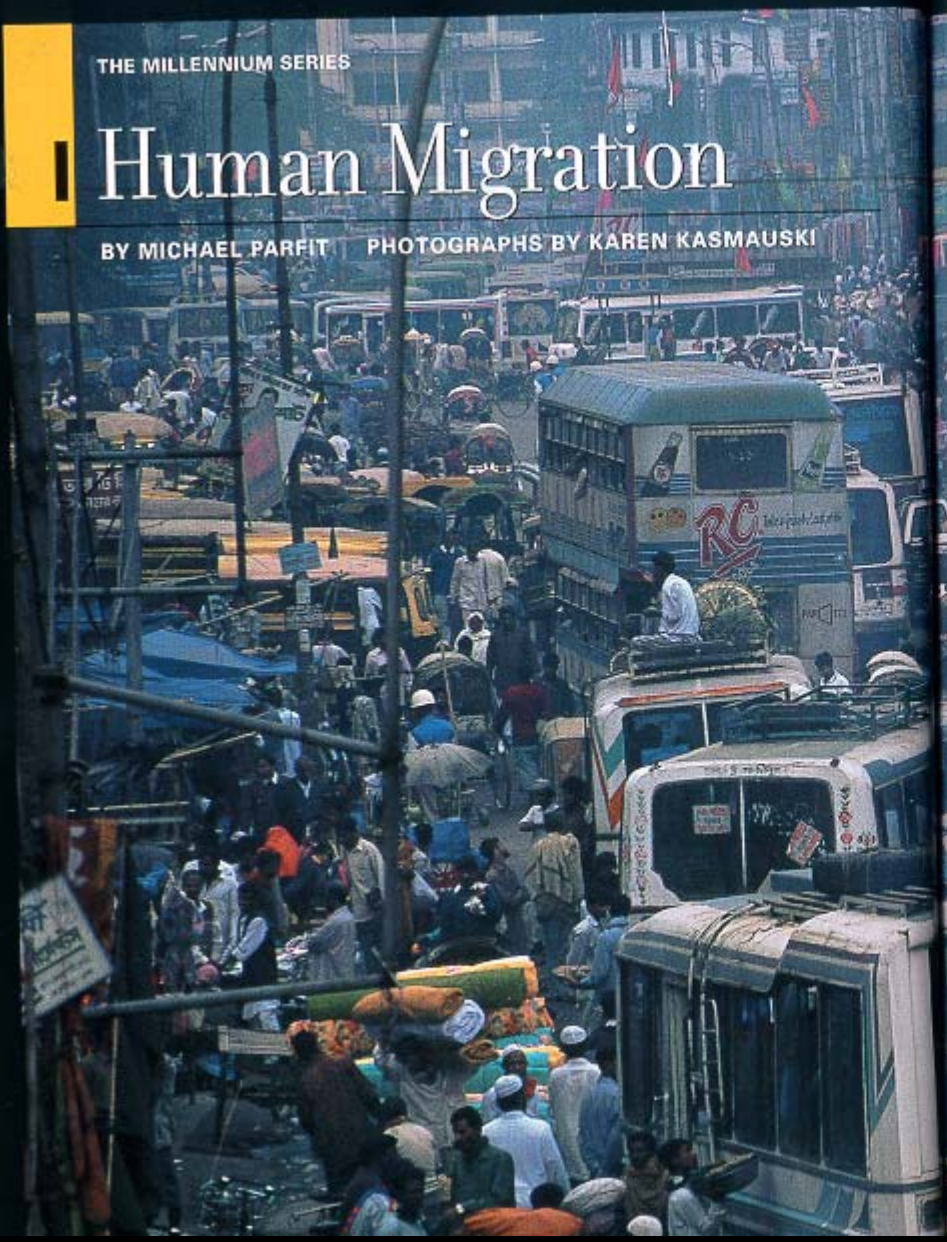
WHO Report on Infectious Diseases 1999
"Removing Obstacles to Healthy Development"

CDC

THE MILLENNIUM SERIES

Human Migration

BY MICHAEL PARFIT PHOTOGRAPHS BY KAREN KASMAUSKI



■ Leaving home to dwell in an unfamiliar world—more than a million rural Bangladeshis have done it, seeking jobs in Dhaka (below). So too have tens of millions of others, whose movements endlessly transform the planet's human face.

Human Migration

- "… the dynamic undertow of population change; everyone's solution, everyone's conflict."
  - Michael Parfit

  National Geographic, October 1998

Congolese refugees arriving on shore of Lake Tanganyika, 1998
photo by Karen Kasmauski

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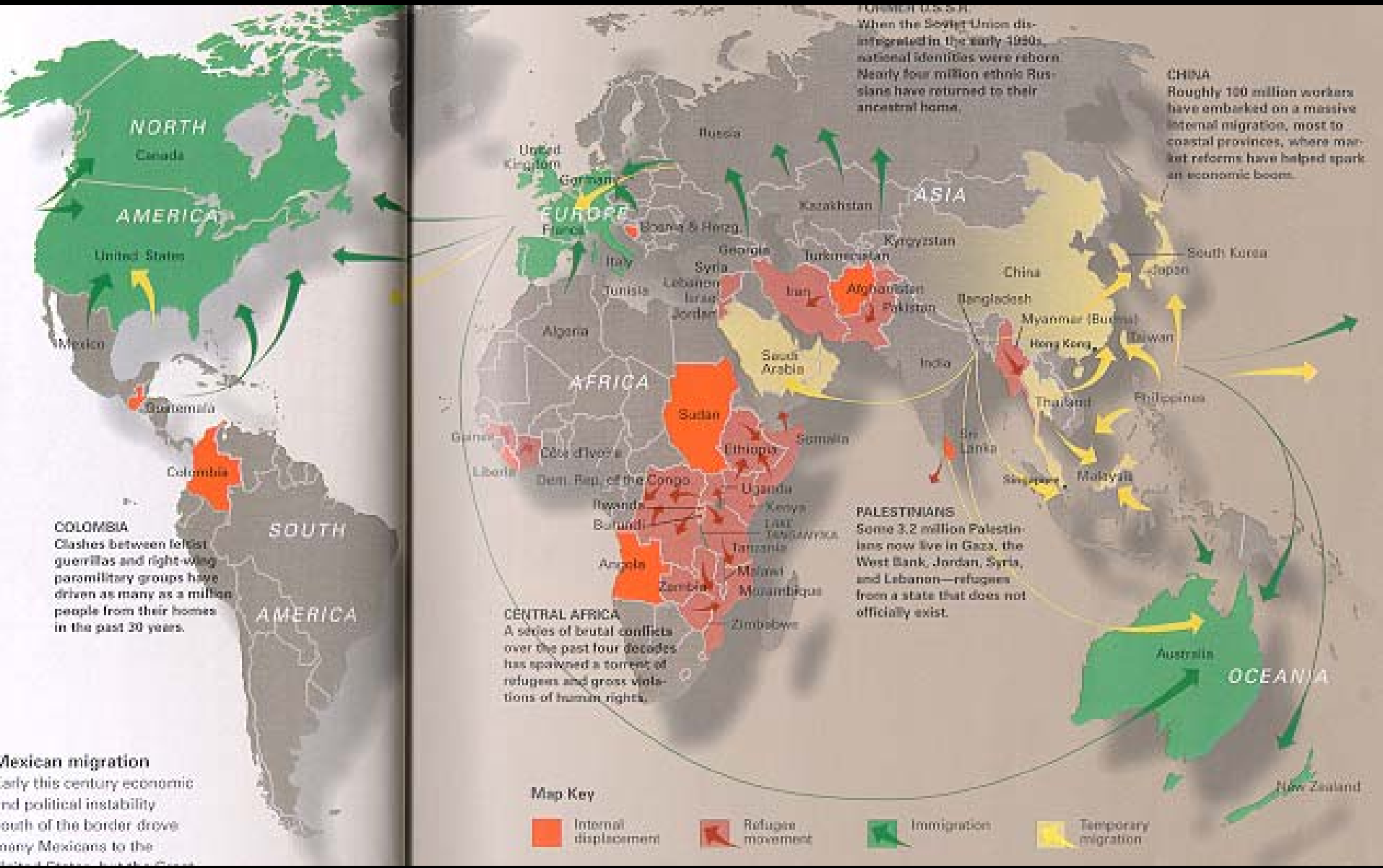
Human Migration: *"Push" <------> "Pull"*

- **Origin**
  - **War, strife, persecution, famine**
- **Destination**
  - **peace, freedom, sustenance, economic opportunity, pleasure**

Refugees, IDPs, Immigrants, Temporary Migrants- 1990's



Making Tracks: Migration 1990's

Mobile Populations

Making tracks: migration in the 1990s

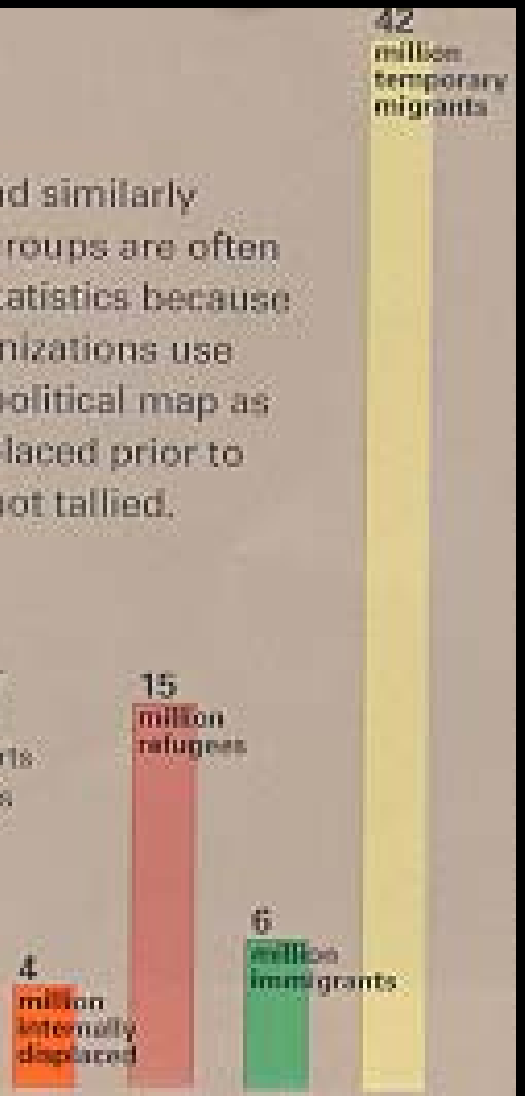
What drives migration? Demographers point to the interaction of two forces: the lure of a distant place—hope of a job, for instance—and the negatives of life at home, such as political unrest or a natural disaster.

While men and women in, say, the Philippines are often motivated by both impulses—the "push" of an anemic economy at home plus the "pull" of jobs in the Middle East—other migrants are uprooted involuntarily, often at gunpoint, and become refugees. Legally defined as a person who has "a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion," a refugee must reside outside his own country. Otherwise he is considered "internally displaced."

Native Americans and similarly uprooted indigenous groups are often missing from official statistics because the UN and other organizations use the post-World War II political map as a baseline. People displaced prior to that era are generally not tallied.

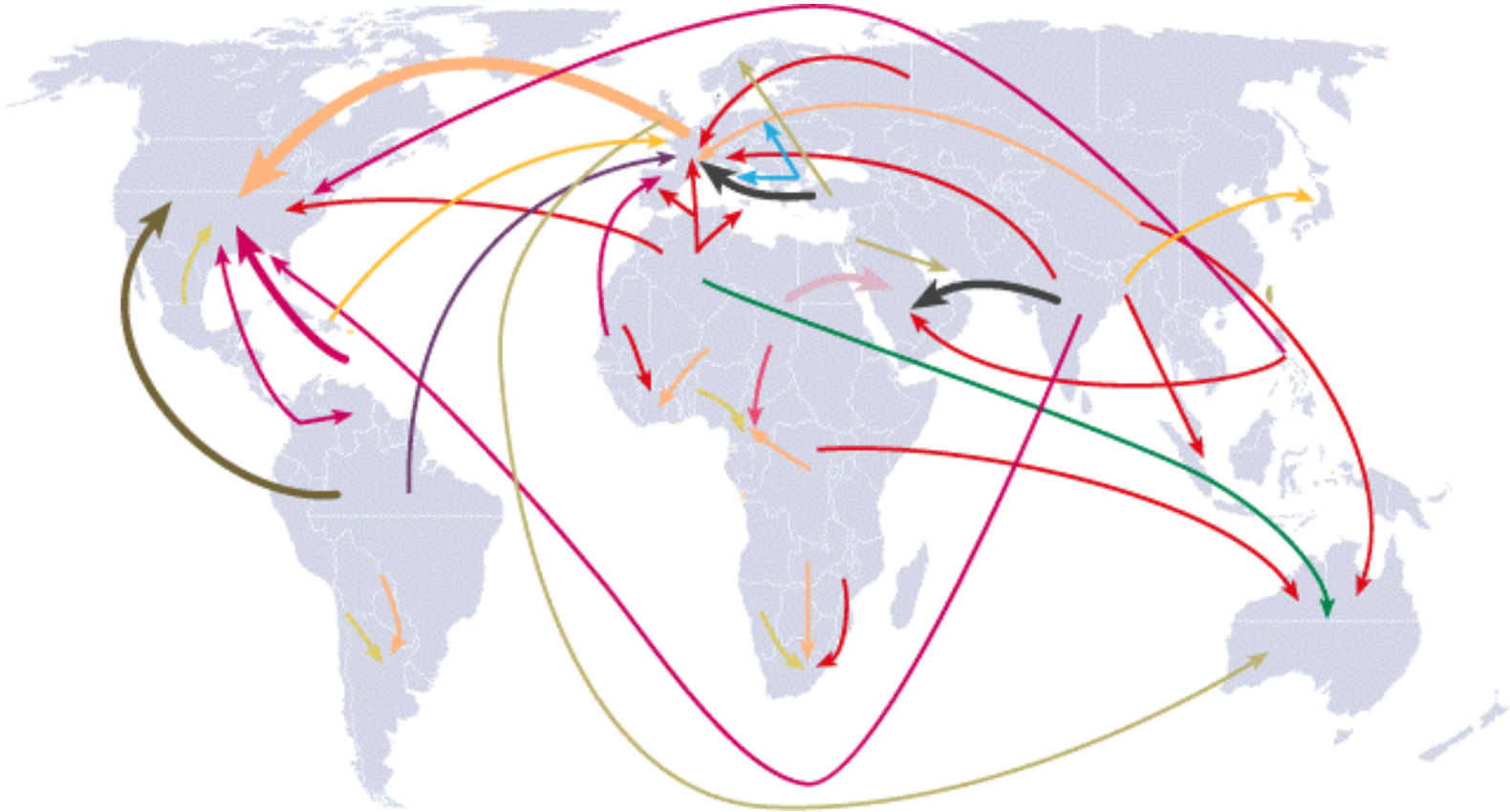
COUNTING HEADS

Estimates of the total number of "internally displaced" persons vary widely. Some experts believe this group might be as large as 50 million.



*National Geographic Oct. 1998

Major Migration Flows: 1960-75



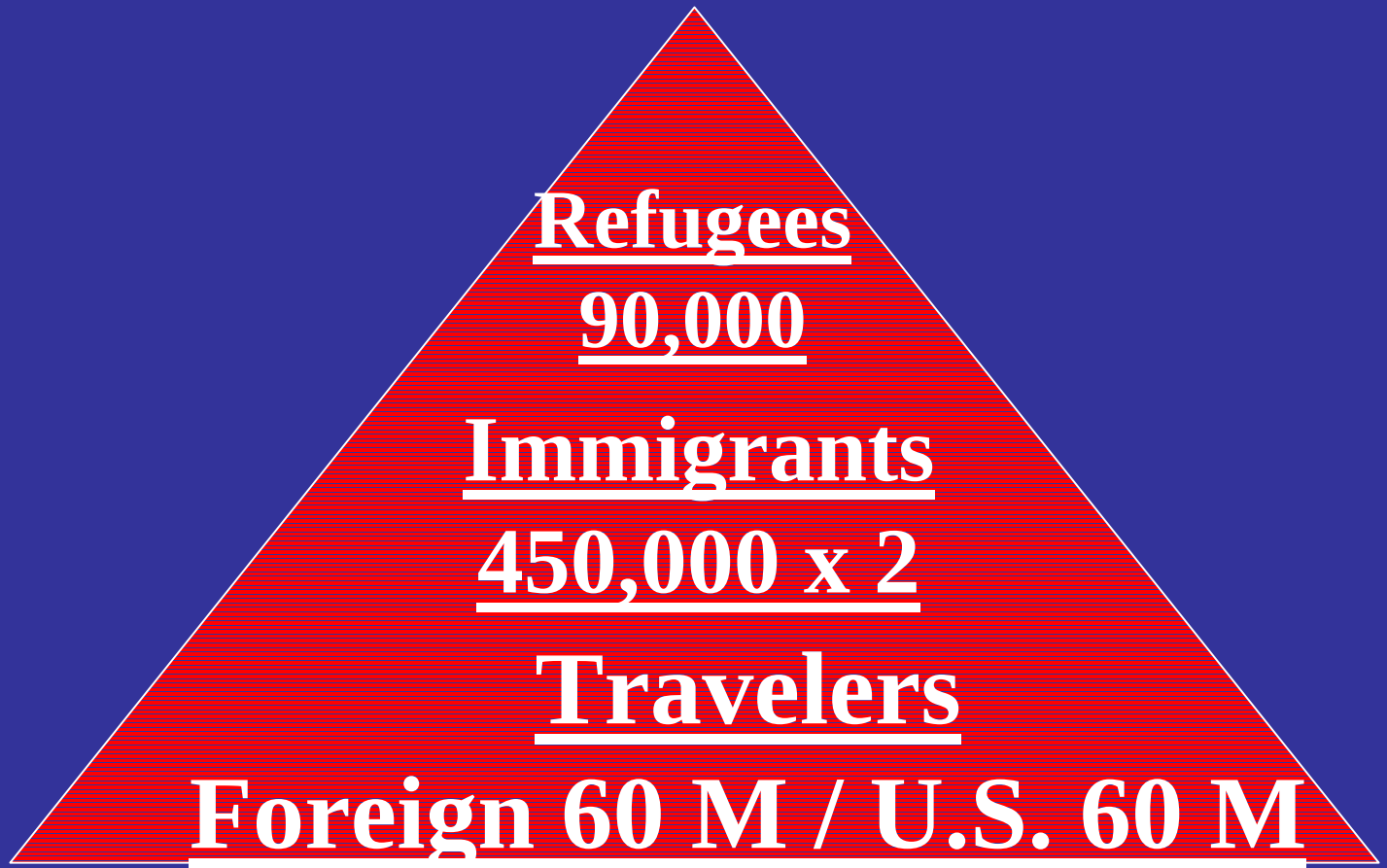
Source: Population Action International 1994

Major Migration Flows: 1990s

4 x increase in volume as compared to 1960-75

Source: Population Action International 1994

Est. Annual International Arrivals , U.S.A. Year 2000



U.S.-Mexico Border Crossings 400M?

Refugee Migrations

- Arriving on the Congolese shore of Lake Tanganyika in spring 1998, a woman tends her grandchild in the homeland he may no longer remember. “You might die in the Congo of a bullet,” said one mother leaving a camp. “But here your children will die of hunger.”

Source: Michael Parfit and Karen Kasmauski
National Geographic, October 1998

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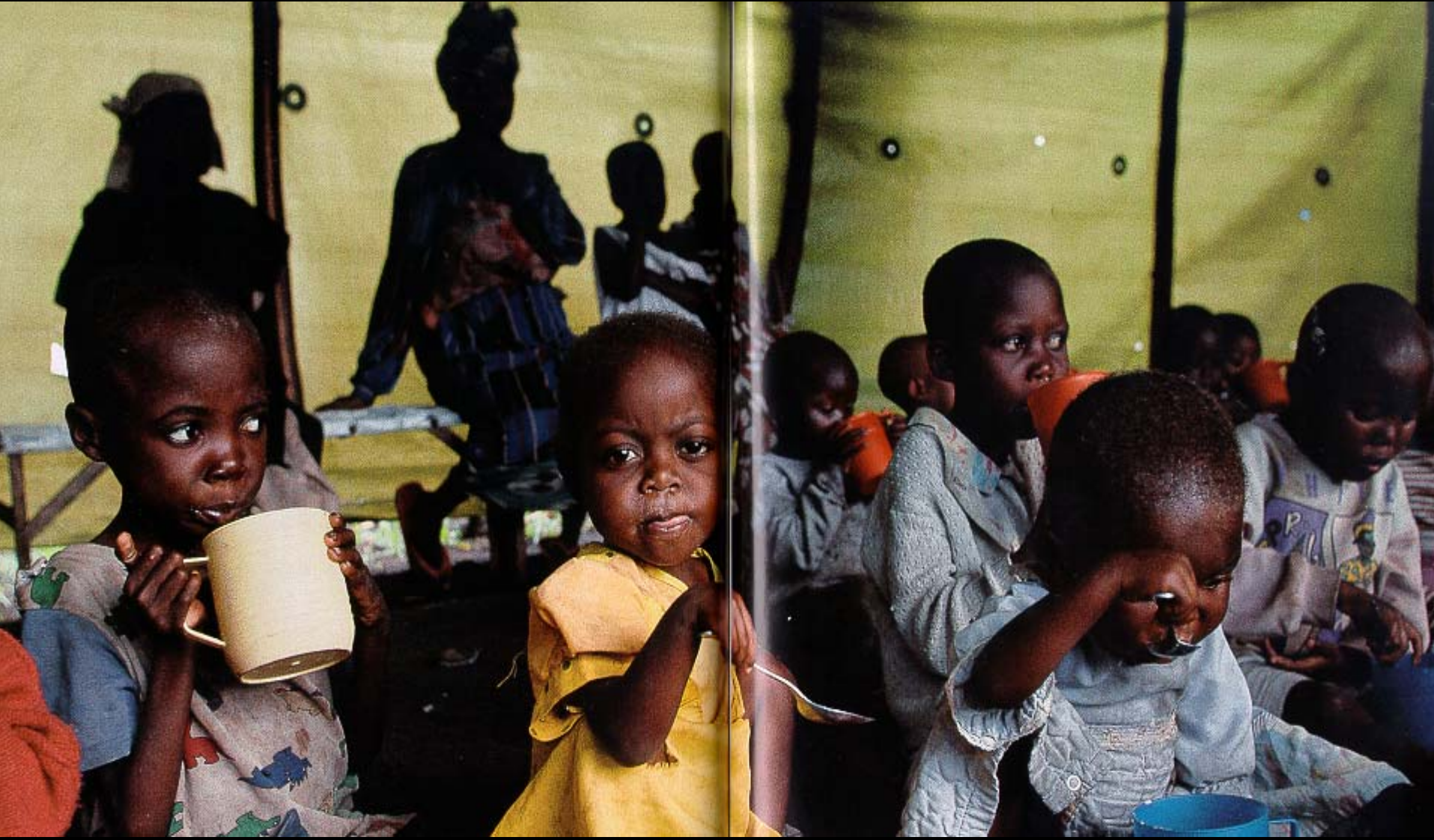


Hungry children receive porridge in Congolese refugee camp

National Geographic Oct 1998

Global Enemies

6 maladies account for 90% of deaths from Inf. Diseases

Influenza
HIV/AIDS
Diarrhea
TB
Malaria
Measles

Influenza

Prone to mutate, influenza viruses continually appear in different forms, requiring the production of a new vaccine each flu season. In some years the symptoms are mild; in others they can be lethal. Three episodes were especially virulent: the influenza pandemic in 1918-19, the Asian flu in 1957-58, and the Hong Kong flu in 1968-69.

HIV / AIDS

Passed on through bodily fluids, human immunodeficiency virus, or HIV, almost invariably leaves the body defenseless against the infections that define full-blown acquired immunodeficiency syndrome, or AIDS. Sub-Saharan Africa, with one-tenth of the world's population, has more than 70 percent of all HIV cases.

Diarrheal Diseases

Waterborne bacteria, viruses, and parasites produce about four billion cases of diarrhea a year. Those at highest risk include the 1.1 billion people lacking access to safe drinking water and the 2.4 billion without adequate sanitation facilities. Cholera, an acute diarrheal disease, claims more than 5,000 lives a year.

Tuberculosis

Propelled by a cough or sneeze from an infected person, tuberculosis bacteria can begin to grow in the lungs and throat of anyone who breathes them in. Drugs discovered in the 1940s beat back the disease, but the bacteria have recently begun to develop resistance, and tuberculosis has reappeared with a vengeance.

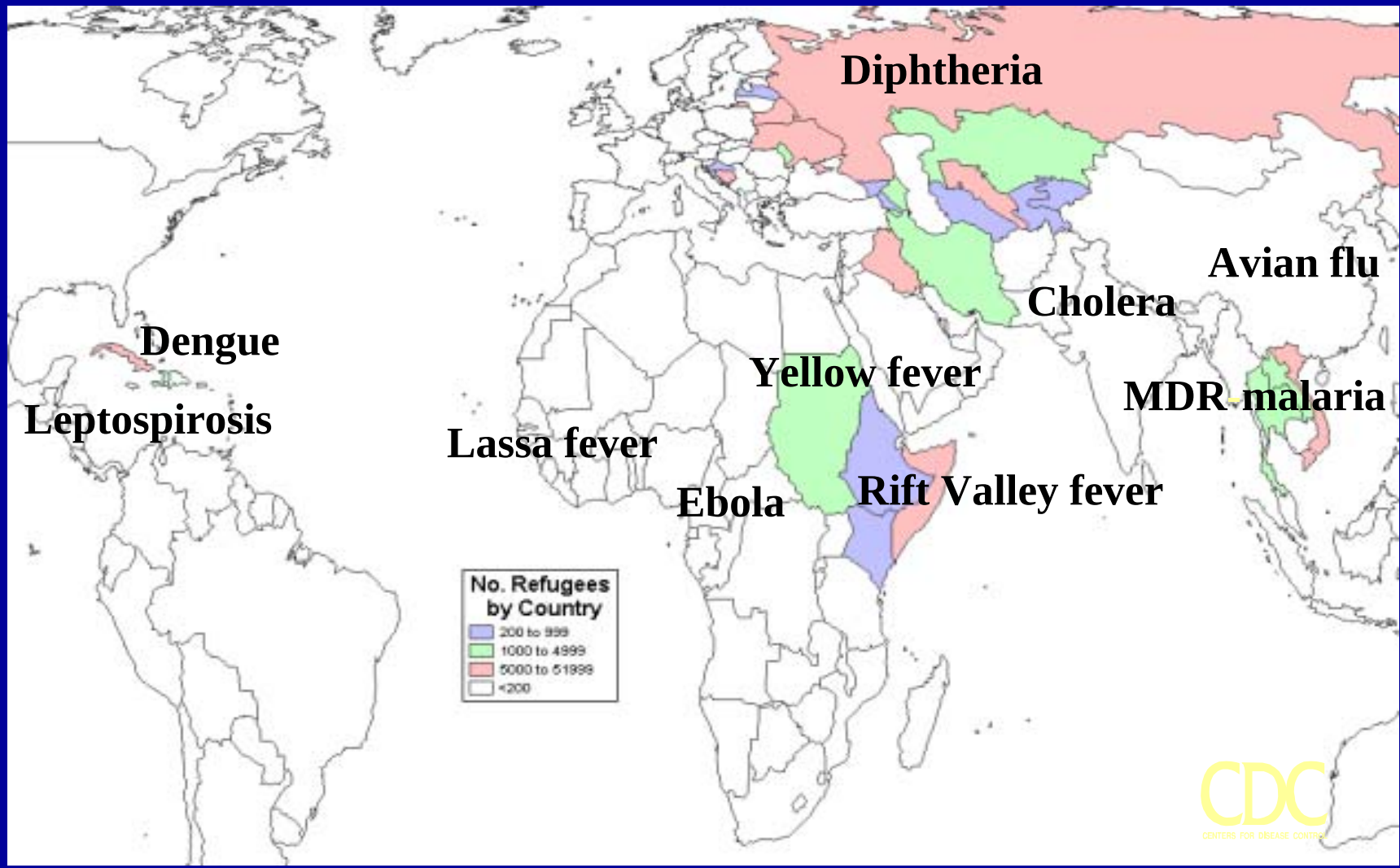
Malaria

Caused by microscopic parasites transmitted by the bites of infected mosquitoes, malaria attacks red blood cells. Global warming has expanded the range of malaria-carrying mosquitoes, putting more than 40 percent of the world's population at risk. In addition, warmer weather makes mosquitoes breed faster and bite more often.

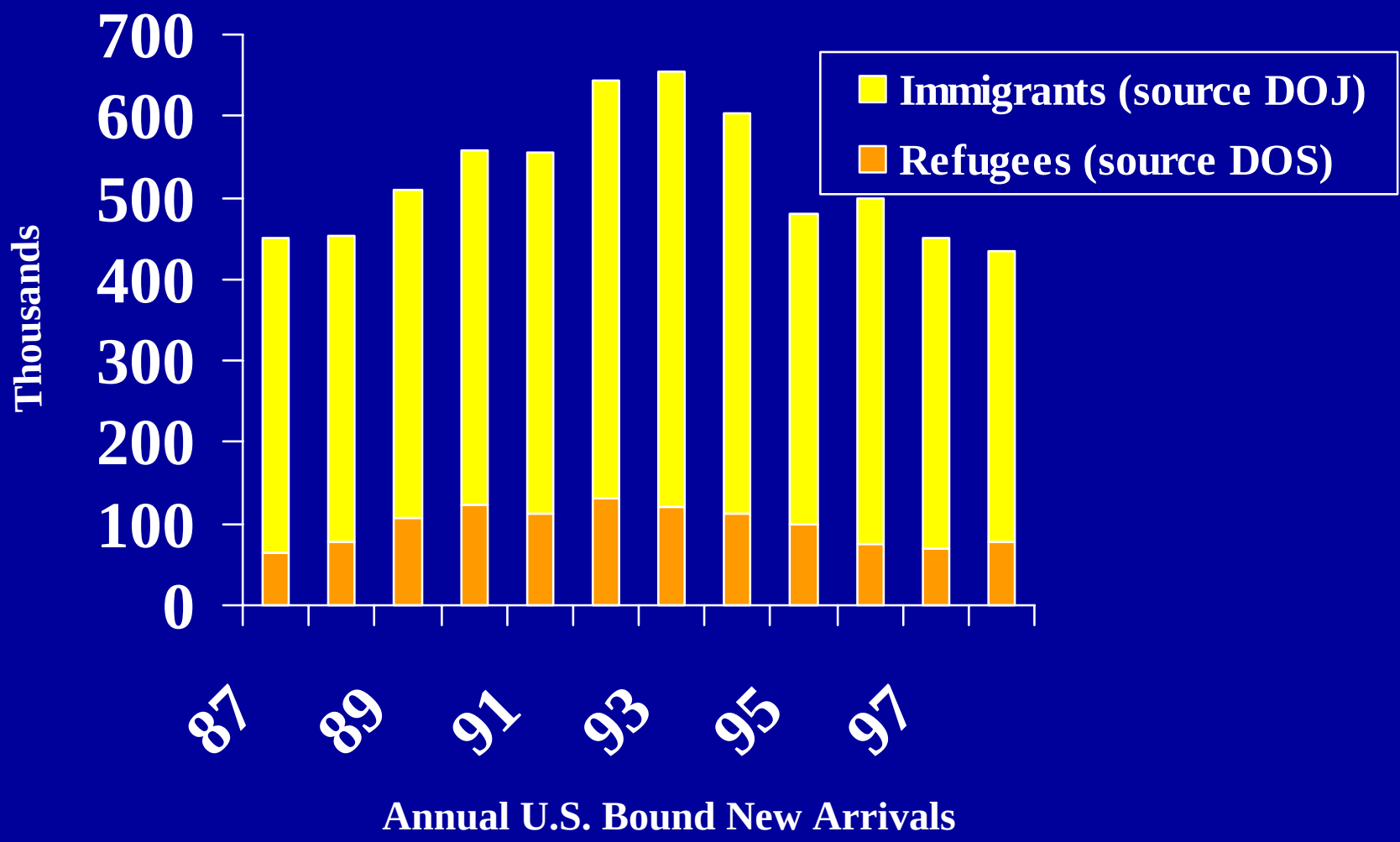
Measles

A highly contagious viral disease that can lead to pneumonia or encephalitis, measles was an inevitable rite of childhood until an effective vaccine became available in 1963. Still striking more than 30 million a year and killing some 900,000, it is the world's leading cause of vaccine-preventable death in children.

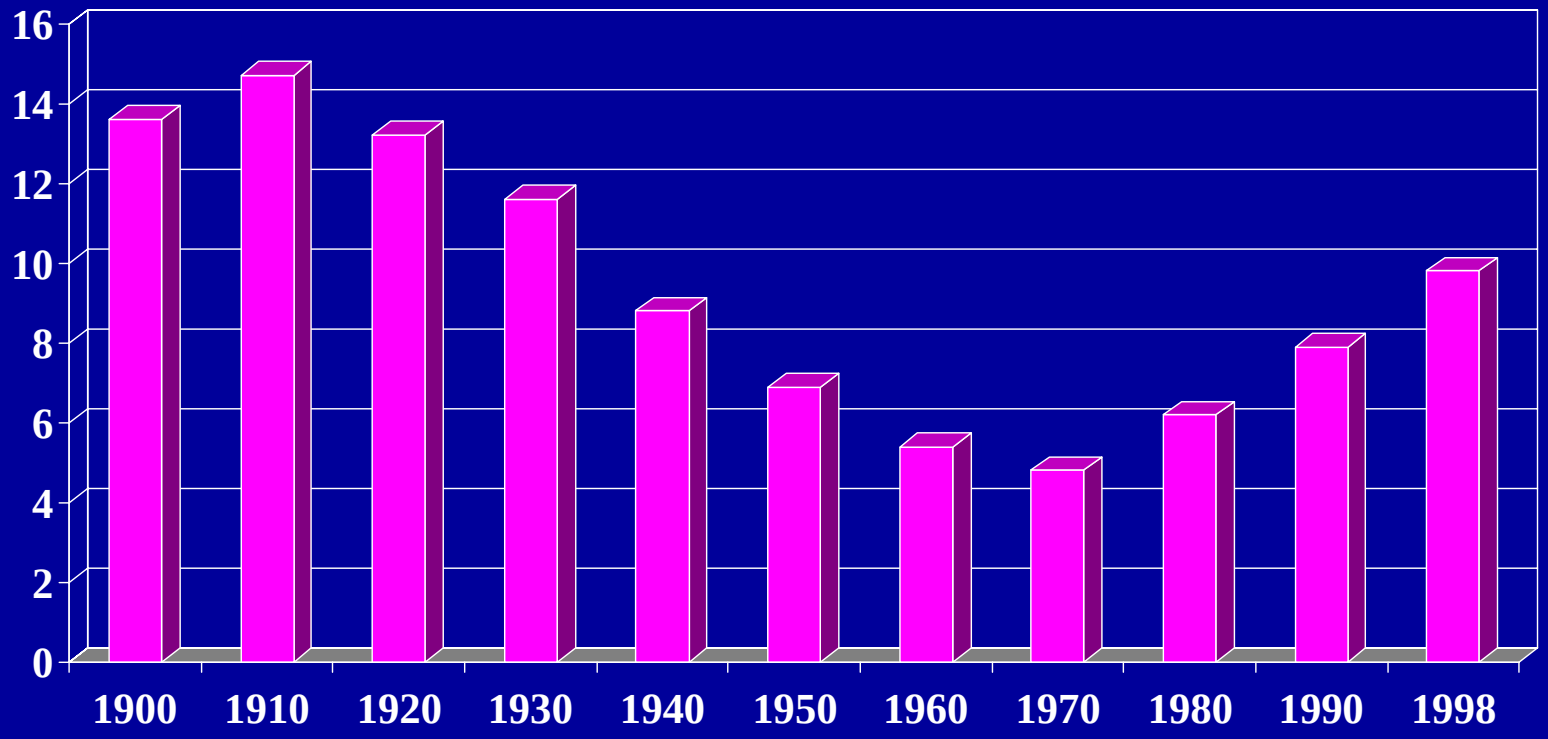
Refugees Entering U.S., FY 1997



Newly Arriving Refugees & Immigrants



Immigrants: Percent of U.S. Population



*Camarota SA January 1999. Center for Immigration Studies

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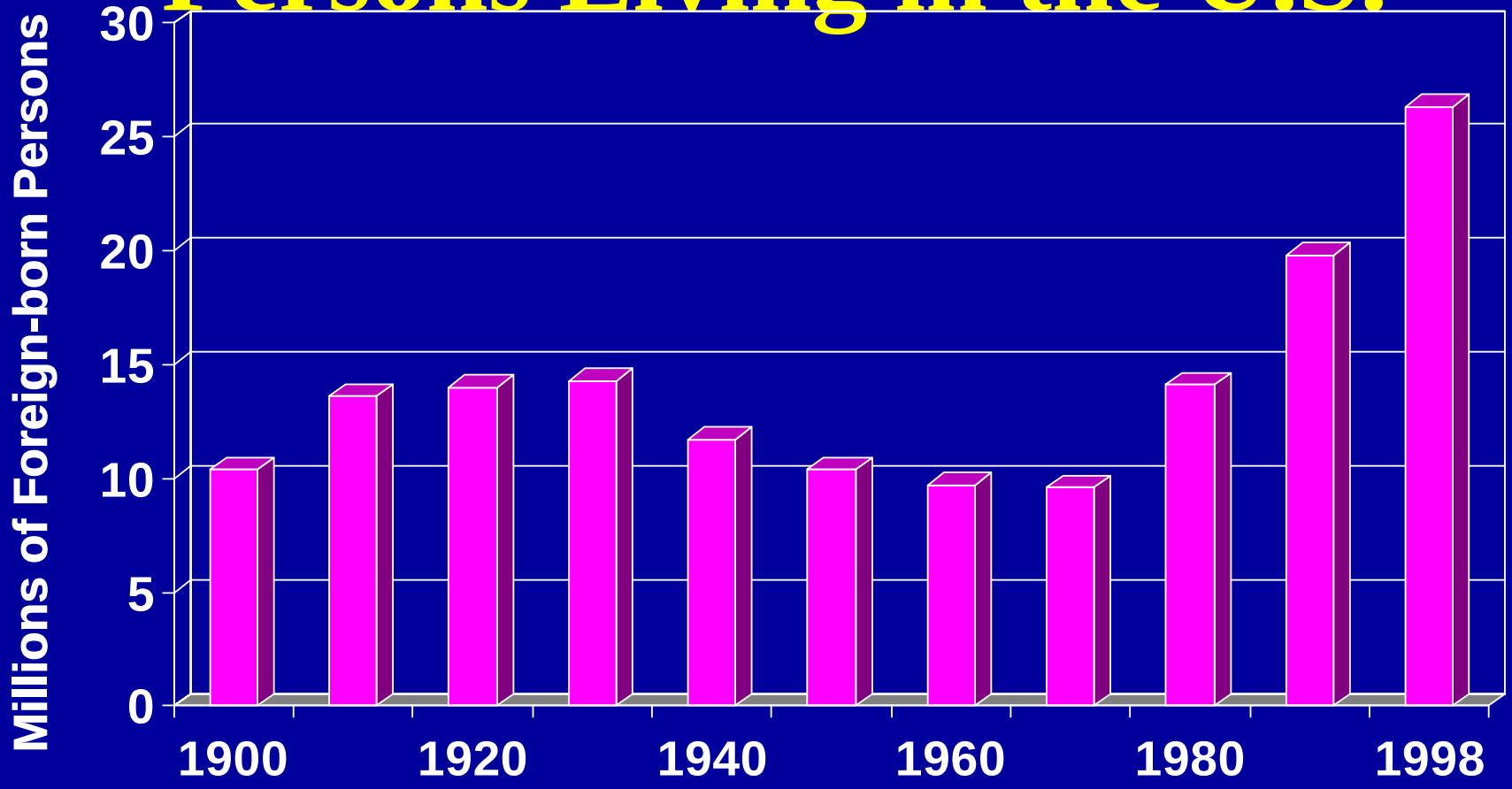
Number of Foreign-Born Persons Living in the U.S.



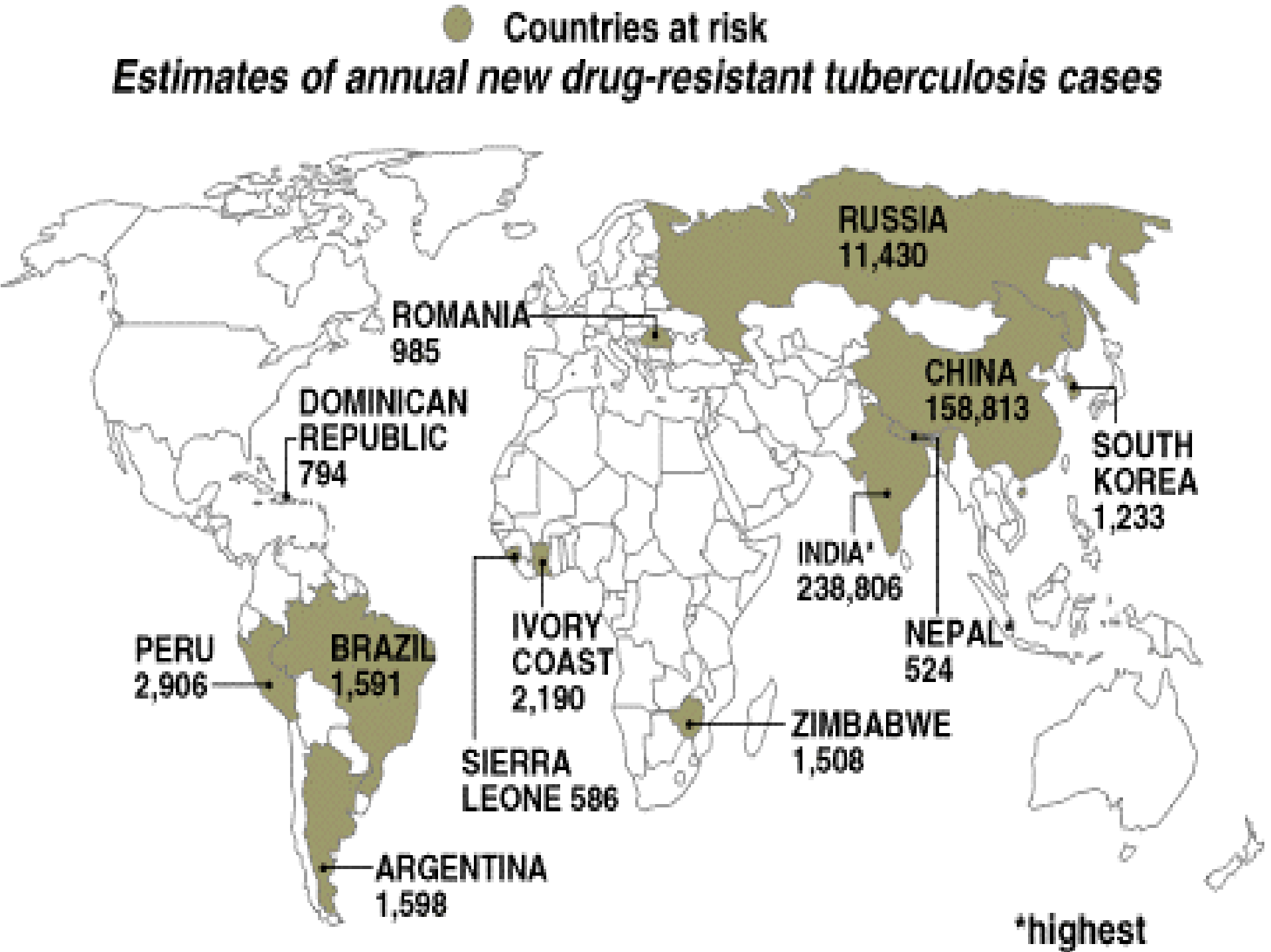
Source: Center for Immigration Studies, 2000

CDC

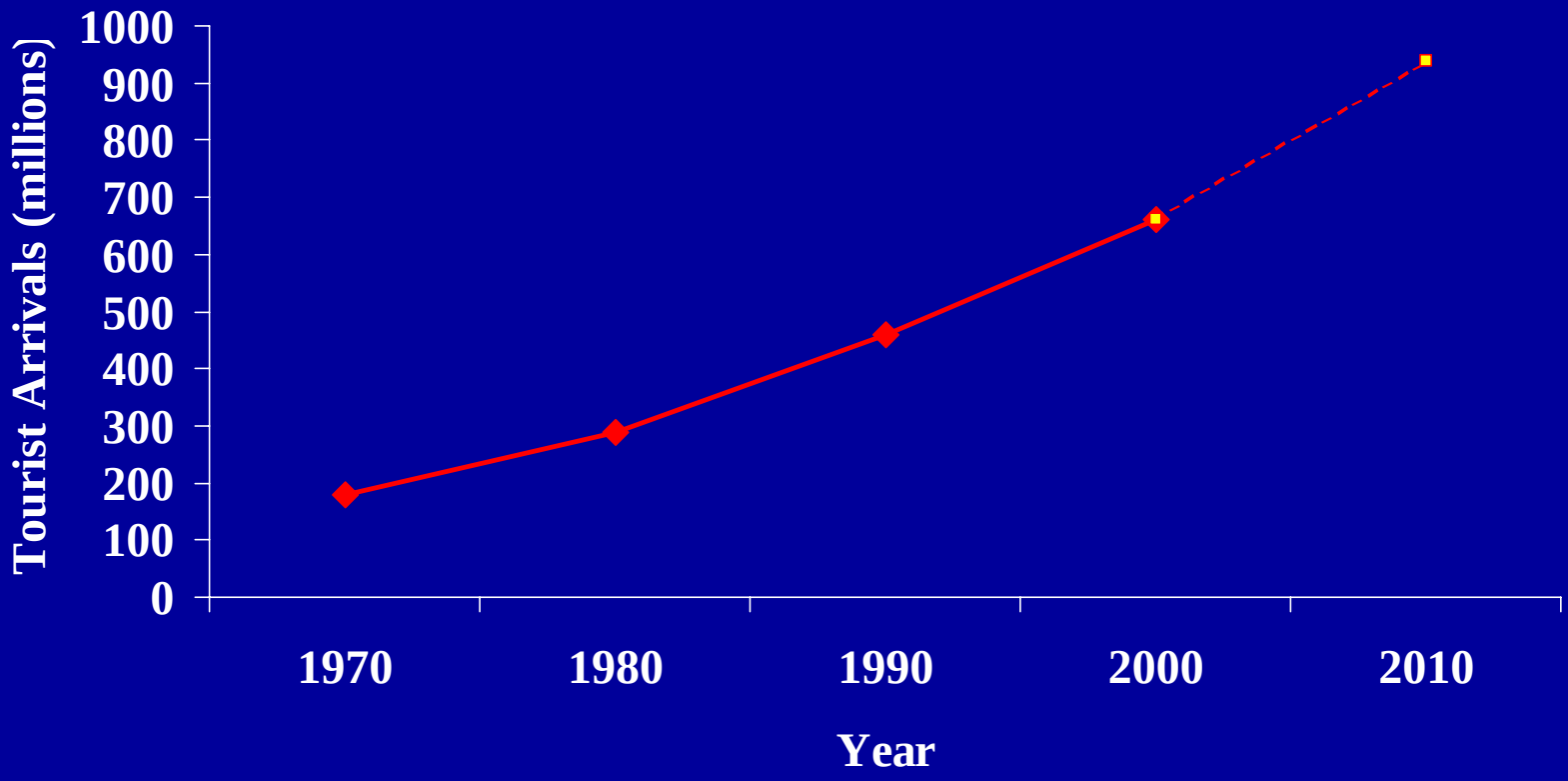
Impact of Immigration on U.S. Population

- Number of foreign-born persons - *unprecedented*
  - Number tripled in last 30 years
  - March 2000: 28.4 M, 10.4% U.S. population
    - 51% Latin America, 25% Asia, 15% Europe, 9% Other
  - Early 20th century peak: 14.2 M

- Immigration strong factor in population growth
  - 70% in past 10 years
    - 11.2 M immigrants
    - 6.4 M children born to immigrants

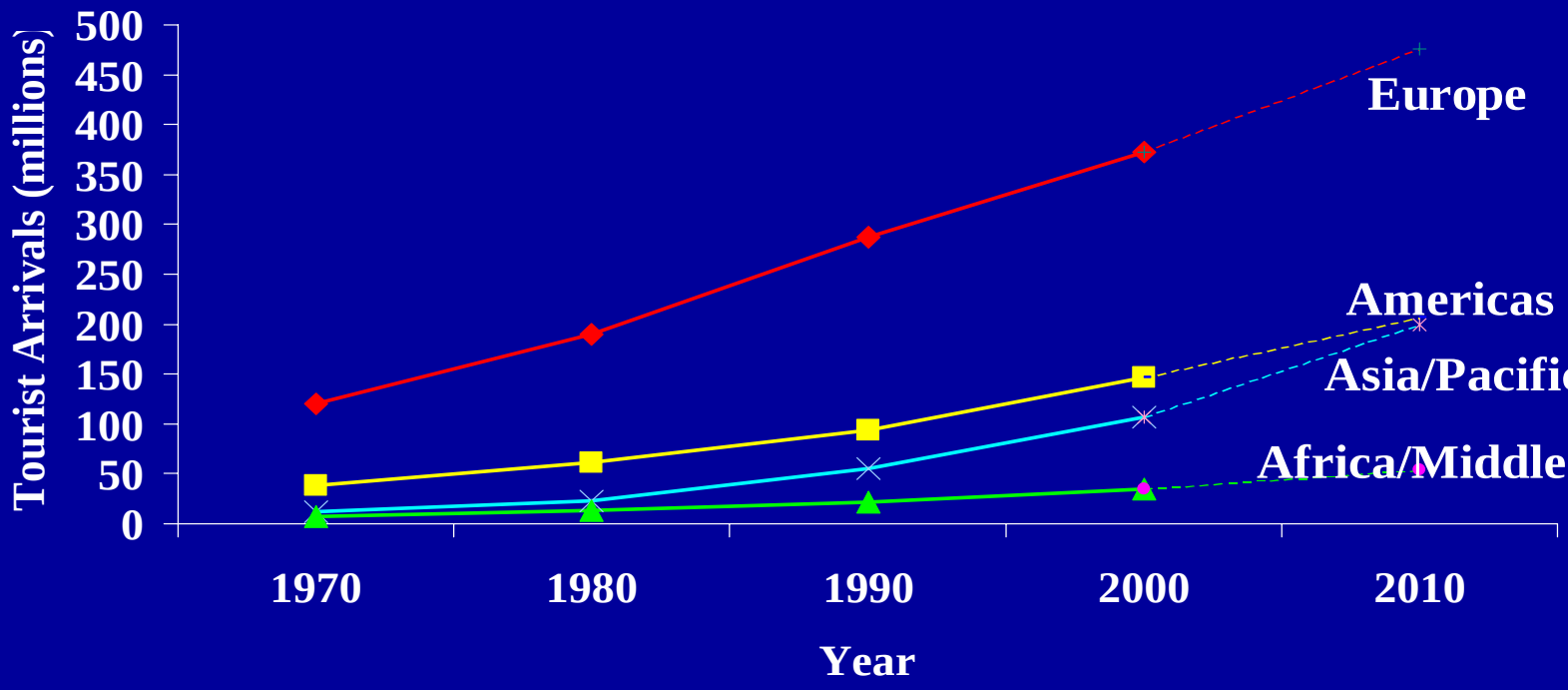

Countries at risk
Estimates of annual new drug-resistant tuberculosis cases
RUSSIA
11,430
ROMANIA
985
DOMINICAN
REPUBLIC
794
CHINA
158,813
SOUTH
KOREA
1,233
INDIA*
238,806
NEPAL*
524
PERU
2,906
BRAZIL
1,591
IVORY
COAST
2,190
ZIMBABWE
1,508
SIERRA
LEONE 586
ARGENTINA
1,598
*highest

International Tourist Arrivals - World

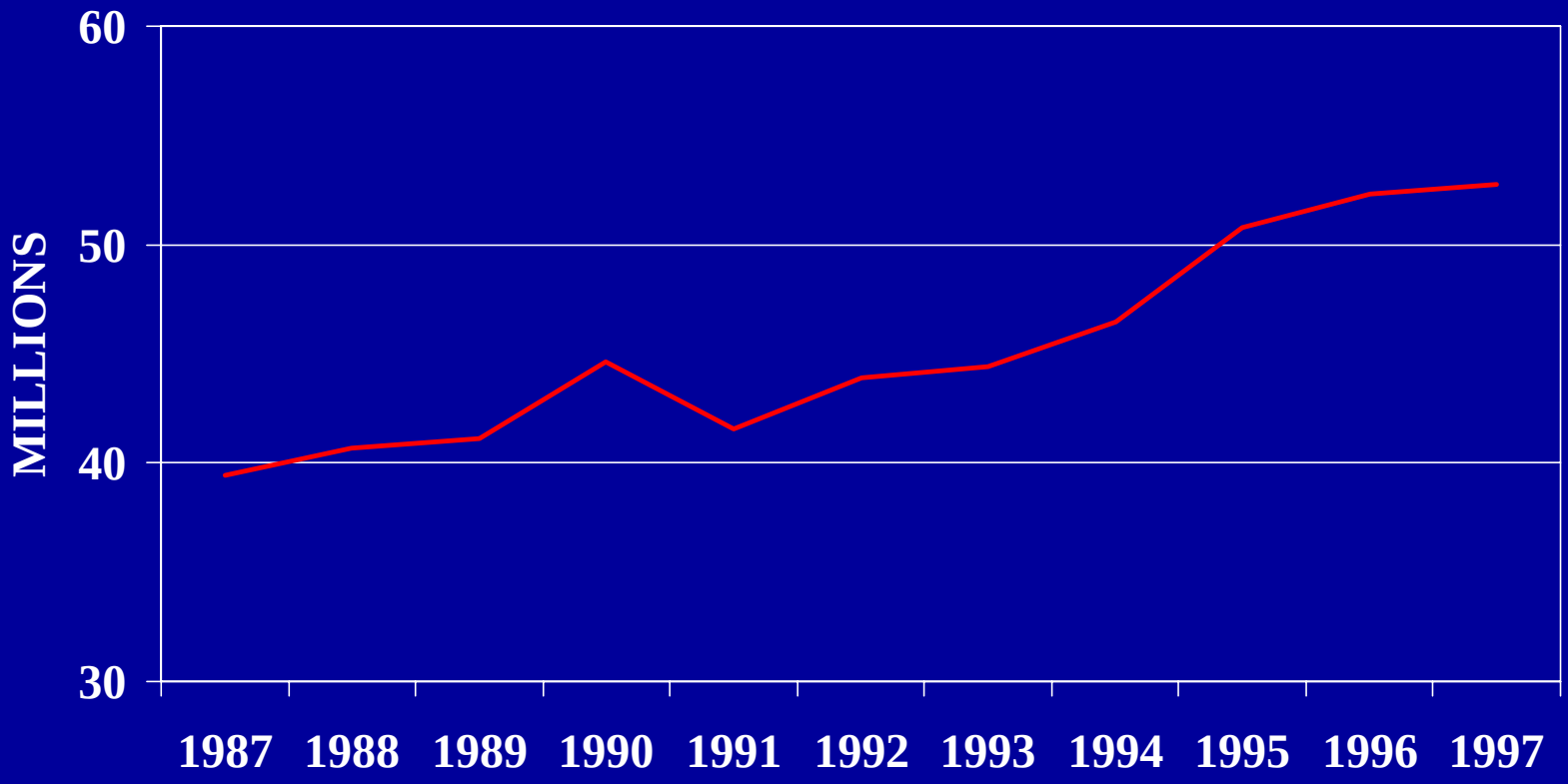


Trends in Global Travel

Tourist Arrivals by Region

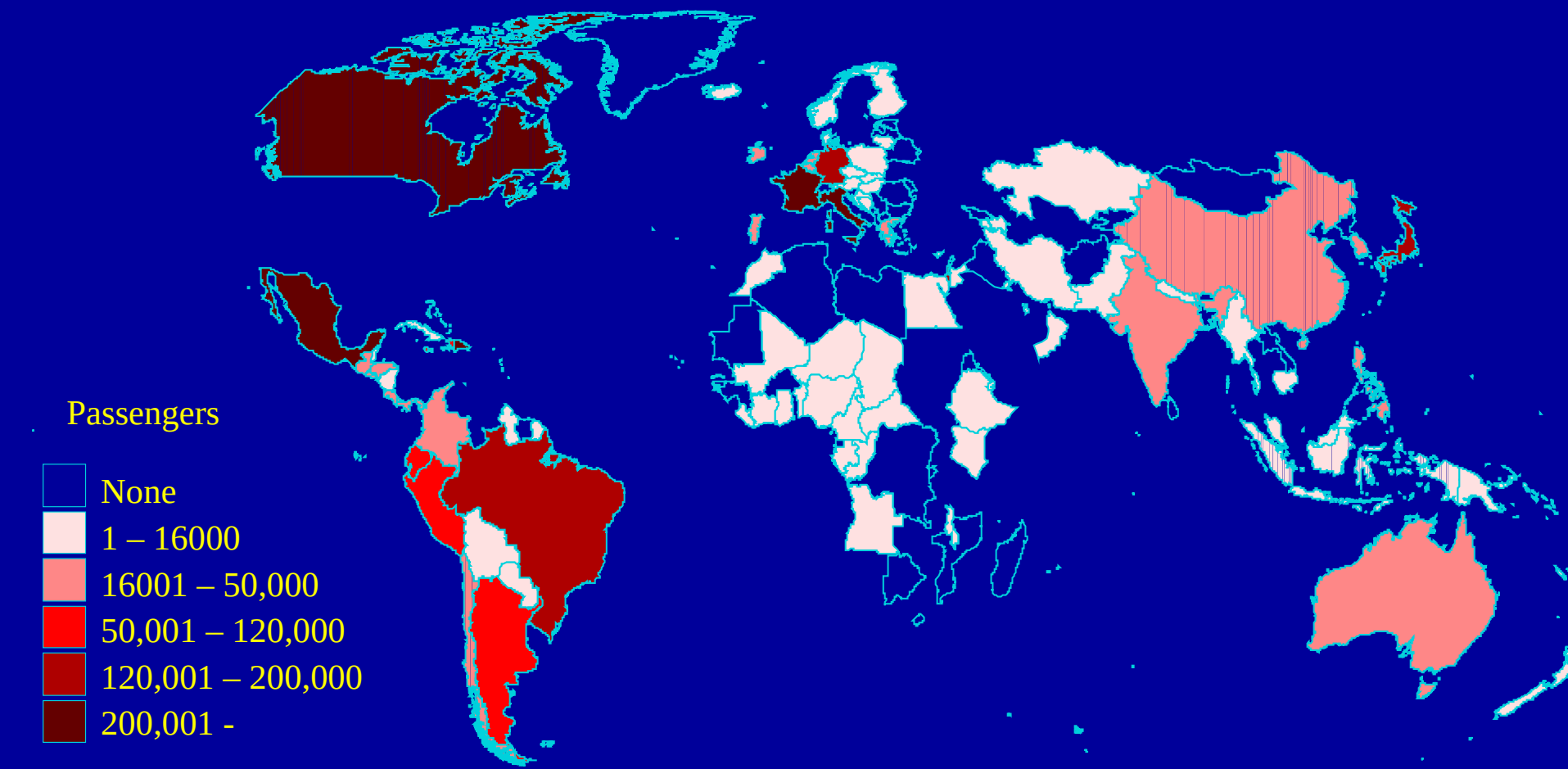


U.S. INTERNATIONAL TRAVELERS (OUTBOUND), 1987-97



International Passenger Arrivals, NY Airports July 1998 – June 1999

N = 4,850,090



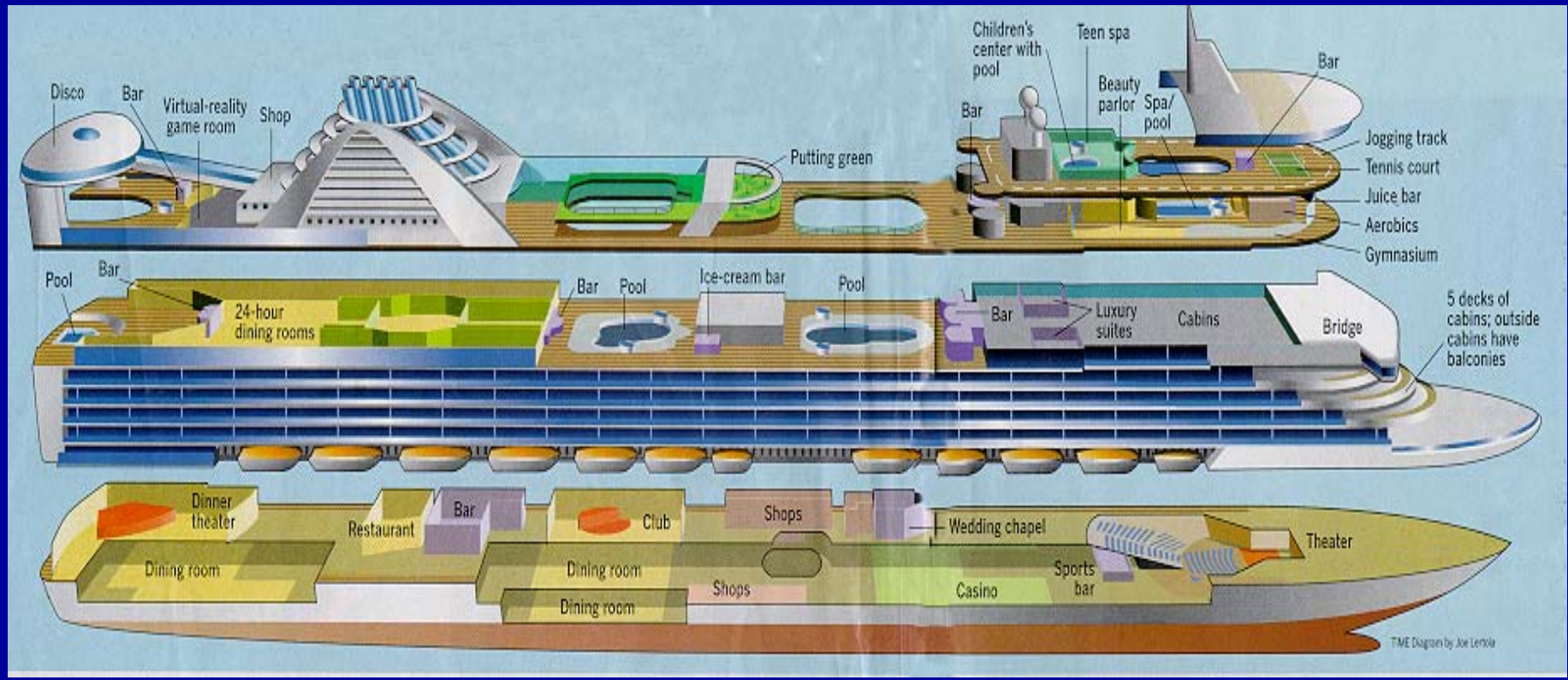
Cruise ship passengers 2000:

7 million/year, North America

CDC

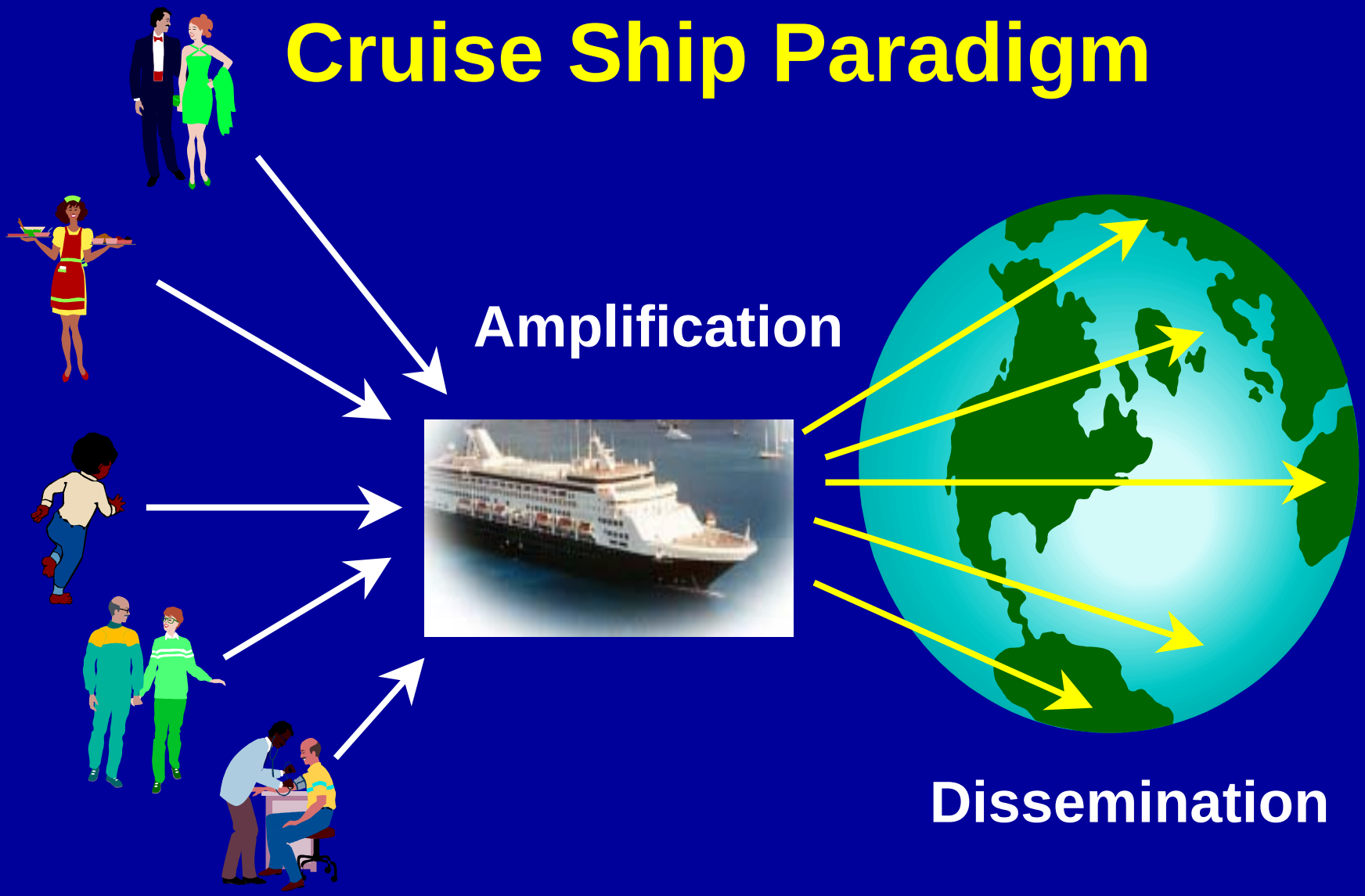
Grand Princess vs U.S. Capitol

The Cruise Ship

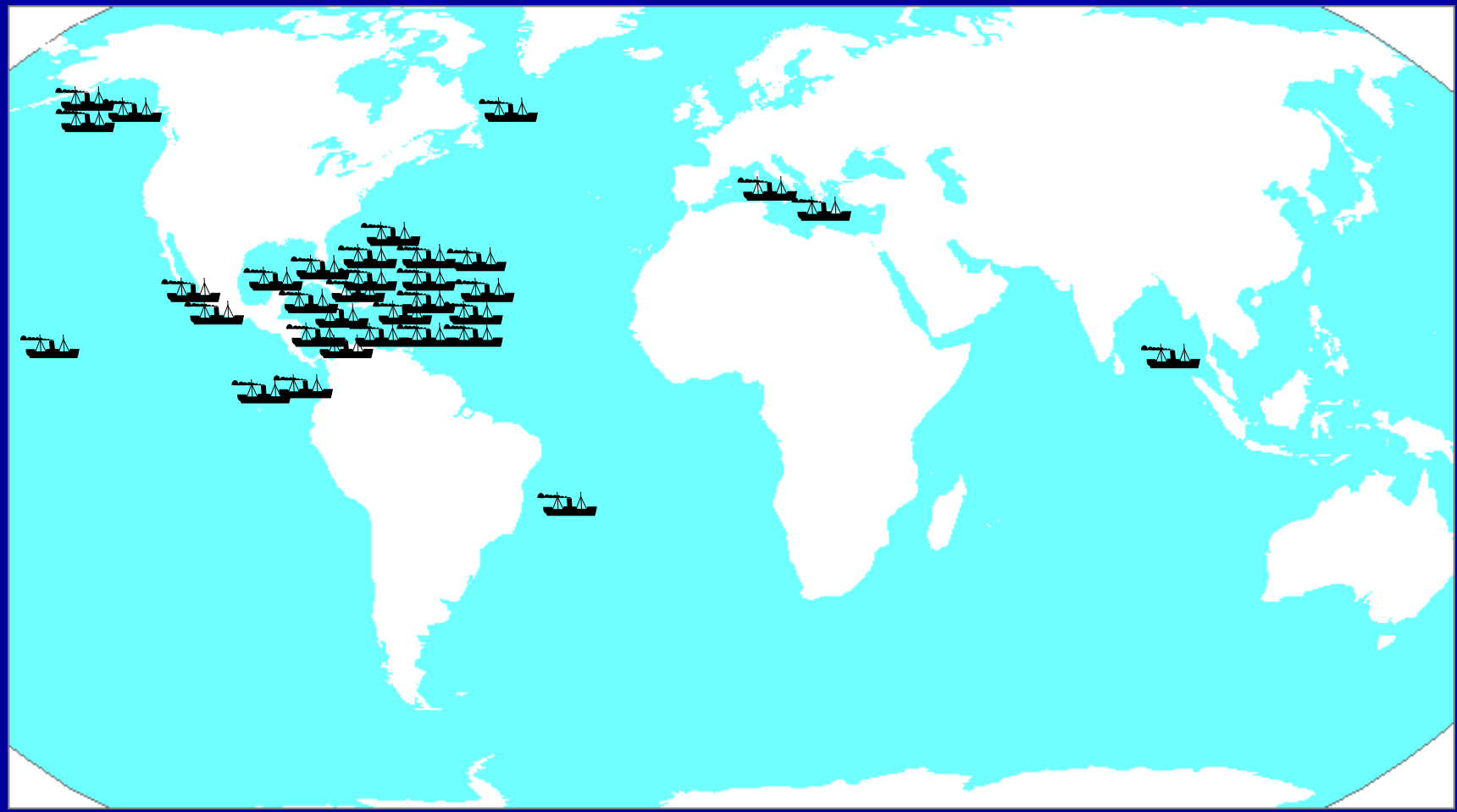


A unique environment for disease transmission, amplification, and dispersal

Cruise Ship Paradigm

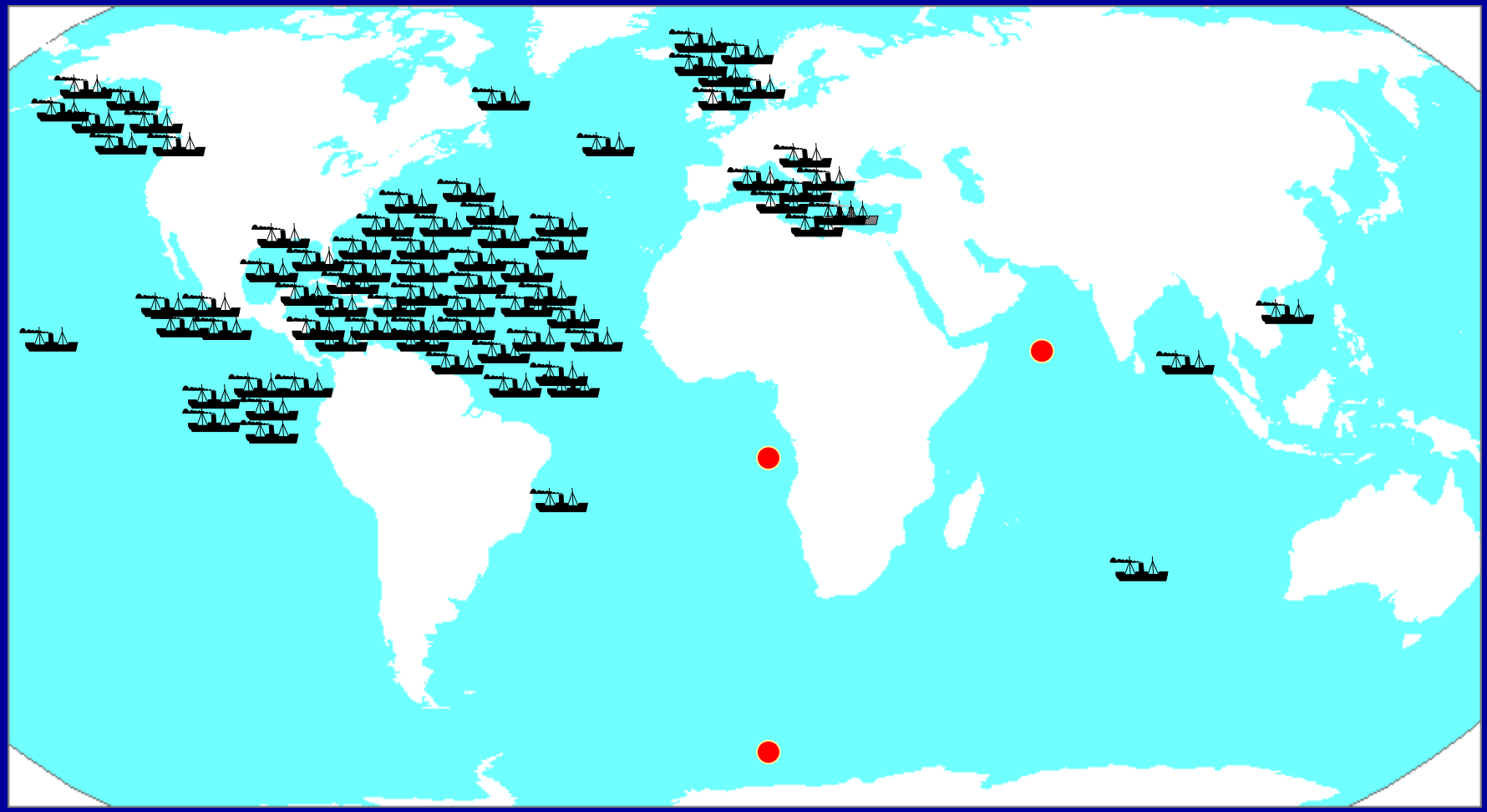


Cruise Destinations, 1987



= 500,000 passenger bed-days

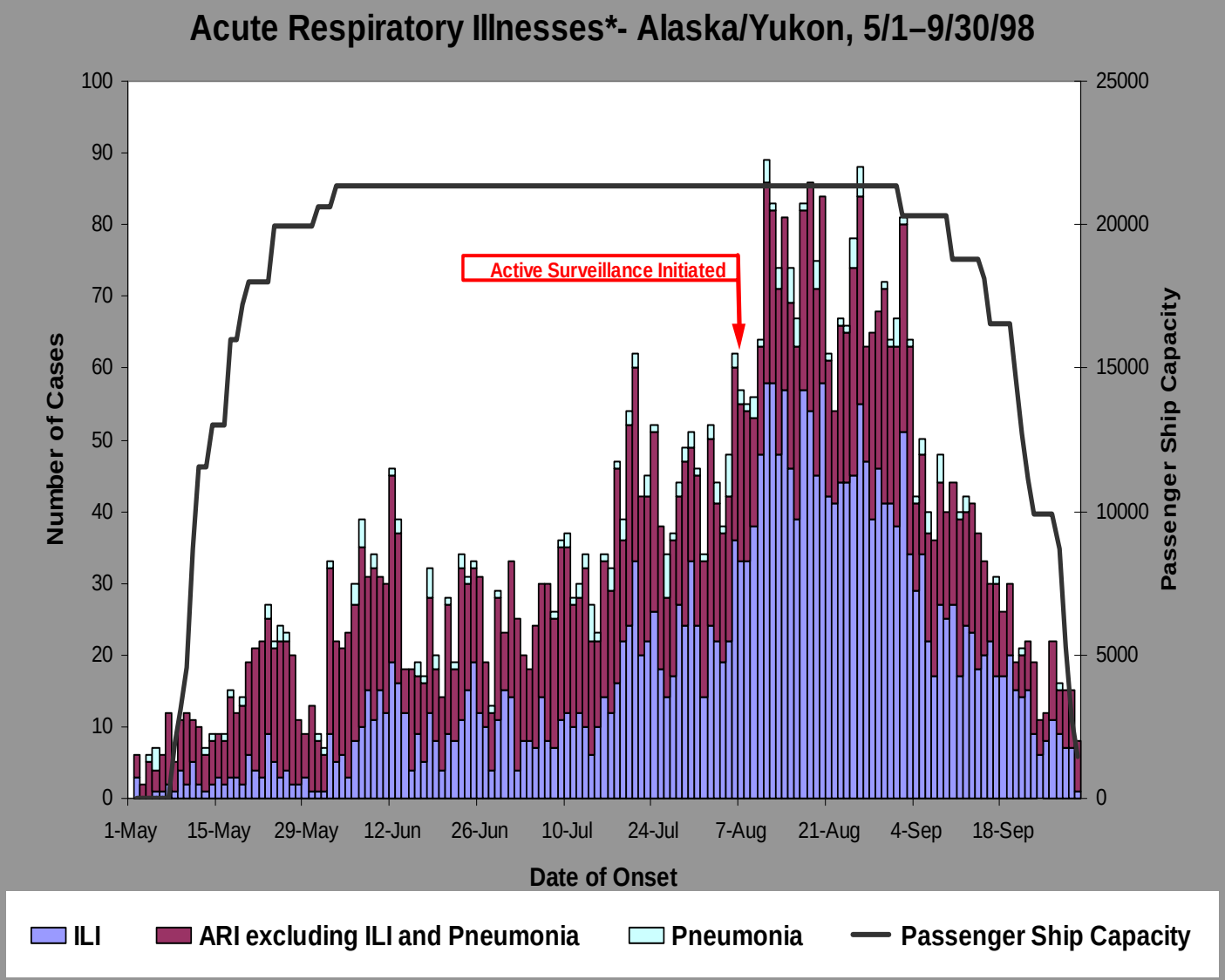
Expanding Cruise Destinations, 1997



= 500,000 passenger bed-days

= New destinations (<500,000 passenger bed-days)

Alaska Cruise Ship Sailing Routes

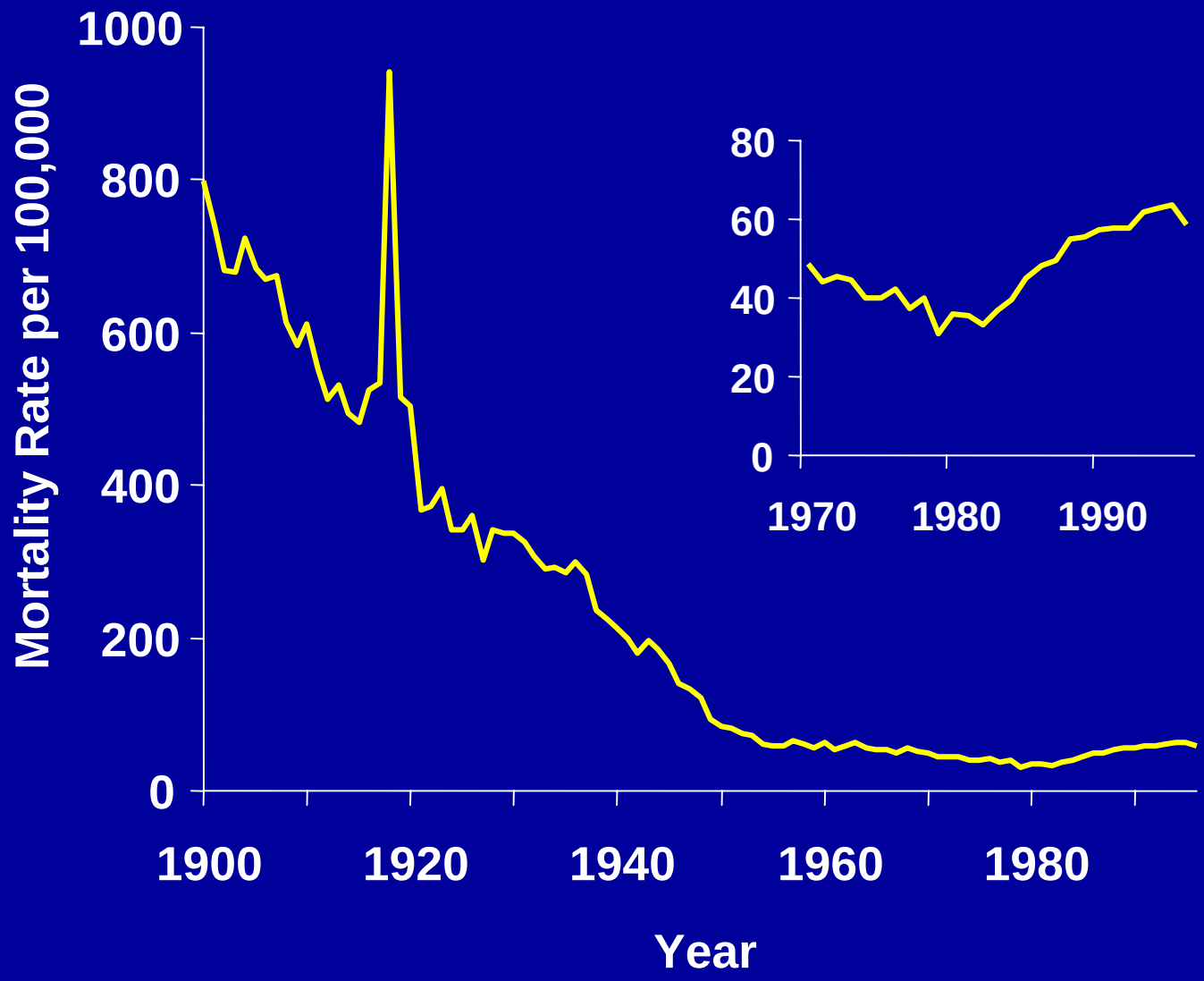


* Acute Respiratory Illnesses (ARI) = [ILI (Influenza-like illness)] + [ARI excluding ILI and pneumonia] + [pneumonia]

"The flu is now arriving at gate 4 … "

Influenza: Past and Present Danger

Infectious Disease Mortality in the U. S., 1900 to 1996



Source: Armstrong, *et al., JAMA* ;1999

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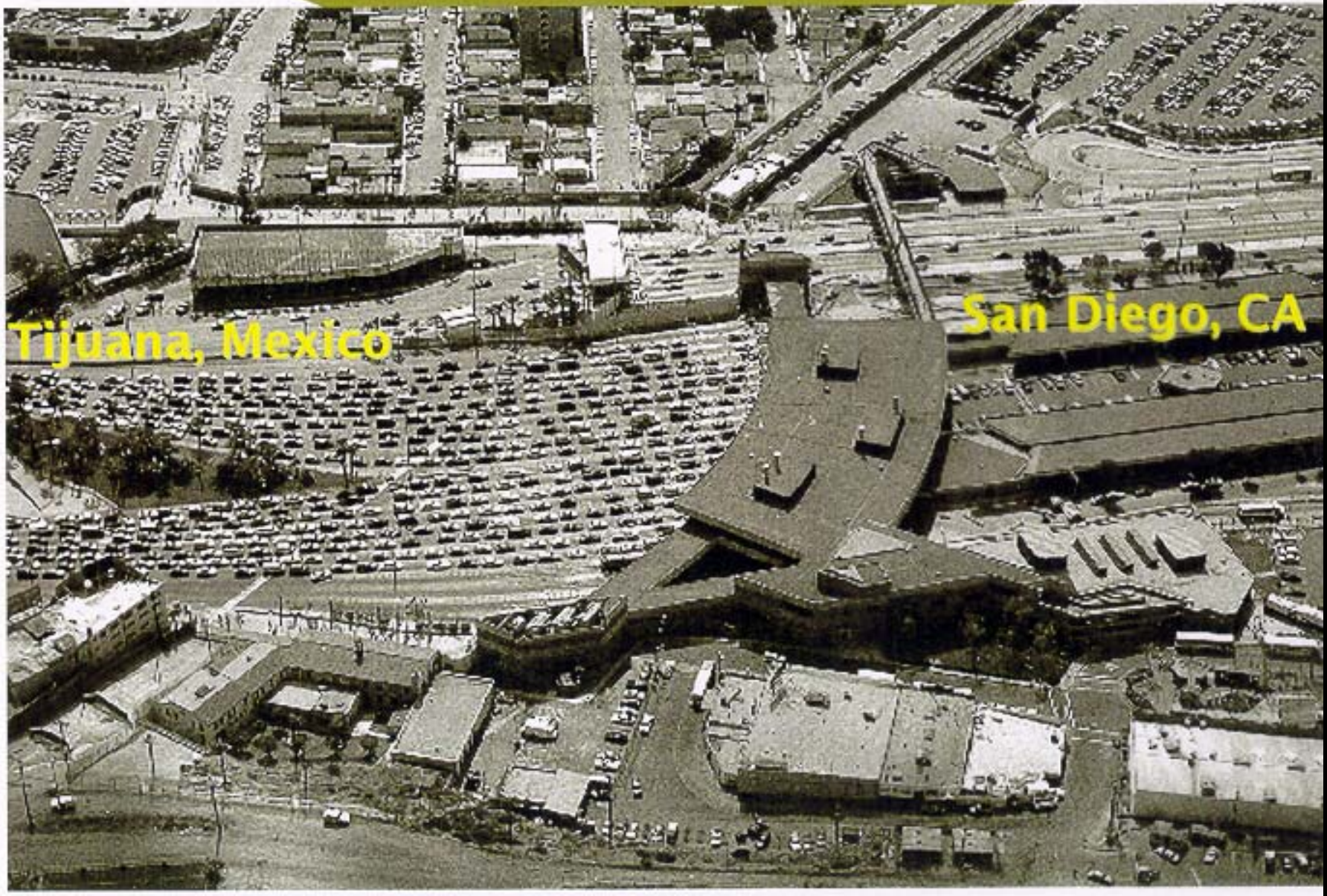
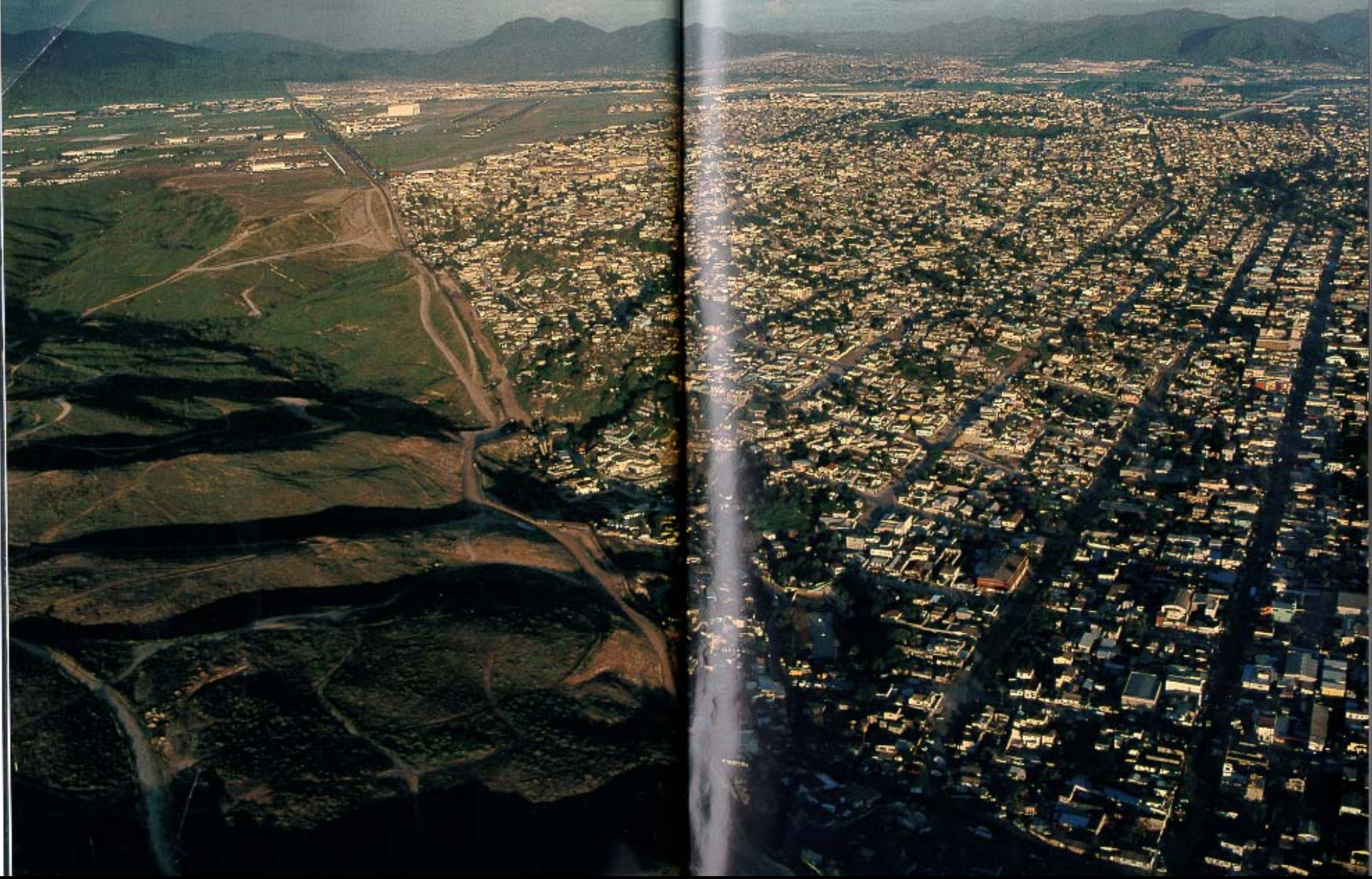
US Port of Entry – USA/Mexico Border





US Mexico Border, San Diego-Tijuana

U.S. Mexico Border
Laredo, Texas - Nuevo Laredo, Coahuila

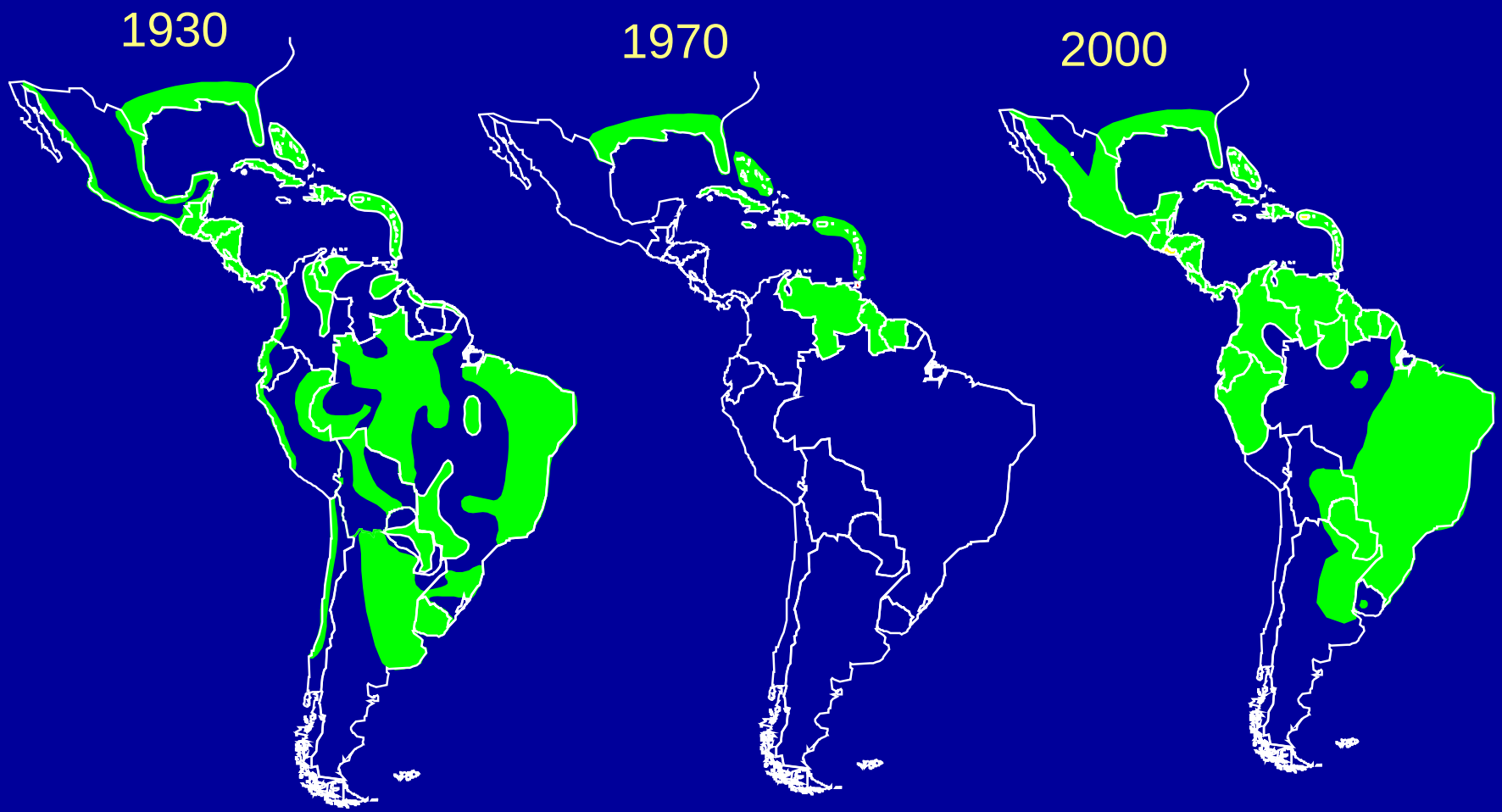
Vector Surveillance on Planes

検疫所
QUARANTINE

機内衛生害虫の調査
Inspection for pests on board

Aedes aegypti Mosquito

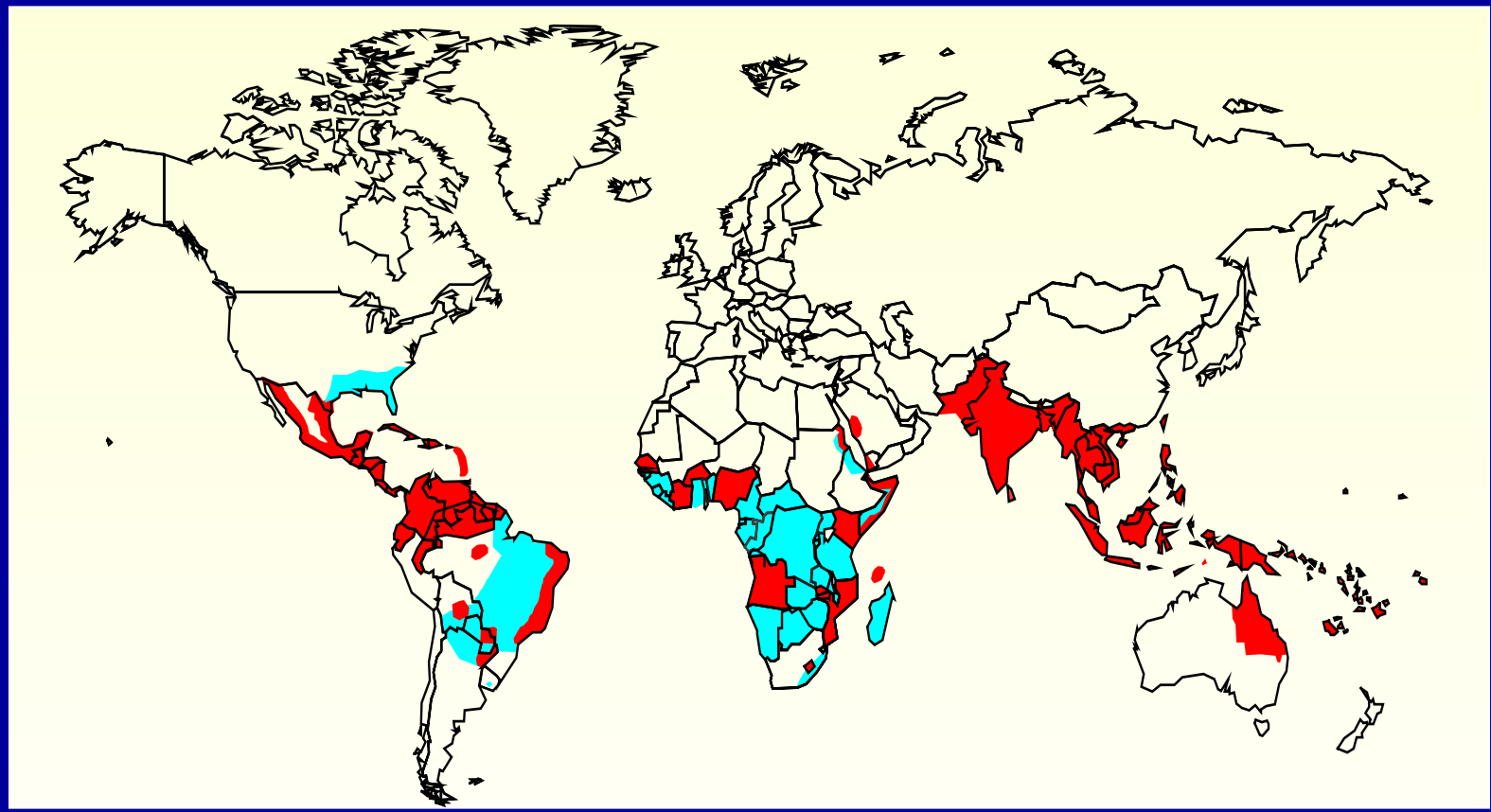
Aedes aegypti Distribution in the Americas



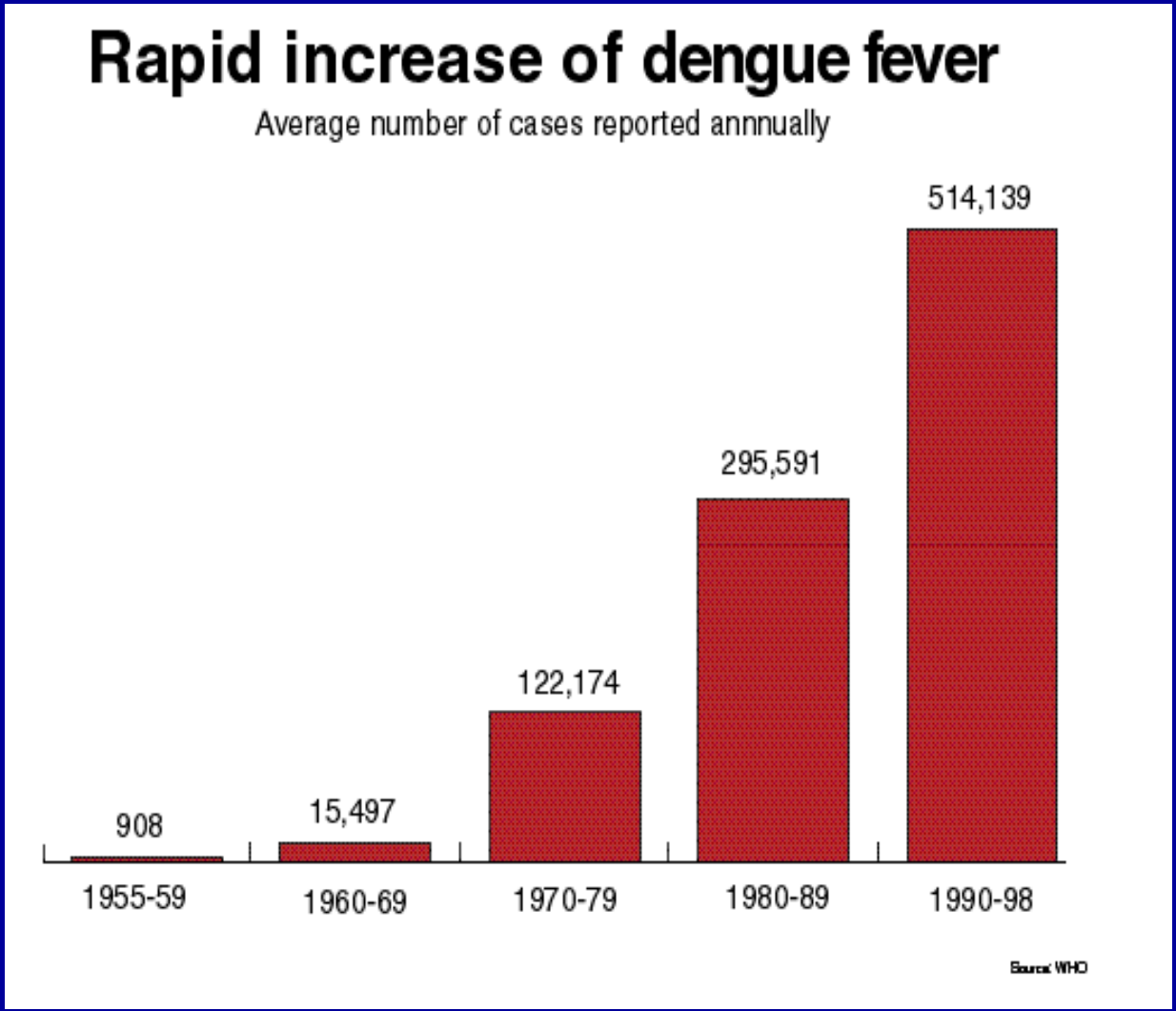
Dengue, DHF

Original image provided by WHO/TDR/STI/Hatz

World Distribution of Dengue 2002

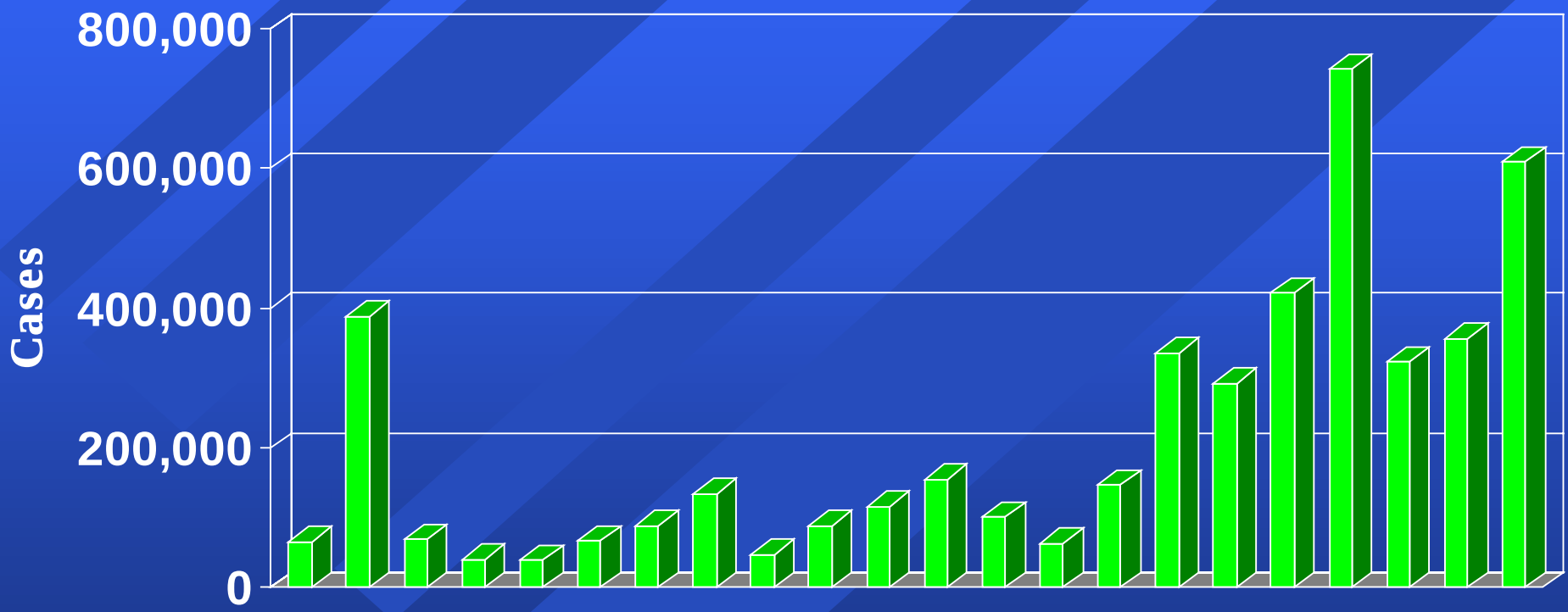


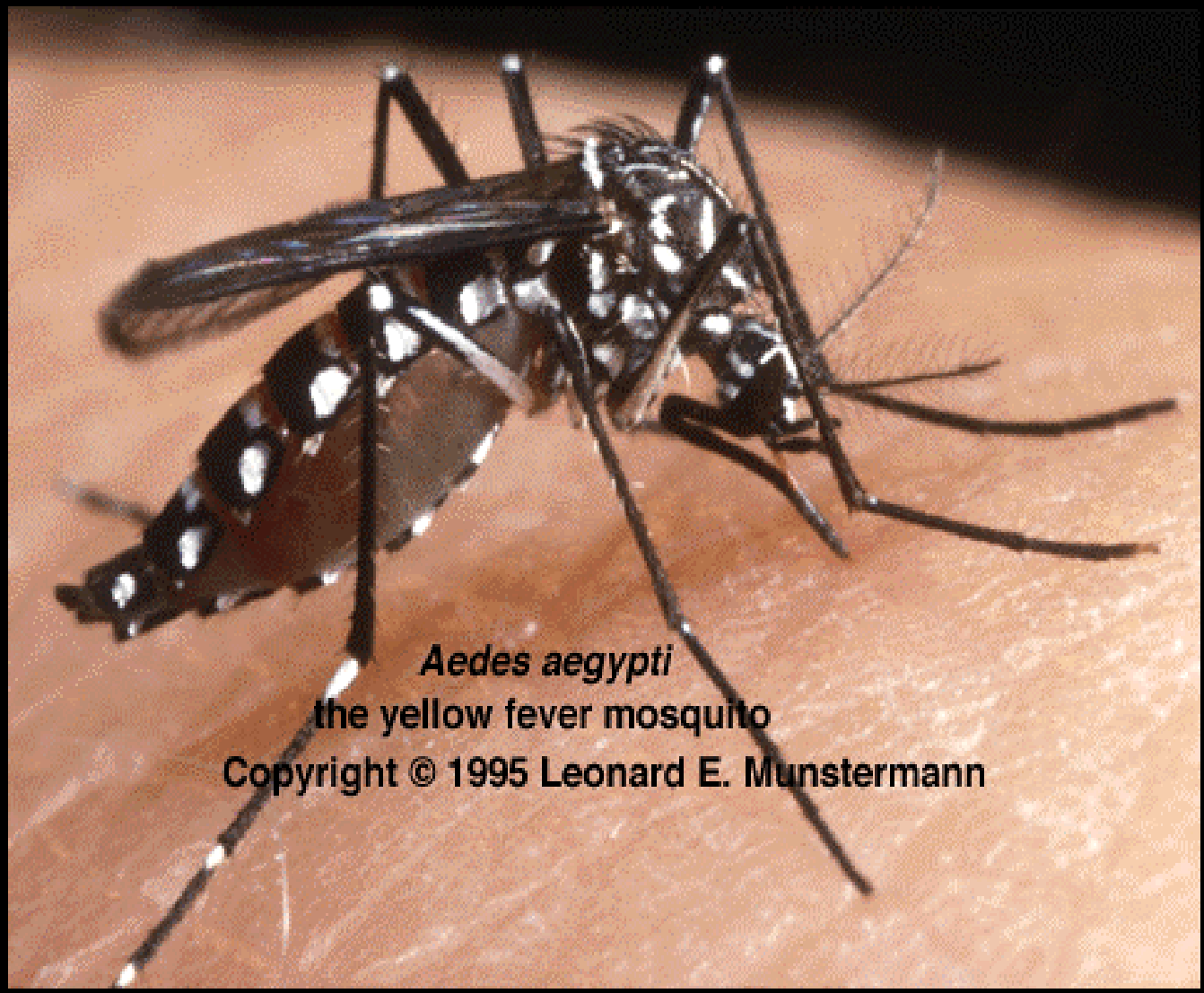
- Areas infested with *Aedes aegypti*
- Areas with *Aedes aegypti* and recent epidemic dengue



WHO Report on Infectious Diseases 1999
"Removing Obstacles to Healthy Development"

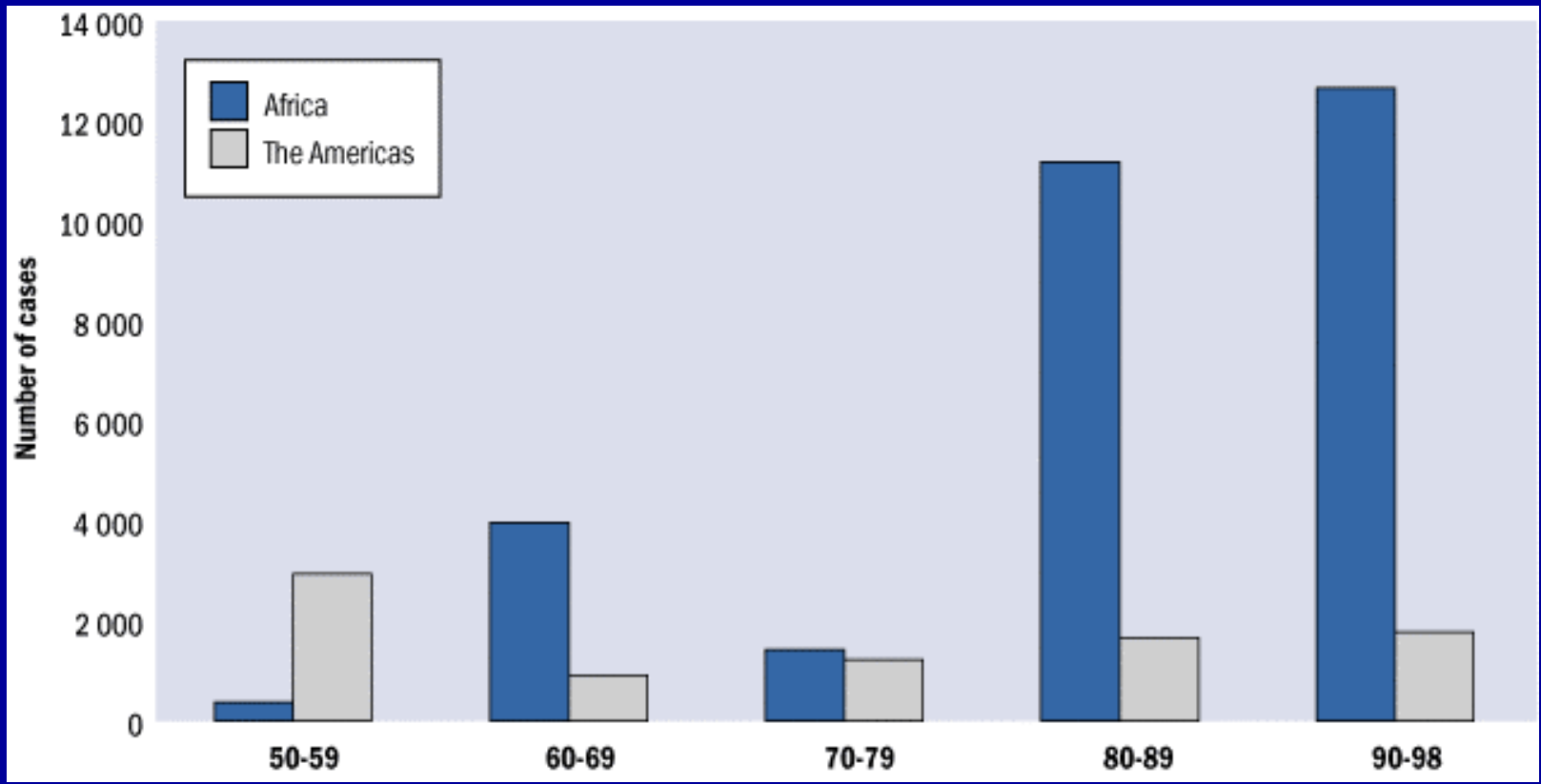
Dengue in the Americas, 1980 - 2001





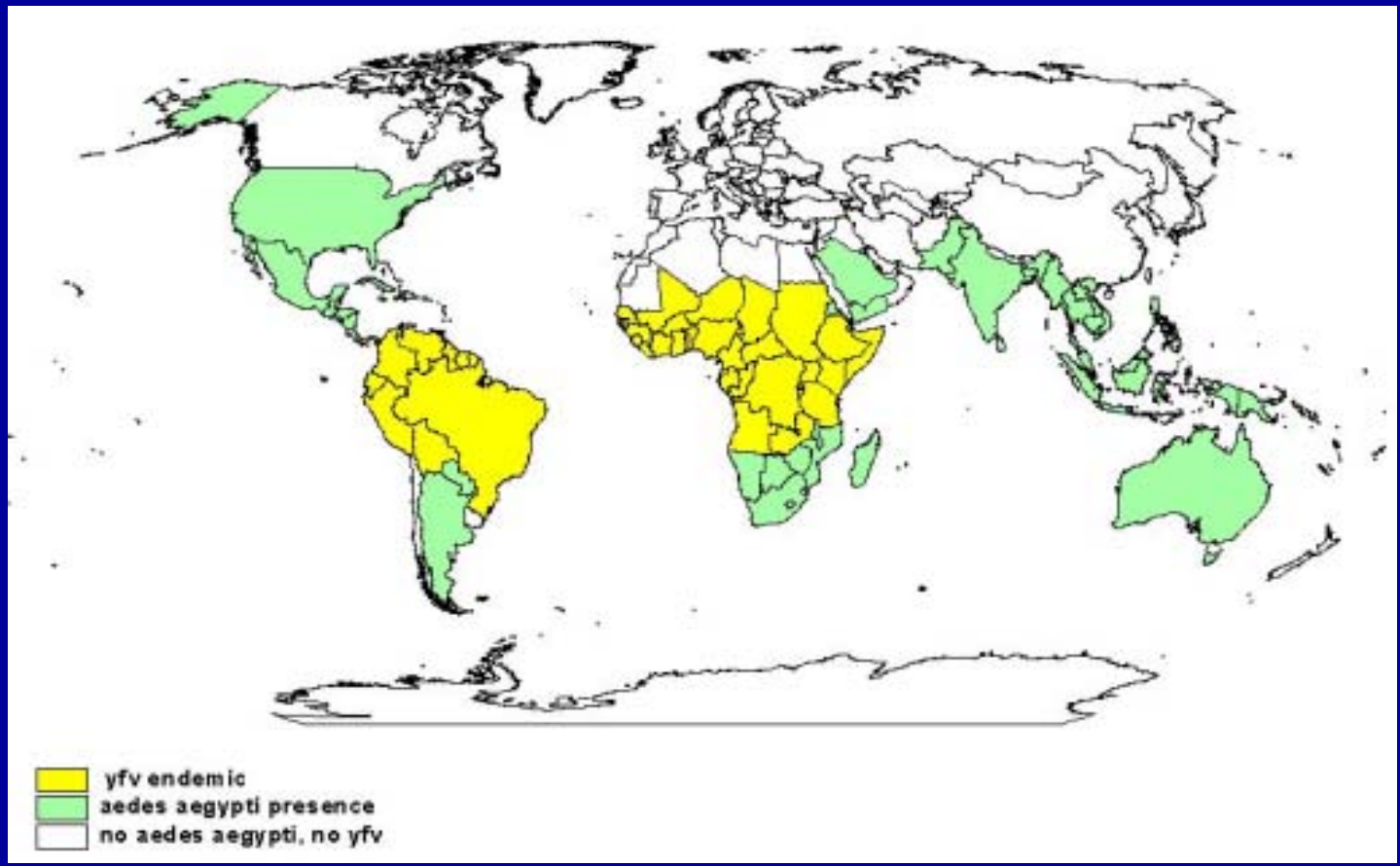
Yellow Fever: Re-emergence?

Reported Cases of Yellow Fever by Decade 1950-1998



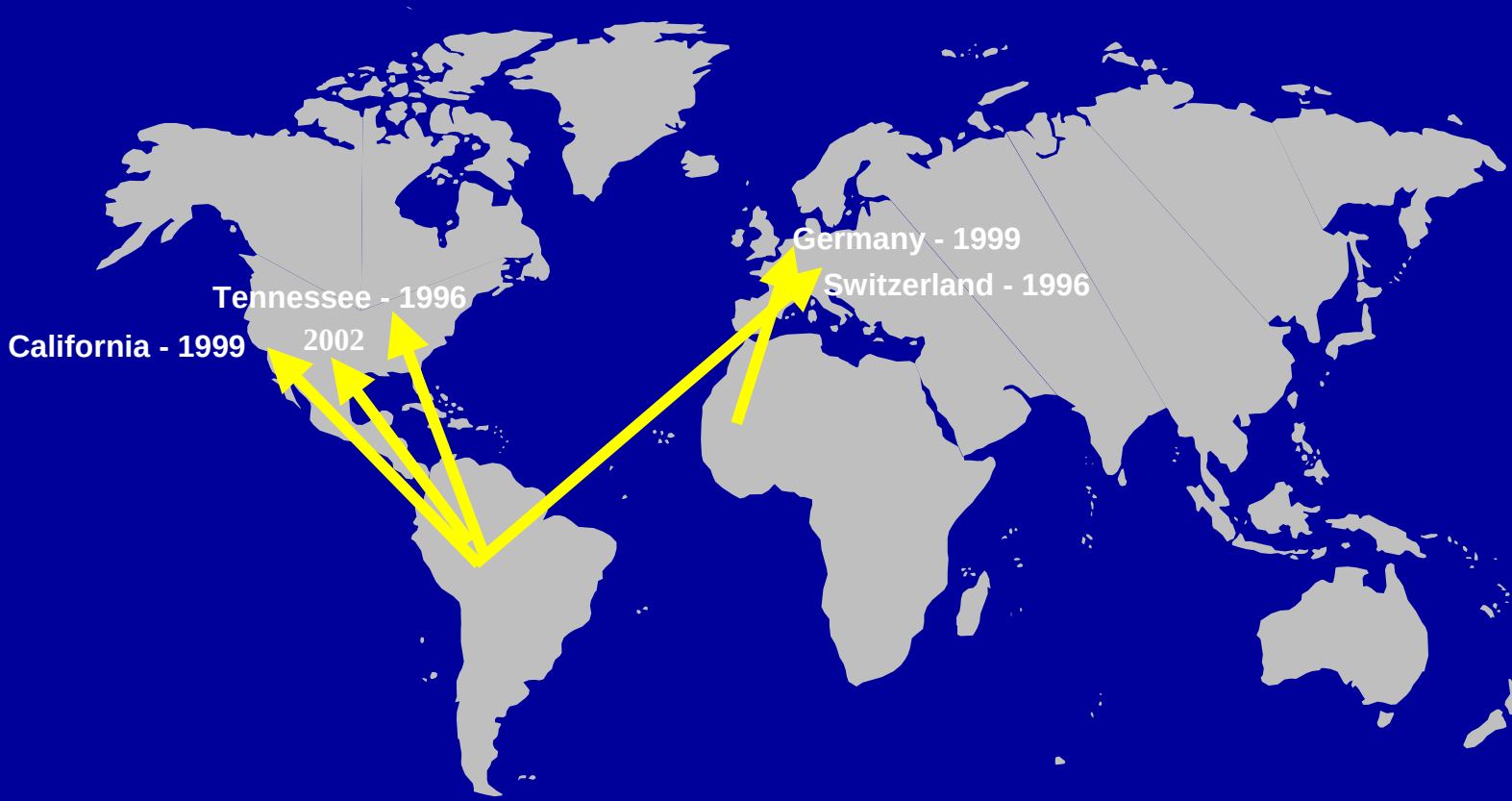
WHO Report, 2000

Yellow Fever Endemicity * and Presence of *Aedes Aegypti**



*Data are shown at the country level, does not reflect distribution within the country

Imported Yellow Fever



Features of the Epicenter, WNV NYC 1999

- Airports
- Marsh Land
- Wildlife Areas
- Queens Ethnic Diversity

Mosquito or Larvae

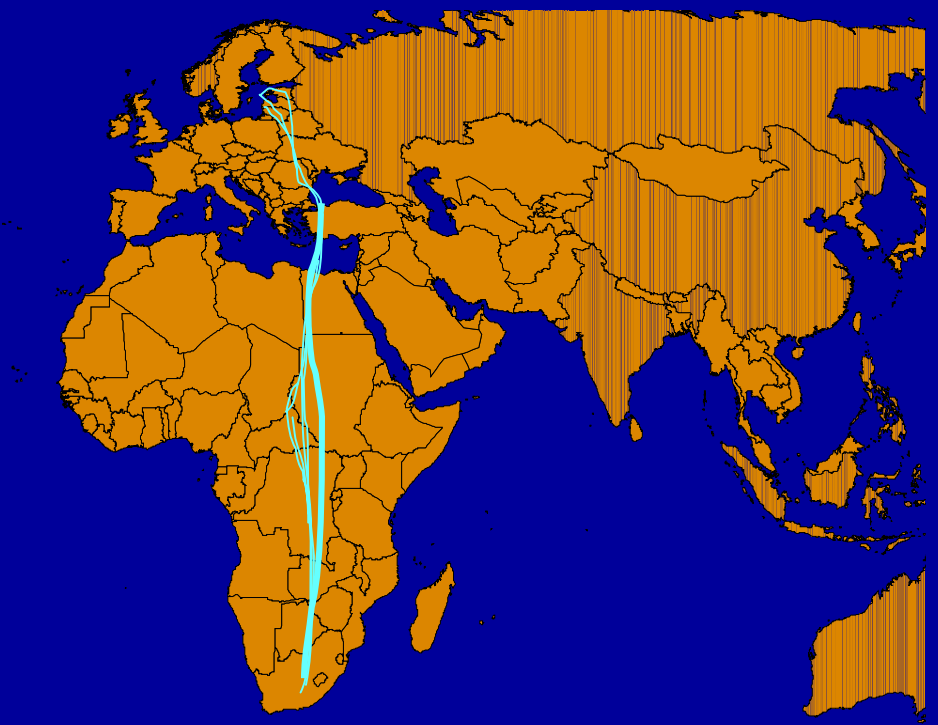
Arboviruses: Mosquito Surveillance

CDC Miniature Light Trap
Cebo de CO_2

CDC Gravid Trap
Cebo de Infusión

Migrating Bird

- Stowaways on planes & ships
- Interspecies contact along migration routes
- Possible bird - bird transmission



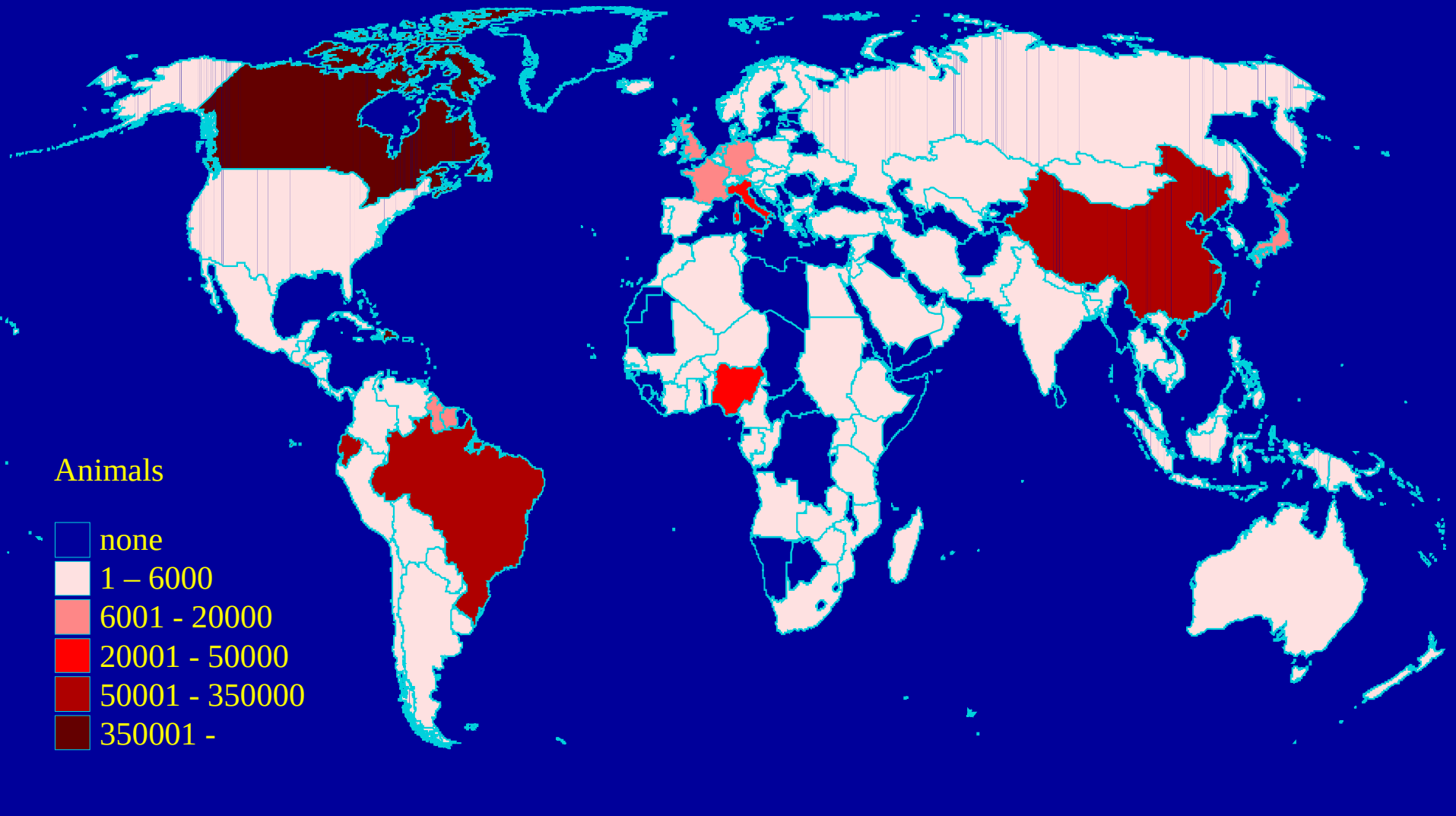
Dead Birds

Sentinel Chickens for WNV, NYC 2000

Karen Kasmauski, National Geographic Feb. 2002

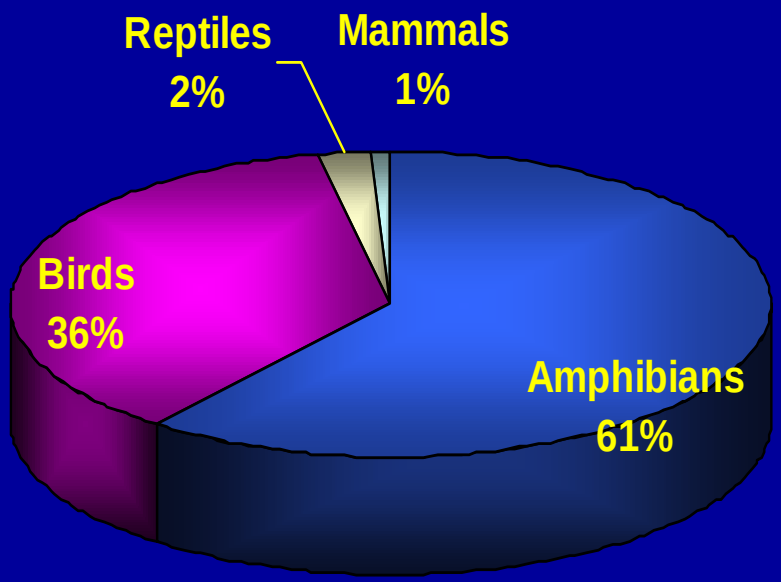
International Animal Importations Into New York August 1998 – July 1999

N = 2,873,144



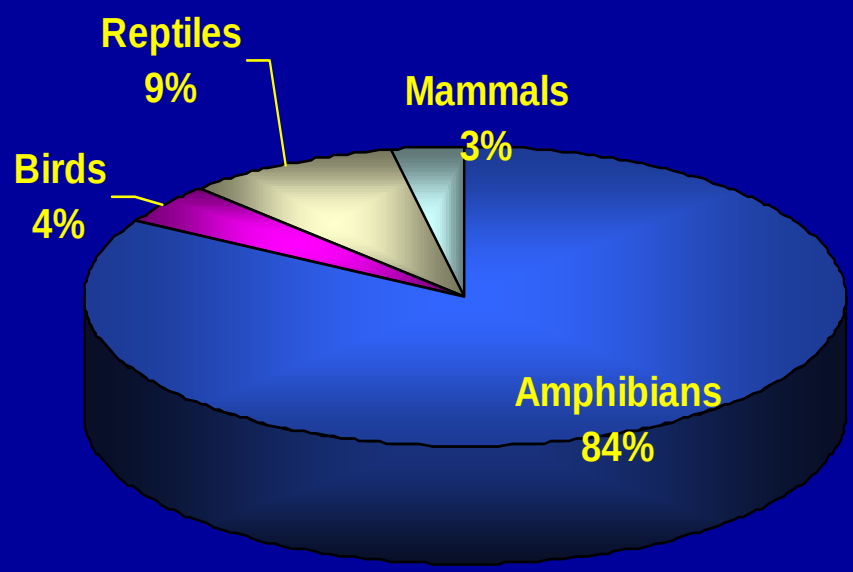
Animal Imports By Class
New York, August 1998 – July 1999

N = 2,873,144



All Countries

N = 123,642



WNV Endemic Countries

Selected Animal Imports Miami, 1996
N=30,297,567

Fish	**28,558,788**
Reptiles	**1,114,160**
Amphibians	**107,842**
Arachnids	**69,592**
Mammals	**6,943**
Arthropods	**2,561**
Birds	**1,408**

K, Murray-Lillibridge, S. Ostrowski, Division of Global Migration and Quarantine

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

Selected Animal Imports Miami, 1996 Fish and Aquatic Invertebrates, N=28,995,061

Fish	28,558,788
Crustaceans	250,108
Corals	49,442
Other invertebrates	136,723

K, Murray-Lillibridge, S. Ostrowski, Division of Global Migration and Quarantine

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

Selected Animal Imports Miami, 1996

Reptiles, N=1,114,160

Lizards	**980,141**
Crocodilians	**16,351**
Snakes	**81,620**
pythons	46,143
boas	26,223
vipers	732
anacondas	555
adders	213
cobras	142
mambas	47
other snakes	7,565
Turtles	**14,423**
Other Reptiles	**21,574**

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

K, Murray-Lillibridge, S. Ostrowski, Division of Global Migration and Quarantine

Selected Animal Imports Miami, 1996
Amphibians, N=107,842

Frogs	77,465
Caecilian	22,480
Toads	5,385
Salamanders	684
Other	1,828

K, Murray-Lillibridge, S. Ostrowski, Division of Global Migration and Quarantine

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

Selected Animal Imports Miami, 1996
Arachnids, N=69,592

Scorpions	**37,482**
Terantulas	**22,480**
Spiders	**9,630**

K, Murray-Lillibridge, S. Ostrowski, Division of Global Migration and Quarantine

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

Selected Animal Imports Miami, 1996
Mammals, N=6,943

Sugar Gliders	4,442
Rodents	1,912
Monkeys	406
Other	183

K, Murray-Lillibridge, S. Ostrowski, Division of Global Migration and Quarantine

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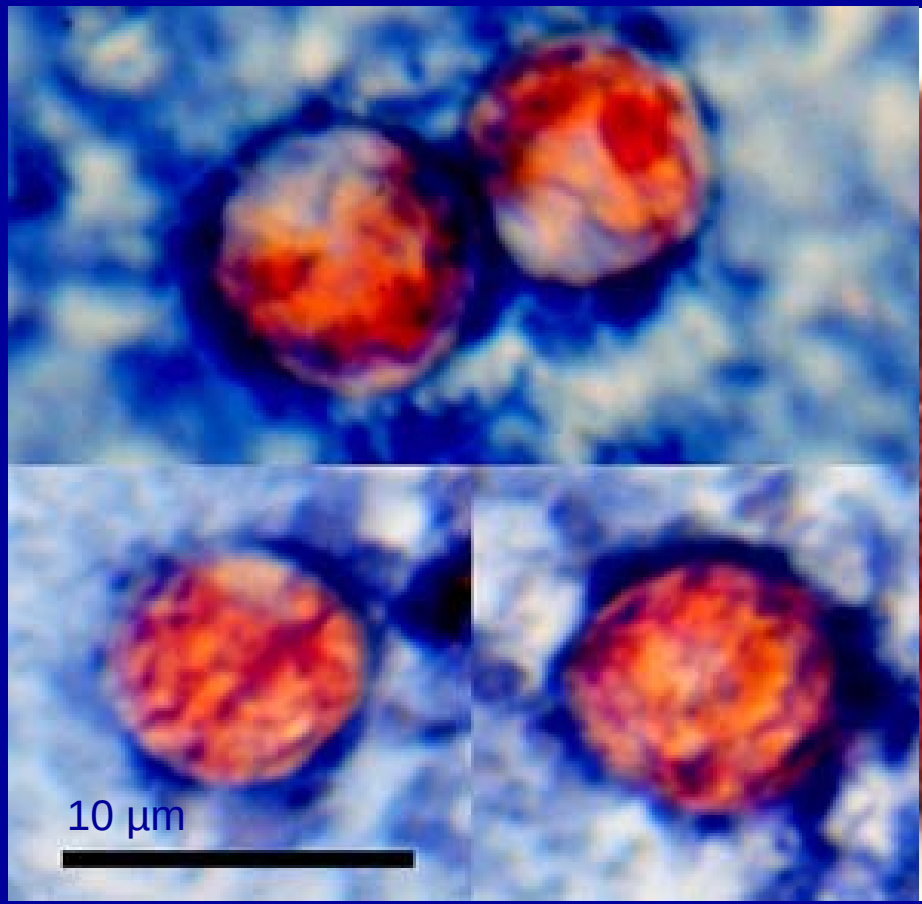
Selected Animal Imports Miami, 1996
Arthropods, N=2,561

Millipedes	**2,440**
Centipedes	**19**
Other	**102**

K, Murray-Lillibridge, S. Ostrowski, Division of Global Migration and Quarantine

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

Cyclospora



Immature oocysts

Contaminated raspberries

The Economist
MARCH 3RD - 9TH 2001
FAT-CAT LIVINGSTONE
BAGEHOT, page 40
GEORGE BUSH, THE GAMBLER
pages 18 and 55
They're burning animals again

DEPARTING FLIGHTS
105
ALL
FLIGHTS
CANCELLD

USAMRIID practices evacuation of contagious patient

The more things change….

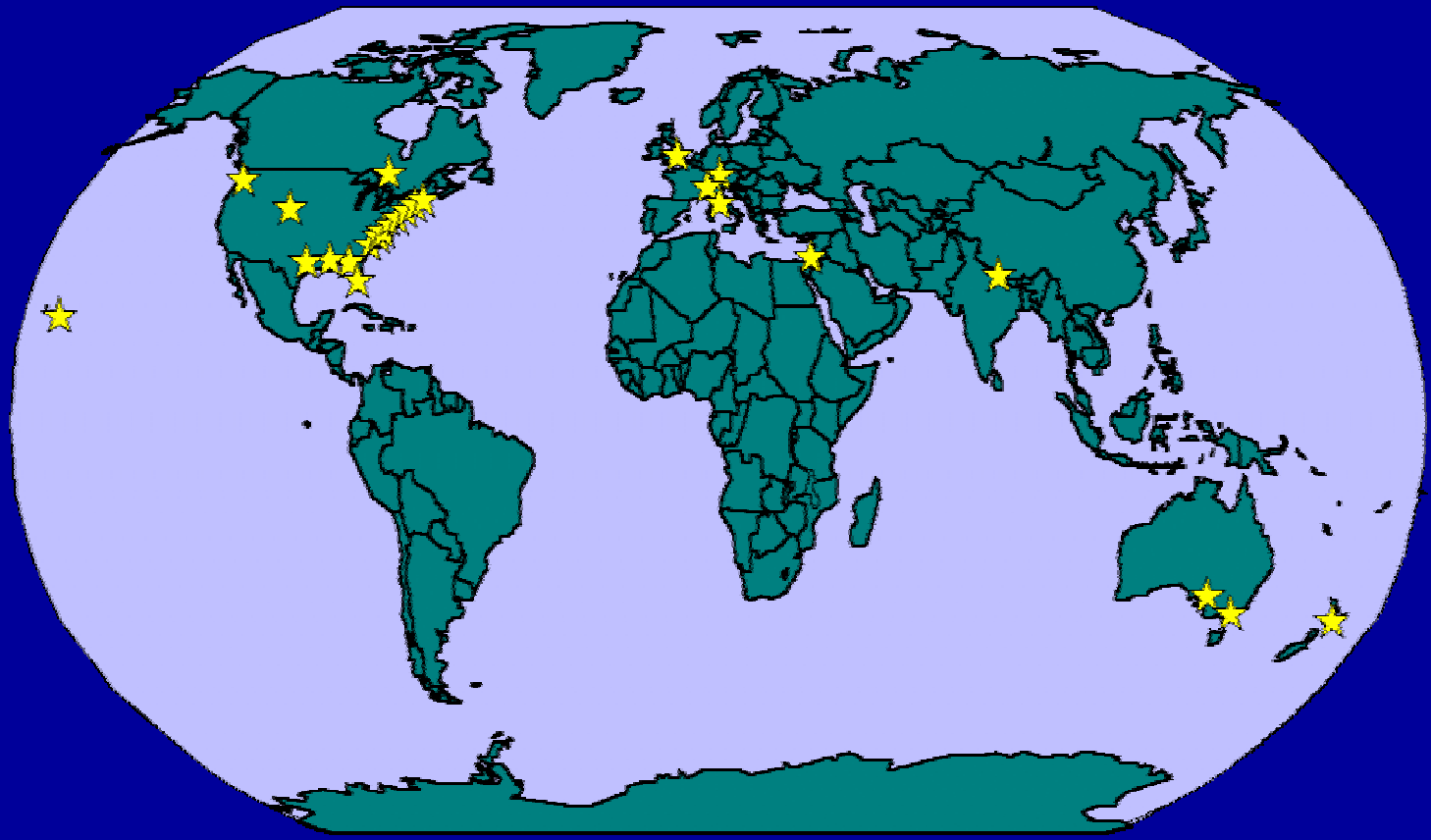
Europe, 1350

Uganda, 2001

"As the human immunodeficiency virus (HIV) epidemic surely should have taught us, in the context of infectious diseases, there is nowhere in the world from which we are remote and no one from whom we are disconnected."

Institute of Medicine, 1992

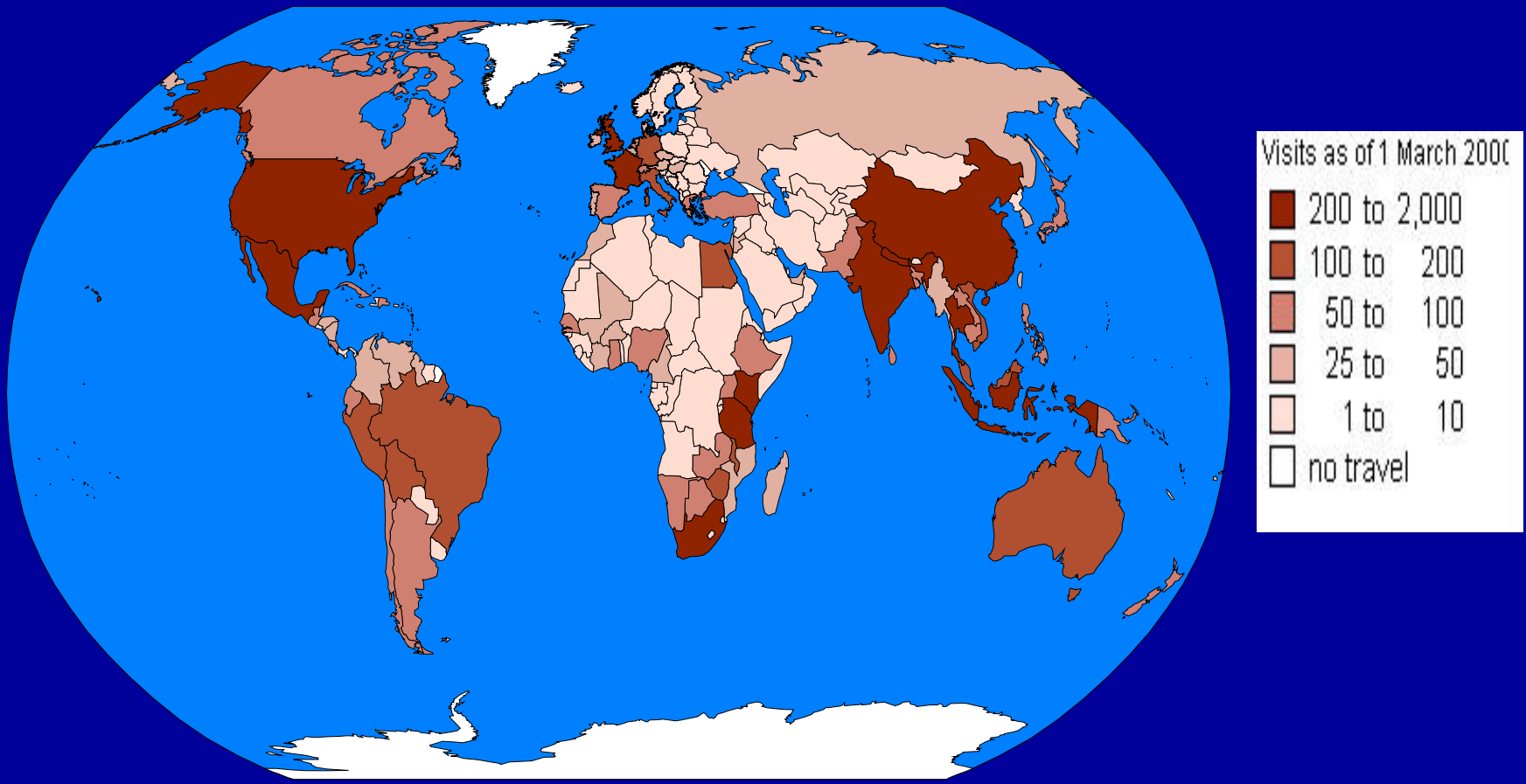
What is GeoSentinel?



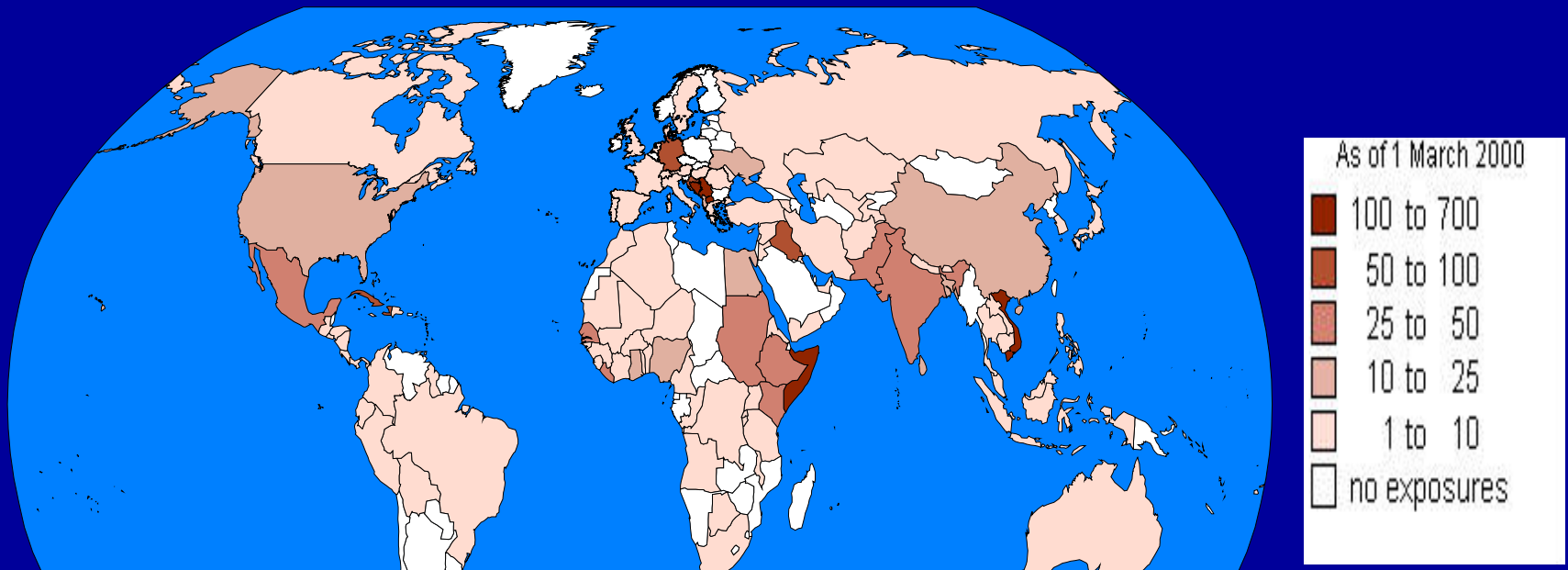
- 25 travel/tropical medicine clinics globally (since 1996)
  - Broader ISTM membership periodically
- Provider based surveillance of international travelers/migrants
- Networking between GeoSentinel, similar networks, and public health agencies

CDC

Countries Visited by Travelers, March 2000



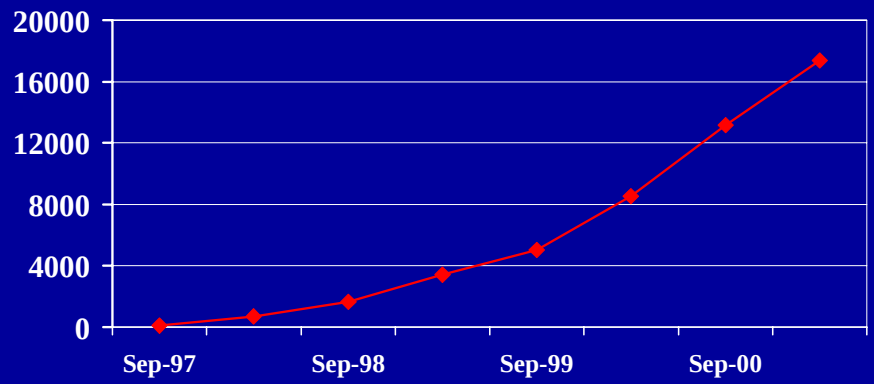
Countries of Exposure for *Recent Migrants March 2000



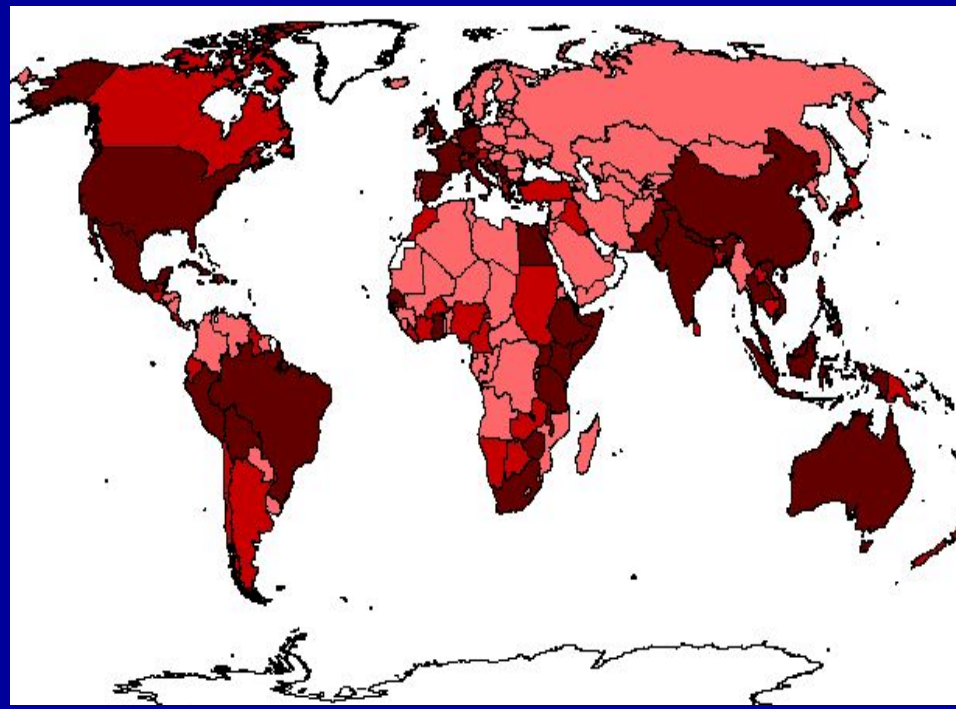
* Immigrants and refugees within last 5 years, includes country of origin

CDC

GeoSentinel Dataset, Mar 2001



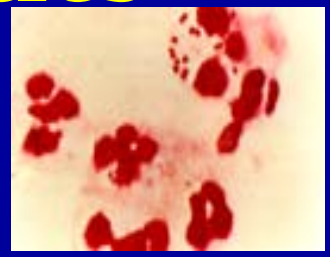
Number of patients in GeoSentinel

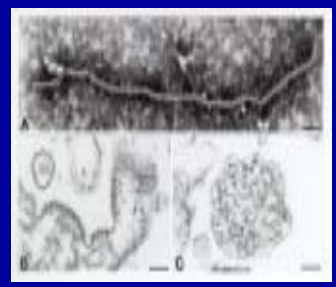


Travel information in GeoSentinel

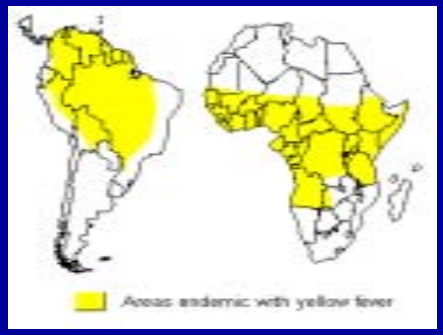
GeoSentinel Response Capabilities

- Alerts
- Recommendations
- Networking
- Broader inquiries



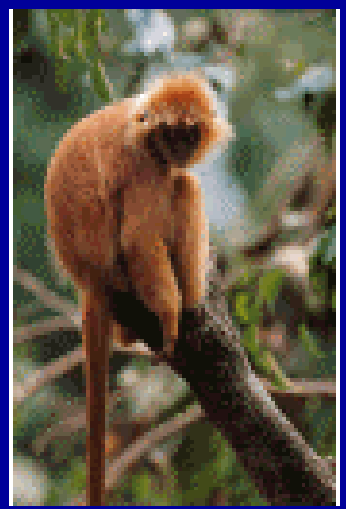


Yellow Fever: Re-emergence?



Low YF vaccine coverage rates

Increased global travel

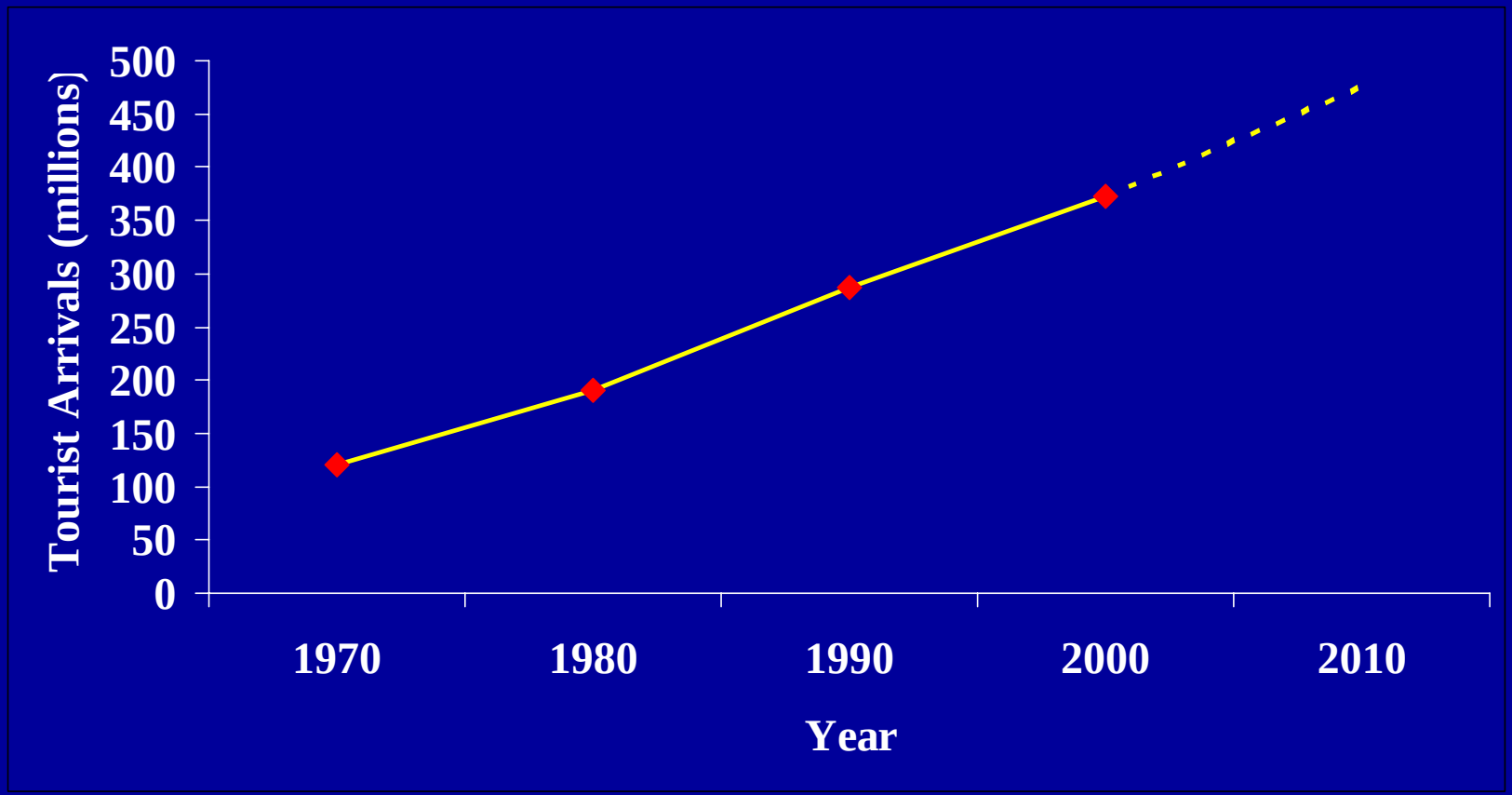


Encroachment of humans into sylvatic cycle

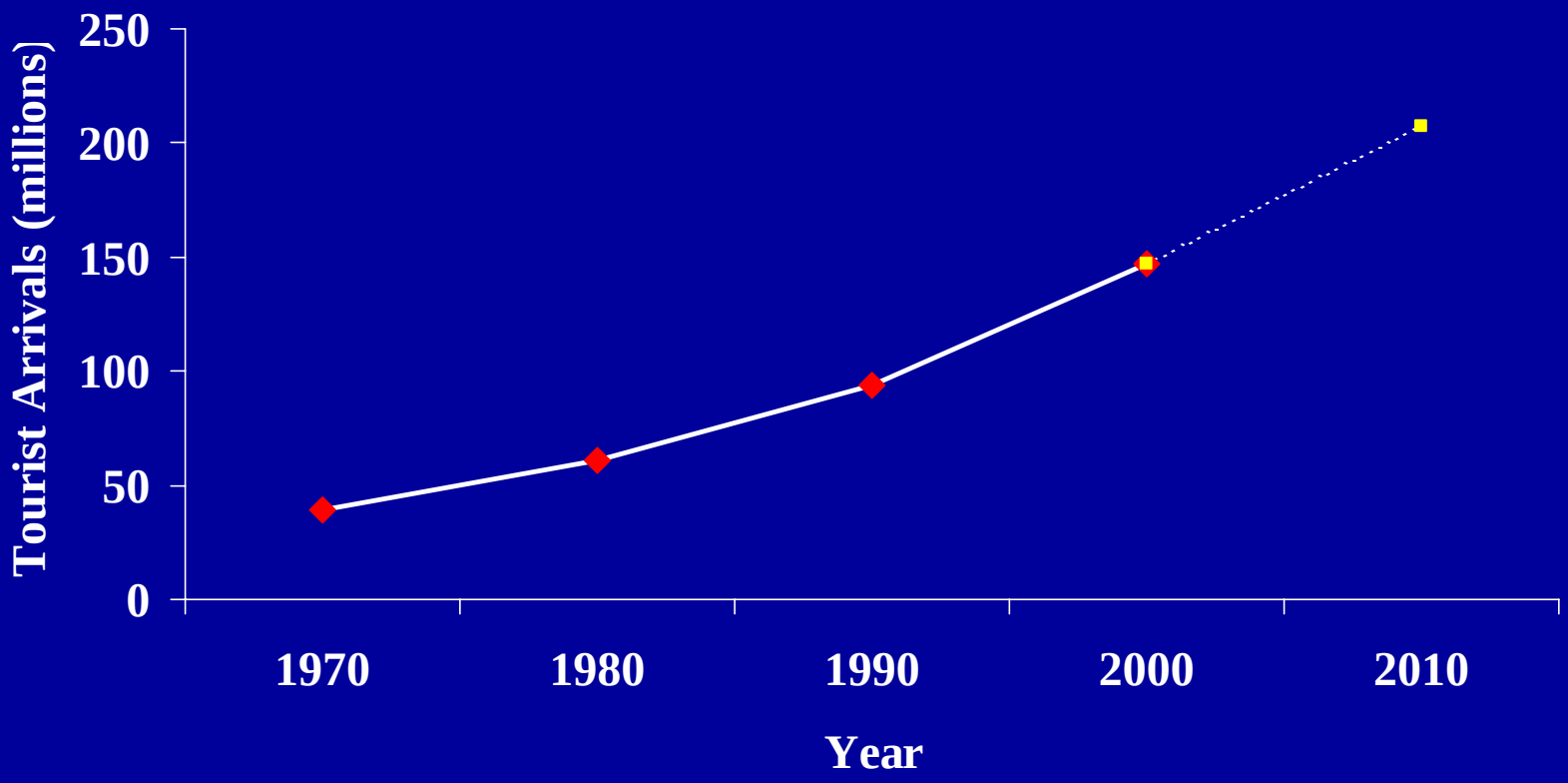
Human migration and urbanization

Resurgence of *aedes aegypti in* urban areas

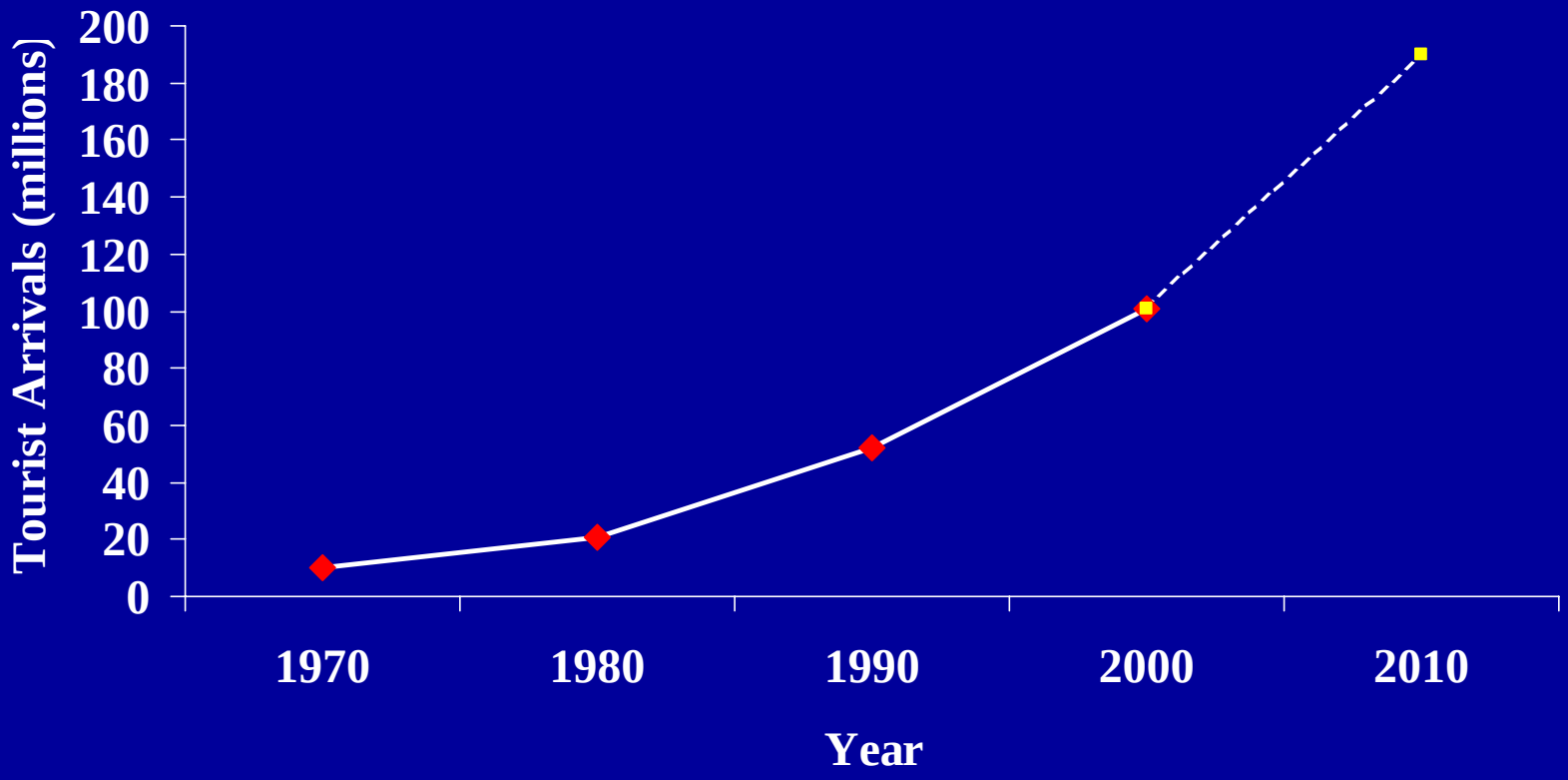
International Tourist Arrivals - Europe



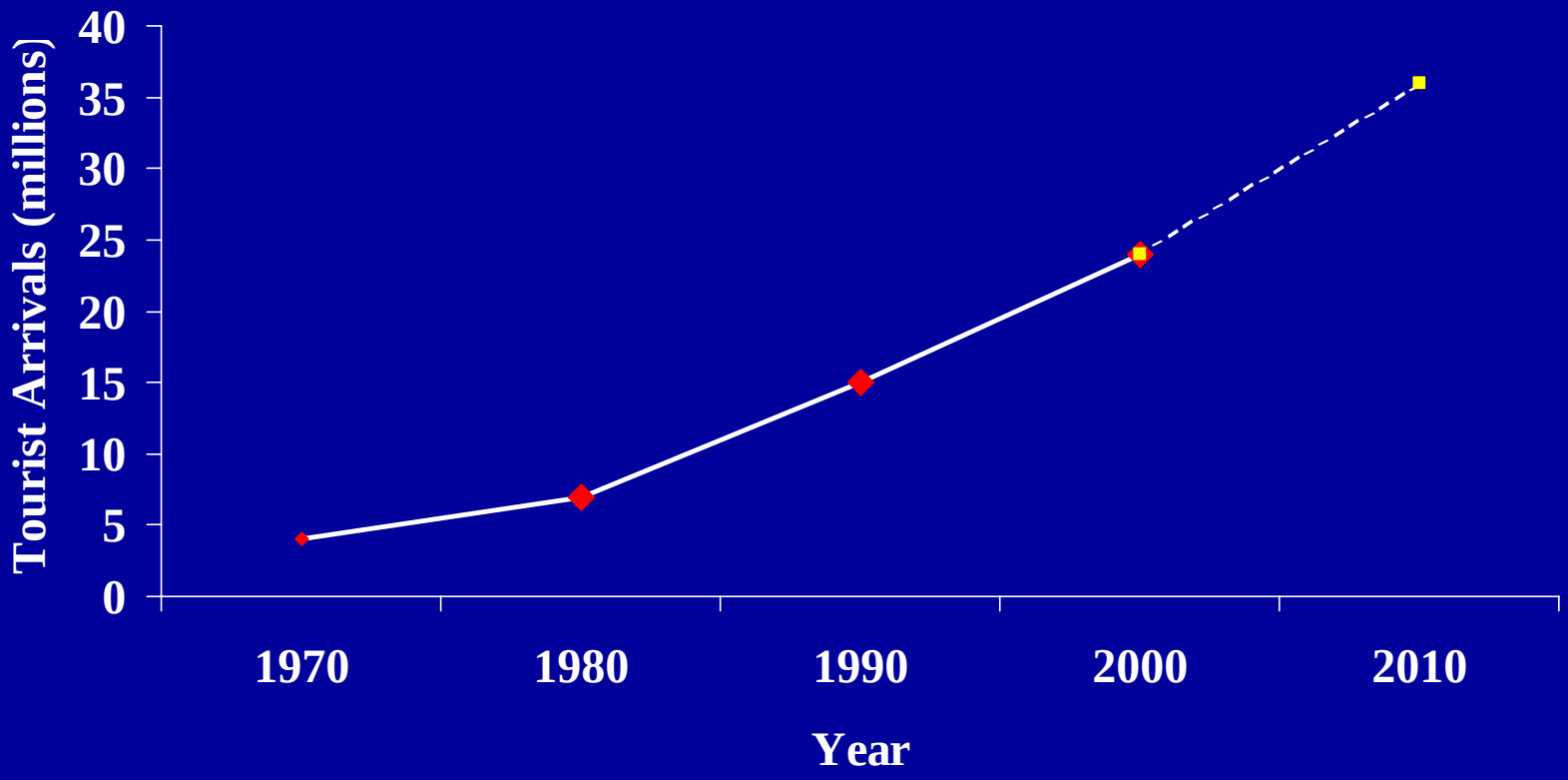
International Tourist Arrivals - Americas



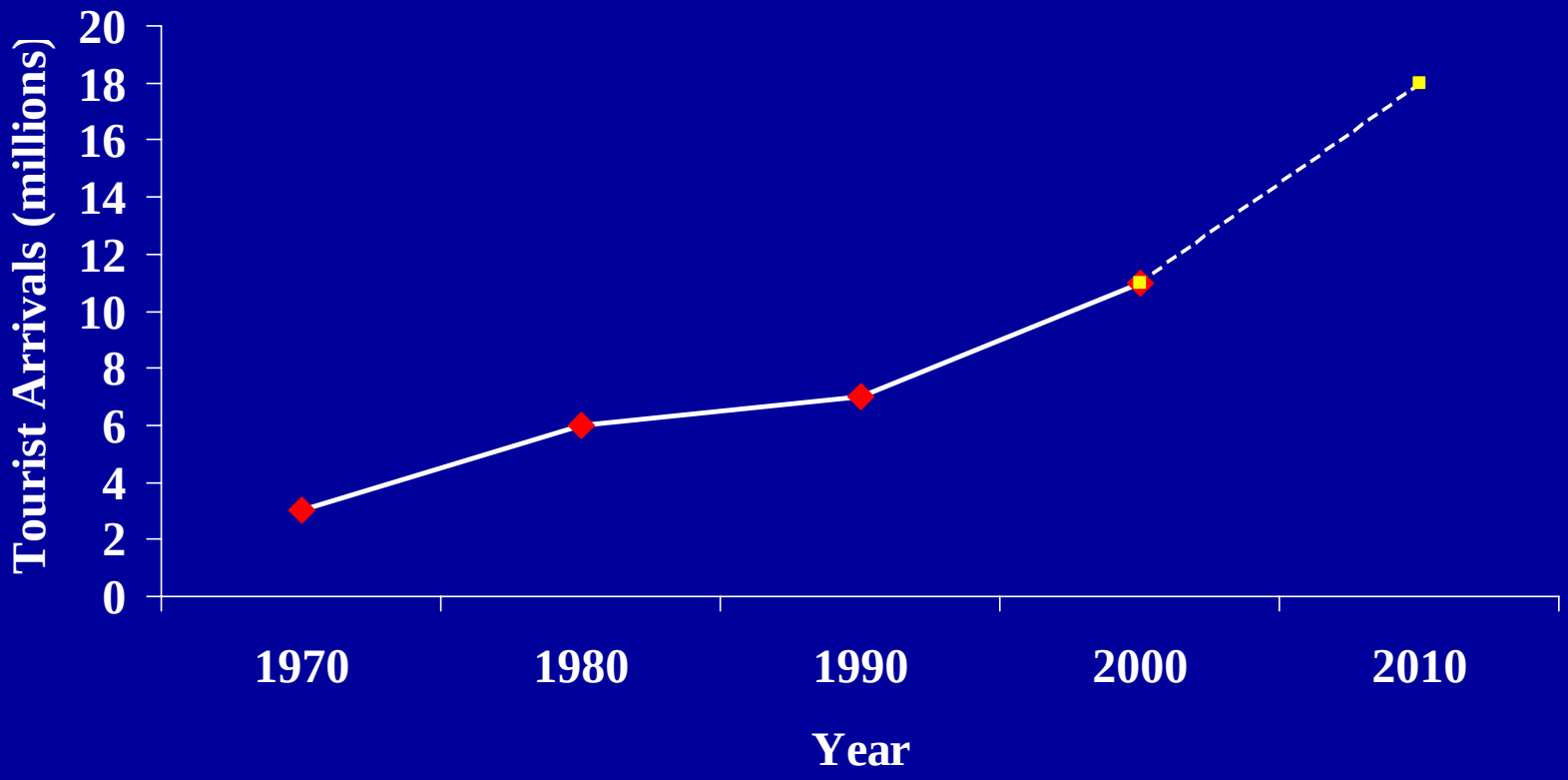
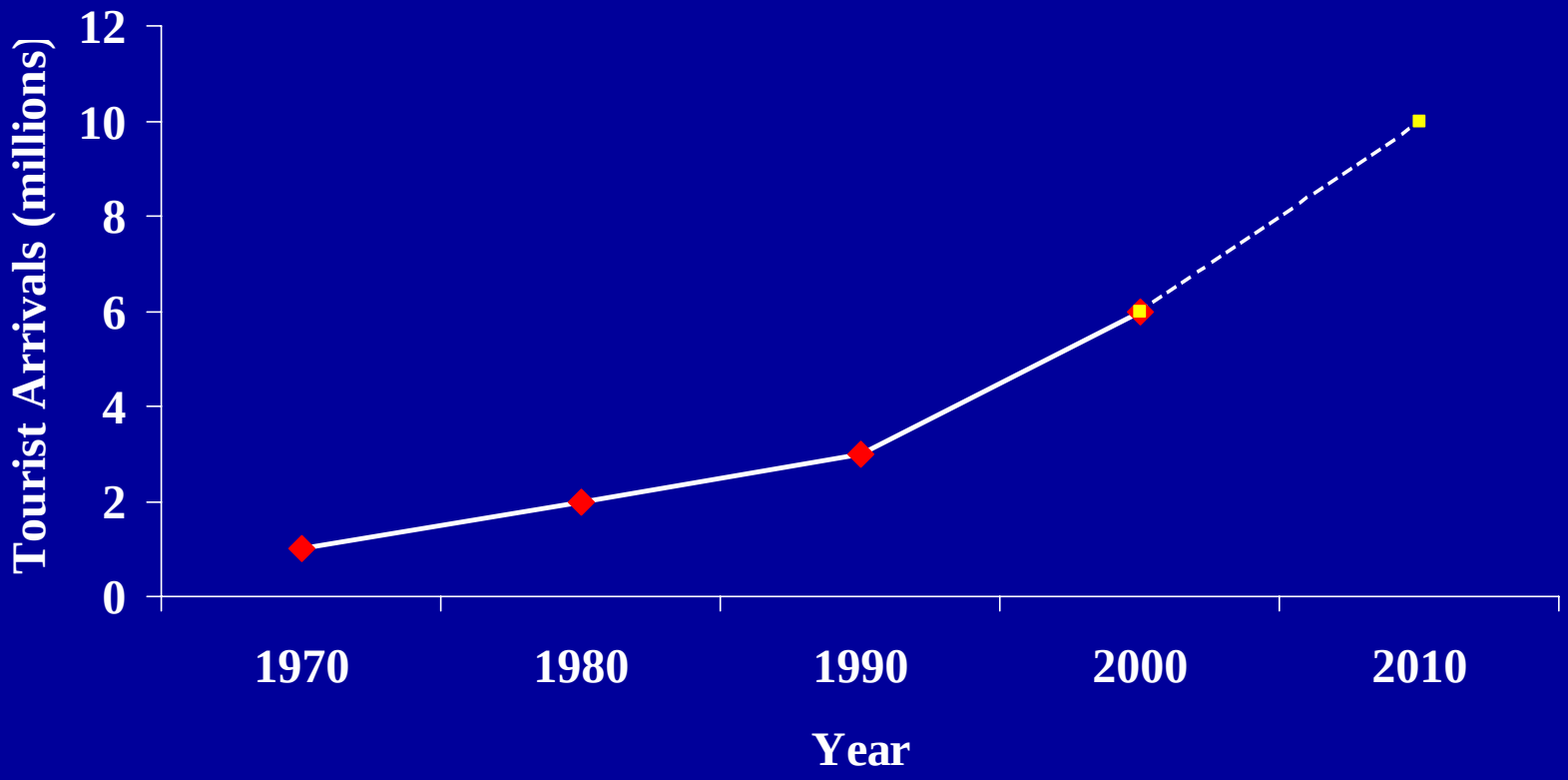
International Tourist Arrivals - East Asia/Pacific



International Tourist Arrivals - Africa



International Tourist Arrivals - Middle East



International Tourist Arrivals - South Asia