Missouri Botanical Garden

Plant Conservation in a Rapidly Changing World

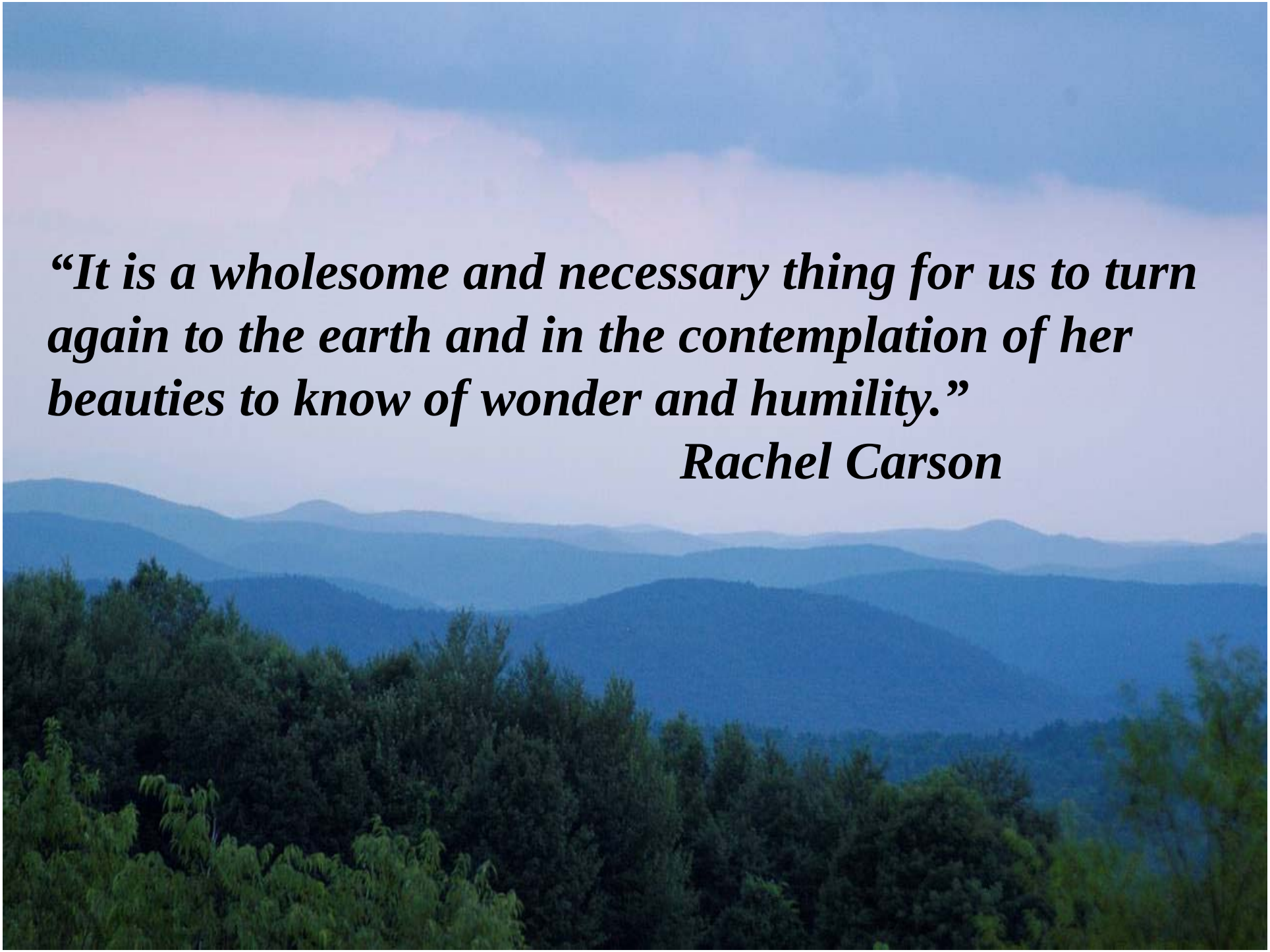
Peter H. Raven
Missouri Botanical Garden
Swarthmore College
March 15, 2009

We Depend on Plants

- Directly or indirectly, all of our food comes from plants
- Most people in the world depend on plants for their medicine
- More than a quarter of prescription drugs are derived from plants
- Ecosystem services
- Ethically, morally and artistically, plants are important.
- Future possibilities

Dong Ba Market, Hue, Vietnam

Herbal Medicines in Mexico


“It is a wholesome and necessary thing for us to turn again to the earth and in the contemplation of her beauties to know of wonder and humility.”
Rachel Carson

How Many Plant Species Exist?

Probably 300,000 valid species have been named, perhaps 50,000 to 100,000 more to be discovered.

But even of those that have been named, we know very little about the great majority

Our Hopes for Plant Biodiversity

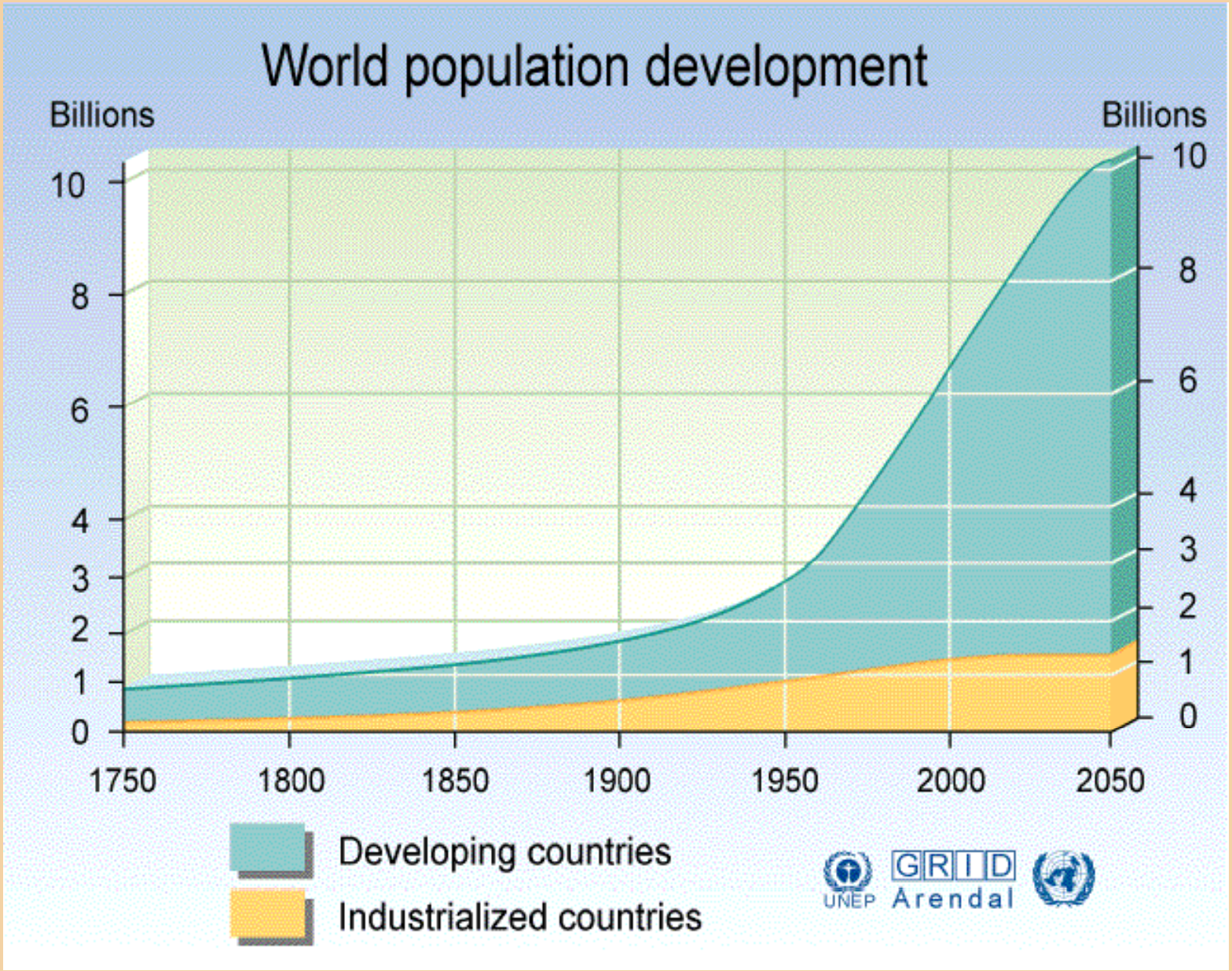
- Improved, sustainable sources of food
- New foods and medicines
- Sustainable ecosystems
- New ways to purify soil and water
- Sustainable energy
- Maintain the beauty in our lives

New Opportunities

- The genetic code was first outlined in the 1960s
- The first transfer of a gene from one unrelated species of organism to another took place only in 1973
- Transgenic (GM) drugs and crops began to be used within the past 20 years
- Genomes decoded easily during past 10 years
- All of these advances depend on the diversity of living organisms, and have great potential for human welfare

Why is There a Problem?

- **Human population growth has reached record levels**
- **Our individual levels of consumption are huge and climbing rapidly**
- **Many of the technologies developed since the start of the Industrial Revolution, when the world population was about 850 million people, have proven destructive in a world of 6.8 → 9+ billion people**


World population development
Billions
Billions
10
8
6
4
3
2
1
0
1750
1800
1850
1900
1950
2000
2050
Developing countries
Industrialized countries
UNEP
GRID
Arendal


75-K1
5471

Ranchettes in Colorado

Cairo skyline

Changes since 1950

Soil Loss 15%

Loss of Agricultural Land 20%

Loss of forests 1/3

CO2 1/6 increase

O3 7% loss

Extinction Rates
(Assuming >12 million species of organisms)

- Historically about a dozen per year
- From 1500 to 1950 about 1000 per year
- Currently several 1000's per year
- Later this century: 10,000's per year

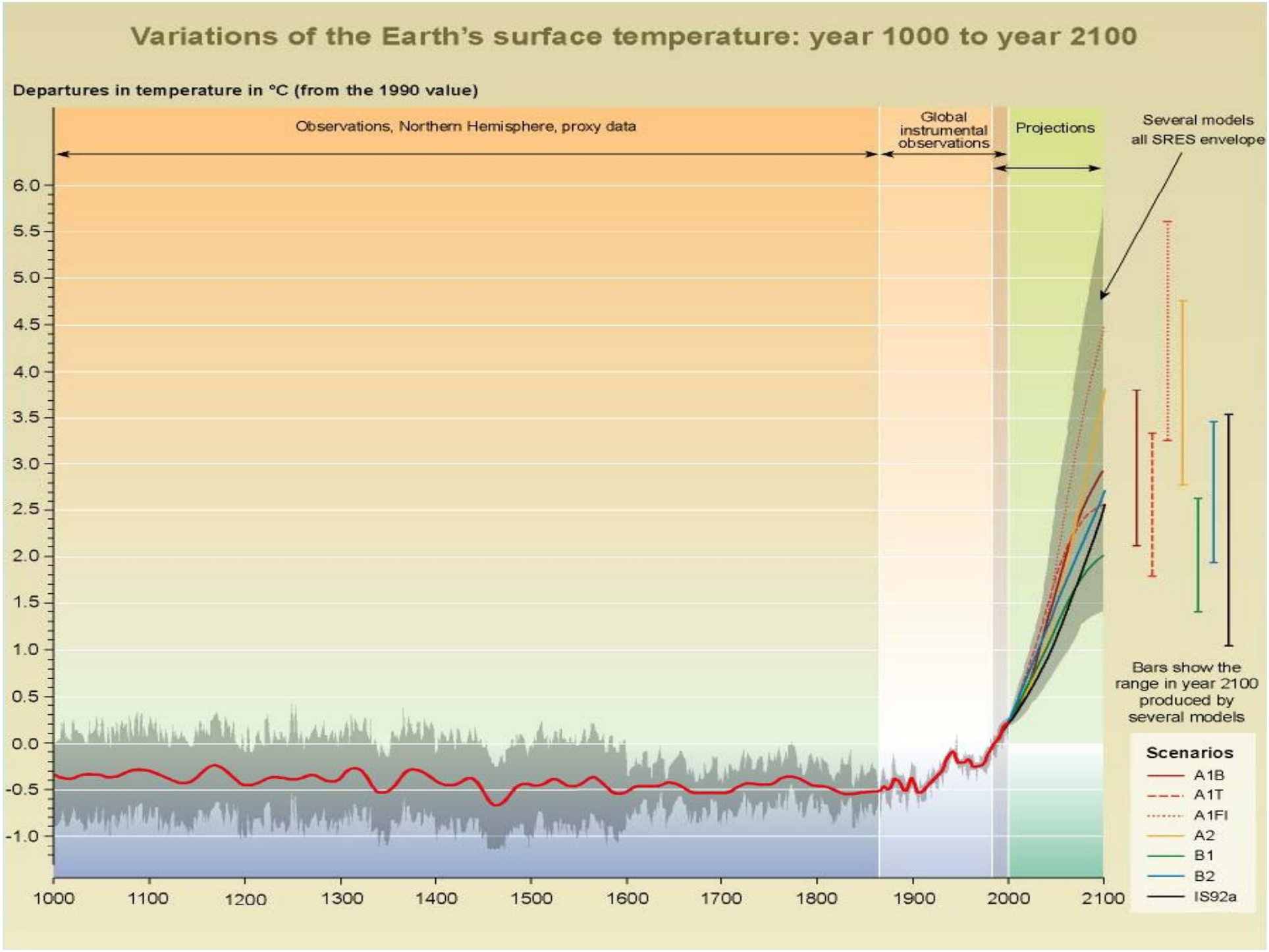
End result:

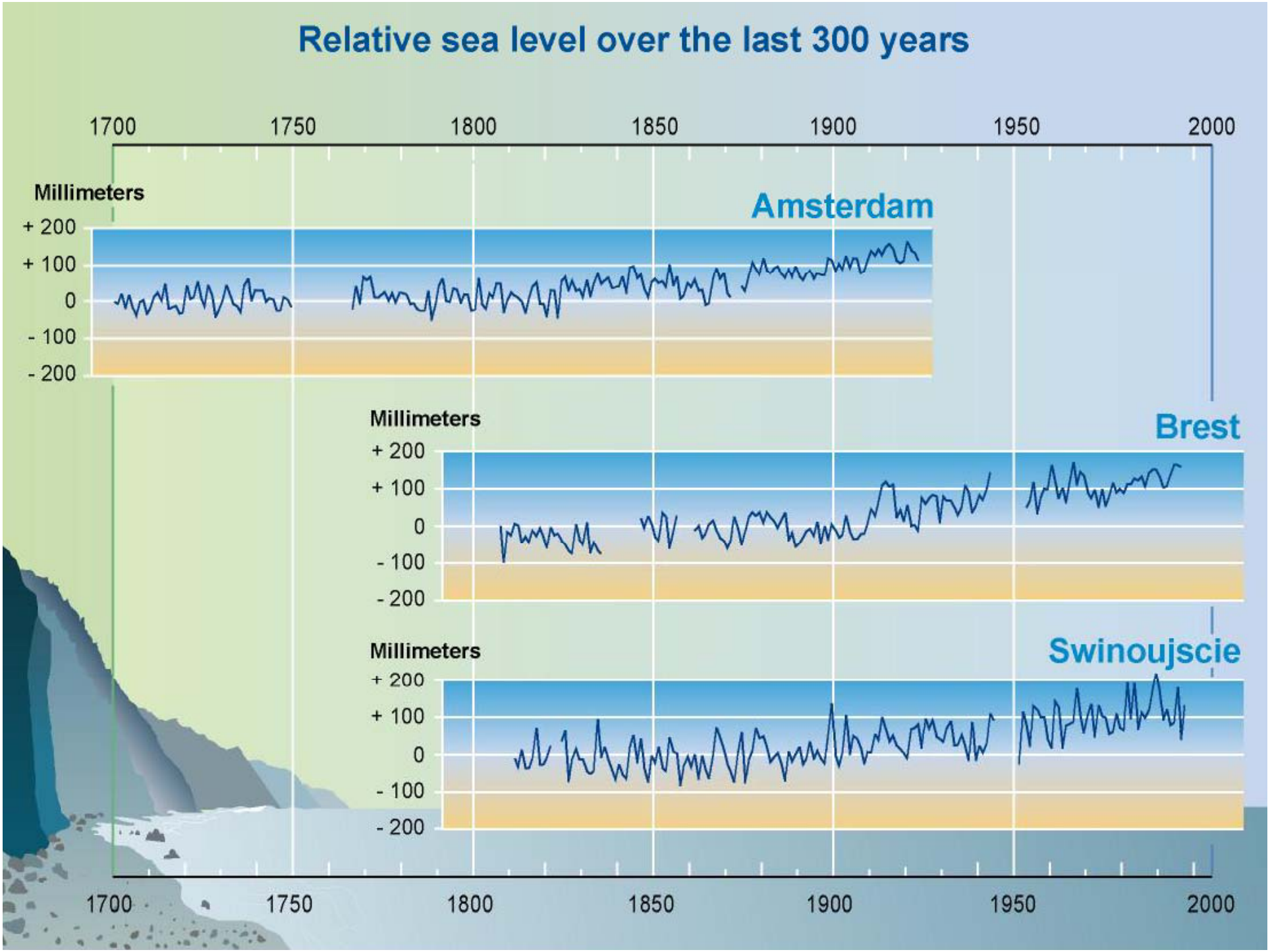
more than half of all species may be lost by 2100

Purple loosestrife

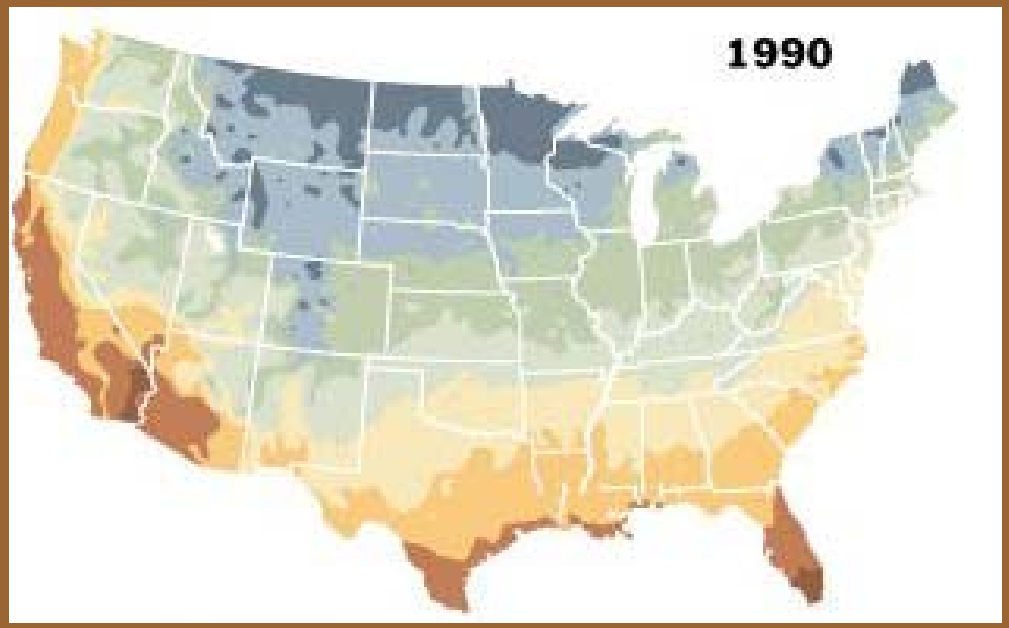
Ginseng

Variations of the Earth's surface temperature: year 1000 to year 2100

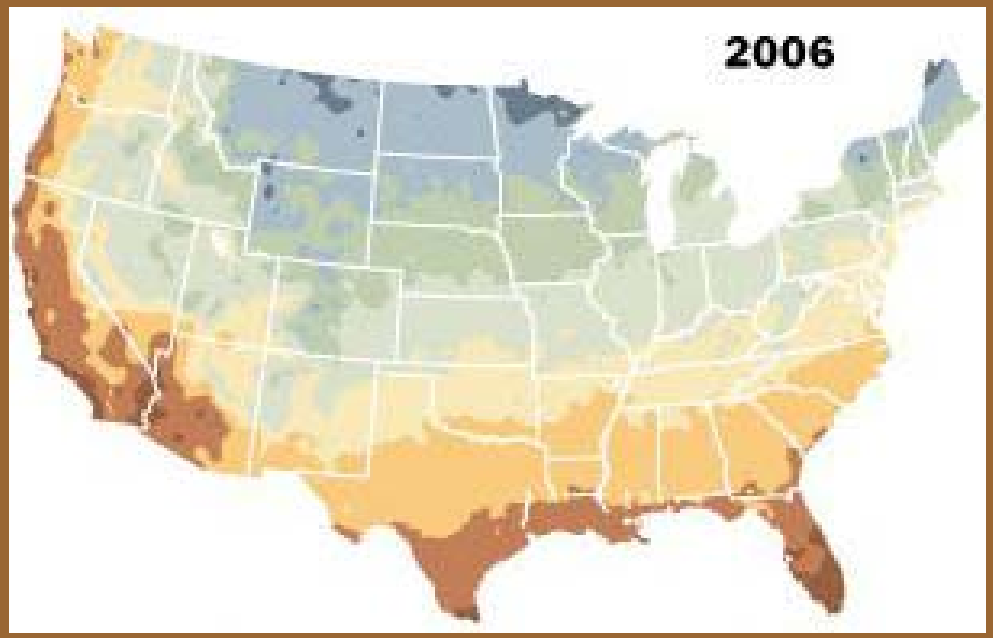



Relative sea level over the last 300 years
1700
1750
1800
1850
1900
1950
2000
Millimeters
+ 200
+ 100
0
- 100
- 200
Amsterdam
Millimeters
+ 200
+ 100
0
- 100
- 200
Brest
Millimeters
+ 200
+ 100
0
- 100
- 200
Swinoujscie
1700
1750
1800
1850
1900
1950
2000

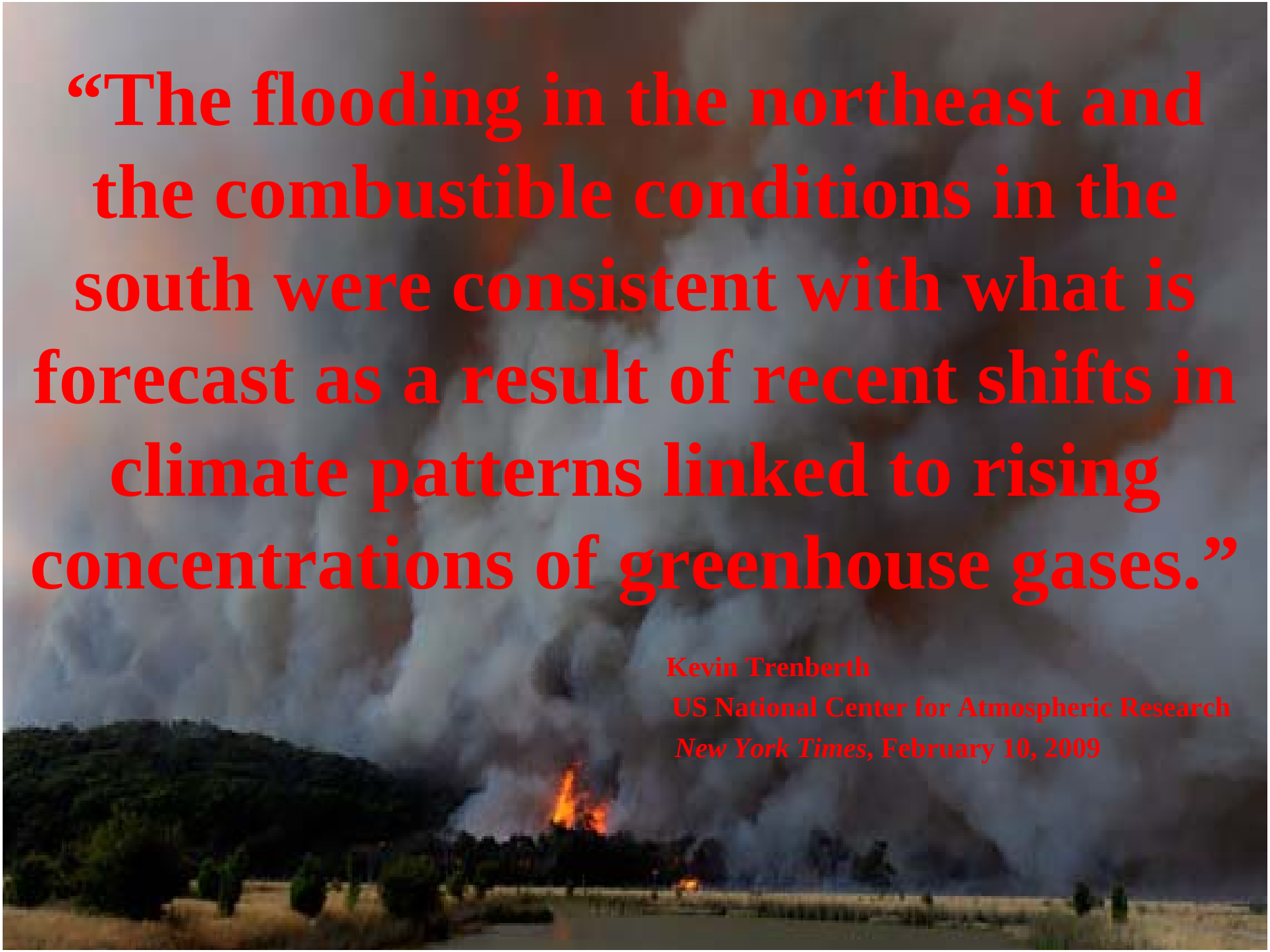
Village along the Mekong River



USDA



National Arbor Day Foundation



"The flooding in the northeast and the combustible conditions in the south were consistent with what is forecast as a result of recent shifts in climate patterns linked to rising concentrations of greenhouse gases."

Kevin Trenberth
US National Center for Atmospheric Research
***New York Times*, February 10, 2009**

Global Warming is a Much Worse Threat To Biodiversity Than We Have Imagined

- The current IPCC report estimates that with a 1.5^{o}C rise in temperature, 20-30% of the world's species could be on the way to extinction.

Global Warming is a Much Worse Threat To Biodiversity Than We Have Imagined

- The current IPCC report estimates that with a 1.5^{o}C rise in temperature, 20-30% of the world's species could be on the way to extinction.
- The greenhouse gases already in the atmosphere will cause a further 1^{o}C rise even with no further emissions

Global Warming is a Much Worse Threat To Biodiversity Than We Have Imagined

- The current IPCC report estimates that with a 1.5^{o}C rise in temperature, 20-30% of the world's species could be on the way to extinction.
- The greenhouse gases already in the atmosphere will cause a further 1^{o}C rise even with no further emissions
- If we can level off our emissions at current levels by 2015-2020 and decrease them by 80% by the end of the century, global temperature still will increase an additional 2^{o}C, to the brink of where unmanageable consequences will occur.

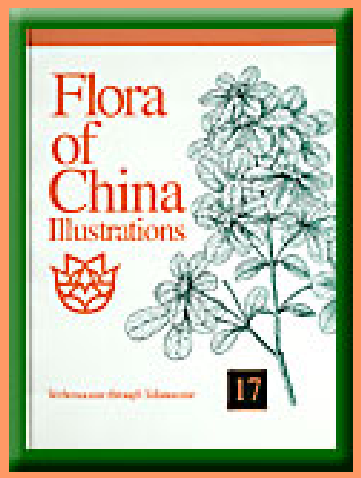
BIODIVERSITY

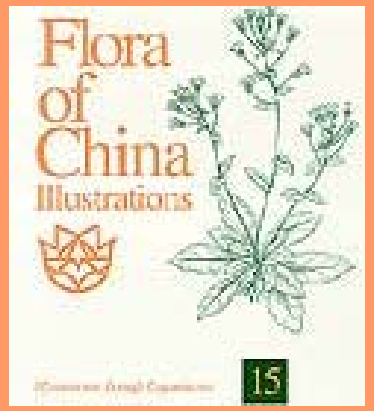
- The living species of plants, animals, fungi, and microorganisms with which we share this planet are essential for our lives.
- We hope to build global sustainability on the basis of their properties.
- Yet we are driving them to extinction at an unprecedented rate.
- How can this process be slowed down?

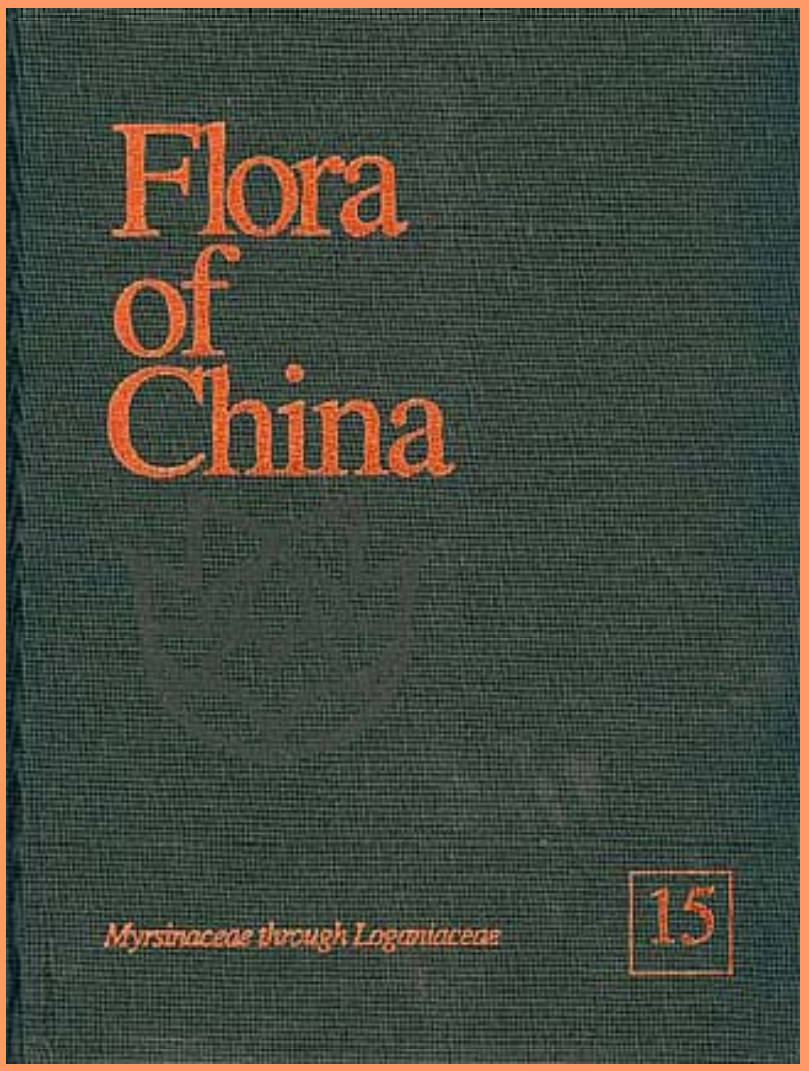
ACTIONS

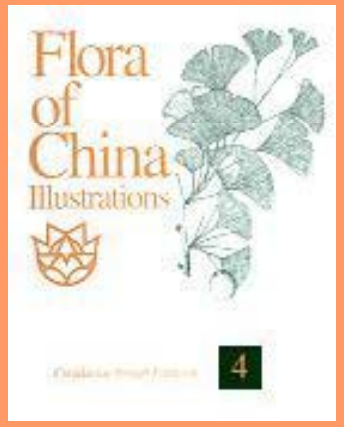
- Discover and document existing species
- Set aside natural areas and protect them
- Bring endangered species into cultivation and when possible reintroduce them
- Combat alien invasive species
- Provide alternatives to gathering species in nature

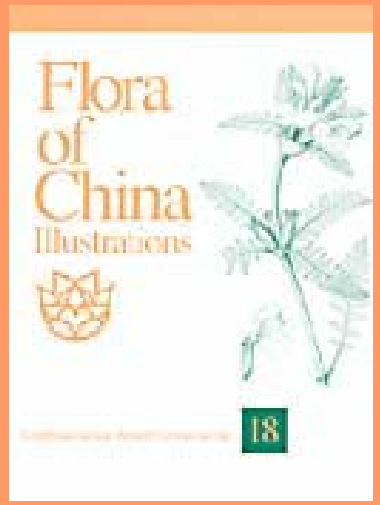
Dr. Tom Croat's
100,000 specimen


Flora
of
China
Illustrations
17


Flora
of
China
Illustrations
15

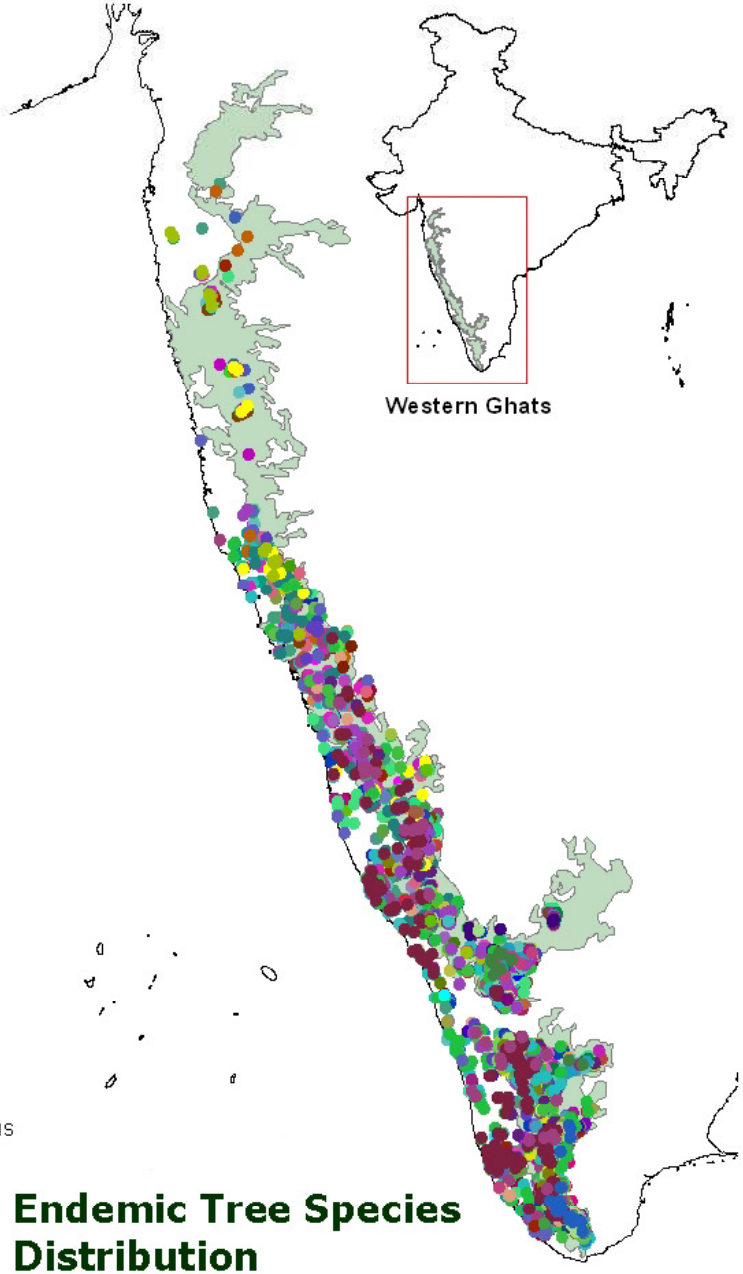

Flora
of
China
Myrsinaceae through Loganiaceae
15


Flora
of
China
Illustrations
4


Flora
of
China
Illustrations
18

Endemic Species of the Western Ghats

- Actinodaphne angustifolia
- Actinodaphne bourdillonii
- Actinodaphne bourneae
- Actinodaphne campanulata
- Actinodaphne hookeri
- Actinodaphne lanata
- Actinodaphne lawsonii
- Actinodaphne malabarica
- Actinodaphne salicina
- Actinodaphne tadulingamii
- Aglaia barberi
- Aglaia canarensis
- Aglaia elaeagnoidea
- Aglaia exstipulata
- Aglaia indica
- Aglaia jainii
- Aglaia lawii
- Aglaia littoralis
- Aglaia maiae
- Aglaia malabarica
- Aglaia simplicifolia
- Anacolosa densiflora
- Apollonias arnottii
- Aporusa bourdillonii
- Aralia malabarica
- Ardisia blatteri
- Ardisia rhomboidea
- Artocarpus hirsutus
- Atalantia wightii
- Atuna indica
- Atuna travancorica
- Baccaurea courtallensis
- Beilschmiedia wightii
- Blachia calycina
- Blachia denudata
- Blachia reflexa
- Blachia umbellata
- Blepharistemma membranifolia
- Buchanania lanceolata
- Byrsophyllum tetrandrum
- Calophyllum apetalum
- Calophyllum austroindicum
- Canthium ficiforme
- Canthium neilgherrense
- Canthium pergracilis
- Canthium travancoricum
- Casearia rubescens
- Casearia varians
- Casearia wynadensis
- Chionanthus leprocarpa
- Chionanthus linocieroides
- Cinnamomum chemungianum
- Cinnamomum filipedicellatum
- Cinnamomum keralaense
- Cinnamomum macrocarpum
- Cinnamomum malabatrum
- Cinnamomum perrottetii
- Cinnamomum riparium
- Cinnamomum sulphuratum
- Cinnamomum travancoricum
- Cinnamomum walaiwarense
- Cinnamomum wightii
- Cleistanthus malabaricus
- Cleistanthus travancorensis
- Croton lawianus
- Croton malabaricus
- Cryptocarya anamallayana
- Cryptocarya beddomei
- Cryptocarya bourdillonii
- Cryptocarya stocksii
- Cynometra beddomei
- Cynometra bourdillonii
- Cynometra travancorica
- Dialium travancoricum
- Dimorphocalyx beddomei
- Dimorphocalyx lawianus
- Diospyros angustifolia
- Diospyros assimilis
- Diospyros atrata
- Diospyros barberi
- Diospyros bourdillonii
- Diospyros bourdillonii.
- Diospyros candolleana
- Diospyros foliolosa
- Diospyros ghatensis
- Diospyros nilagirica
- Diospyros paniculata
- Diospyros pruriens
- Diospyros saldanhae
- Diospyros sulcata
- Dipterocarpus bourdilloni
- Dipterocarpus indicus
- Drypetes confertiflorus
- Drypetes elata
- Drypetes malabarica
- Drypetes oblongifolia
- Drypetes porteri
- Drypetes travancorica
- Drypetes venusta
- Drypetes wightii
- Dysoxylum beddomei
- Dysoxylum ficiforme
- Dysoxylum malabaricum
- Elaeocarpus blascoi
- Elaeocarpus gaussenii
- Elaeocarpus munronii
- Elaeocarpus recurvatus
- Elaeocarpus venustus
- Eugenia argentea
- Eugenia calcadensis
- Eugenia cotonifolia
- Eugenia discifera
- Eugenia floccosa
- Eugenia indica
- Eugenia macrosepala
- Eugenia rottleriana
- Eugenia singampattiana
- Euodia lunu-ankenda
- Euonymus angulatus
- Euonymus crenulatus
- Euonymus dichotomus
- Euonymus indicus
- Euonymus paniculatus
- Euonymus serratifolius
- Ficus beddomei
- Flacourtia montana
- Garcinia gummi-gutta
- Garcinia imbertii
- Garcinia indica
- Garcinia rubro-echinata
- Garcinia talbotii
- Garcinia travancorica
- Garcinia wightii
- Glochidion bourdillonii
- Glochidion ellipticum
- Glochidion johnstonei
- Glochidion malabaricum
- Glochidion neilgherrense
- Glochidion pauciflorum
- Glochidion sisparense
- Glochidion tomentosum
- Gluta travancorica
- Glycosmis macrocarpa
- Glyptopetalum lawsonii
- Goniothalamus cardiopetalus
- Goniothalamus rhynchantherus
- Goniothalamus wightii
- Goniothalamus wynaadensis
- Gordonia obtusa
- Gymnacranthera canarica
- Heritiera papilio
- Holigarna arnottiana



Mapping Endemism

Two million acres of Conservation Reserve land has been taken out of the bank to grow more crops since October.

New York Times
April, 2008

Conserving Plant Biodiversity in the Greenhouse

A Campus Devoted to Sustainability

- Swarthmore College has a great opportunity for leadership as our nation and the world embrace sustainability.
- The elements of the Sustainability Action Plan of 2007 should continue to receive careful attention.
- Academic instruction in the principles of sustainability should be broadened.
- The appointment of a campus sustainability officer is recommended.
- Swarthmore College should be a model of sustainability for the surrounding communities and nationally.

RESPONSIBILITIES OF A UNIVERSITY TO ITS STUDENTS

Major changes that will impact the lives of those graduating now:

- **one third more people**
- **pollution**
- **massive loss of biodiversity**
- **global warming**
- **water shortages**
- **food shortages**

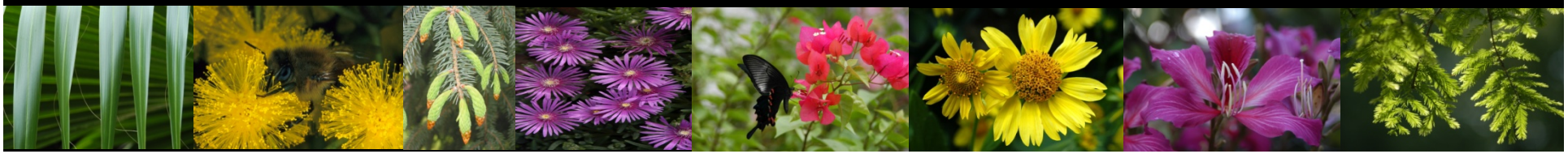
Can anyone *in any discipline* be considered properly educated who does not understand the basic principles of environmental science?

Will they be able to function intelligently as citizens or members of society or of their profession?

Or can we safely just leave environmental education to the media and chance accumulation of information?

A College Education in Sustainability – Looking to the World of the Future

- All graduates should be familiar with the principles of sustainability at environmental, biological, political, economic, and other levels.
- By understanding these principles they will be able to make necessary decisions well for the rest of their lives.
- Swarthmore could enhance its leadership and fulfill the expectations of its students by handling this area in an exemplary fashion.



The Bigger Picture

- Limit, then reverse, global warming
- Alternative energy sources
- Social justice
- Empower people everywhere
- Population stability
- New technologies

Some actions for individuals:

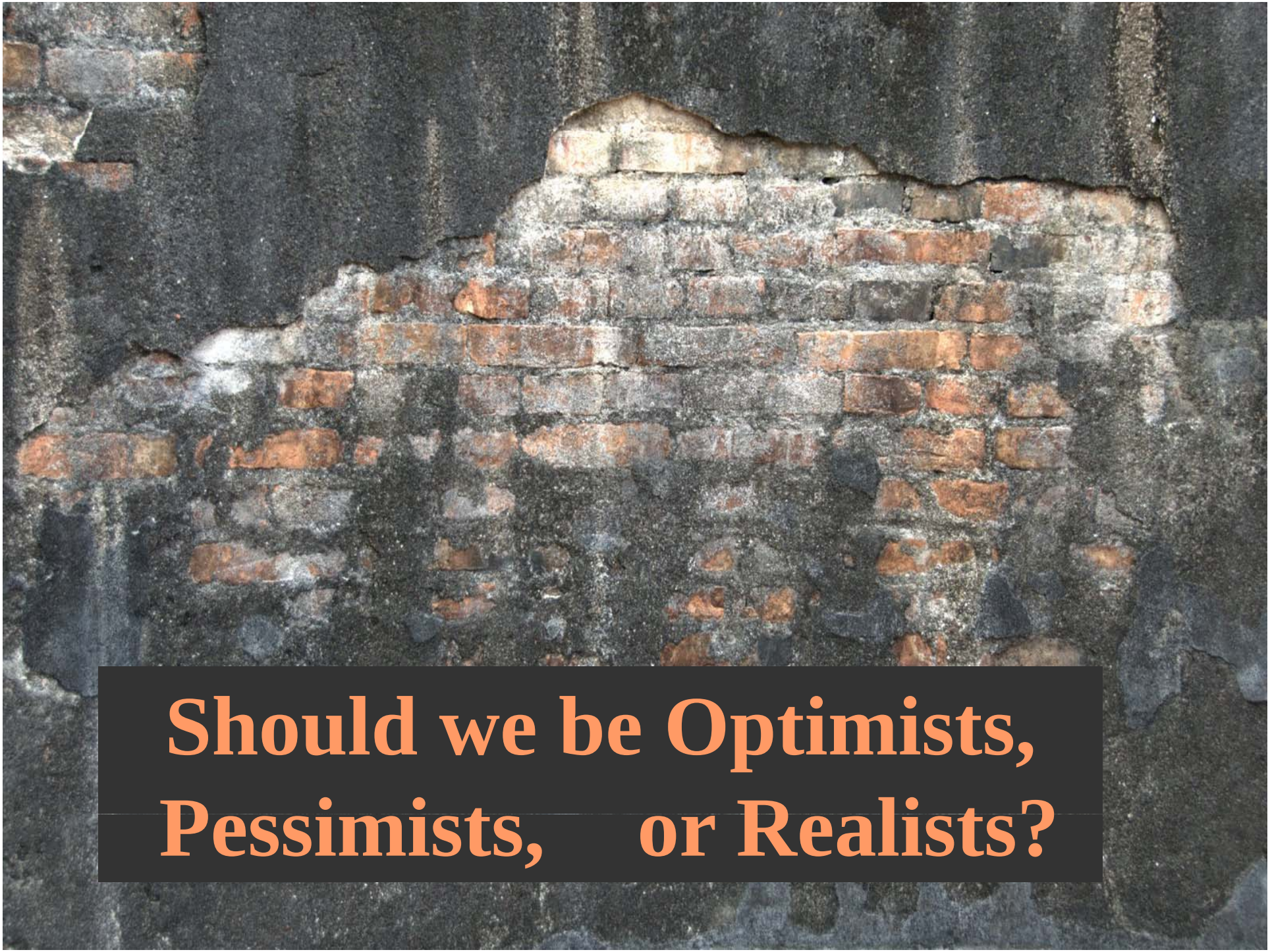
- Promote international understanding
- Learn
- Act
- Vote

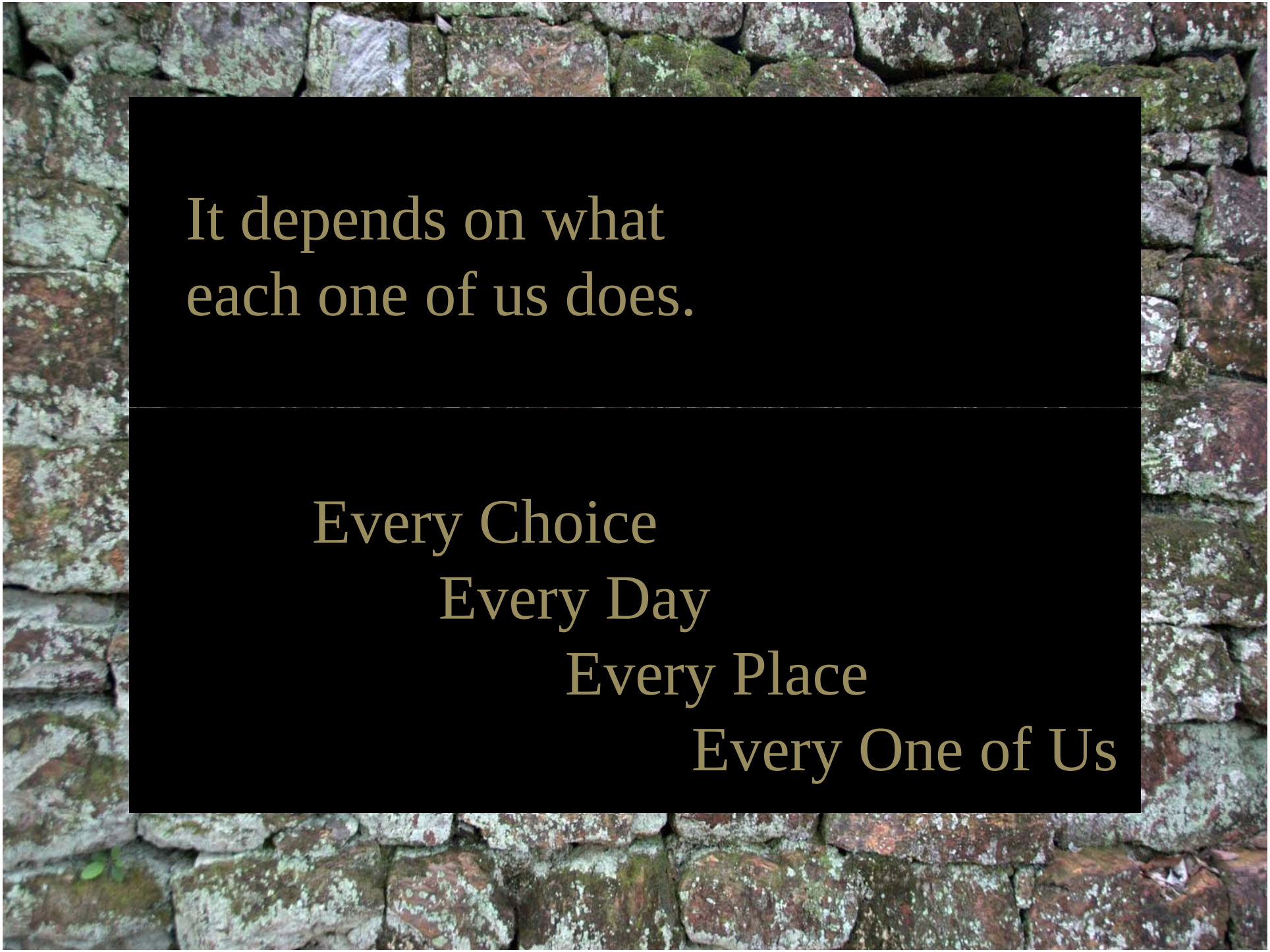




How Many Plant Species Will There Be in 2100?

- Perhaps 300,000 species are known now, of which more than 100,000 are in cultivation in botanical gardens.
- Many of these are not represented by genetically adequate samples.
- The total may approach 400,000 species, and most of those still to be discovered will be rare and in danger of extinction.
- The answer depends on us.


Should we be Optimists,
Pessimists, or Realists?


It depends on what
each one of us does.
Every Choice
Every Day
Every Place
Every One of Us

In the words of Gandhi:

"The world provides enough to satisfy every man's need, but not every man's greed."

Missouri Botanical Garden

Green for 150 Years