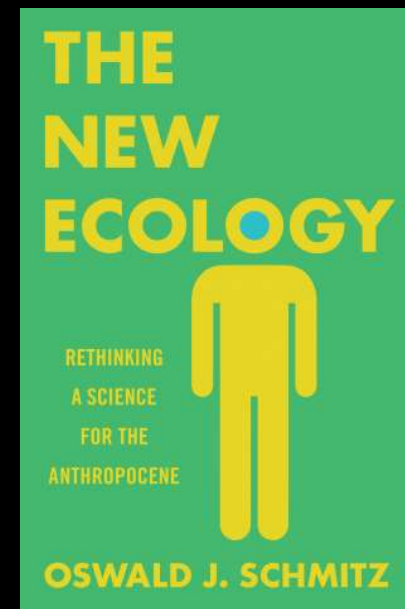
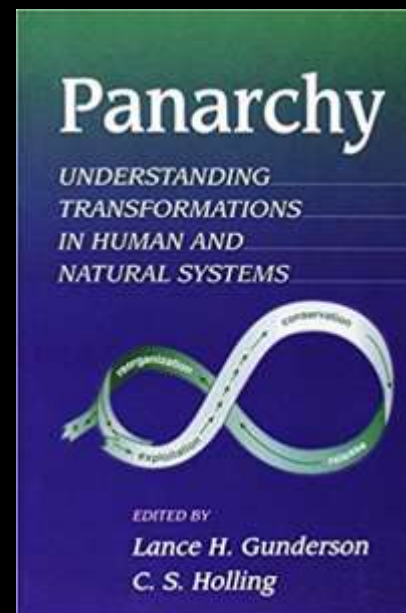
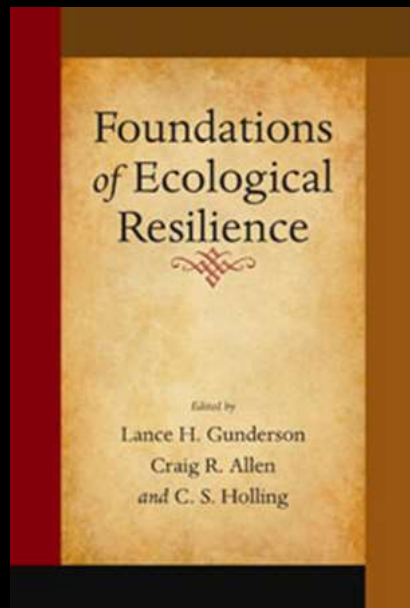
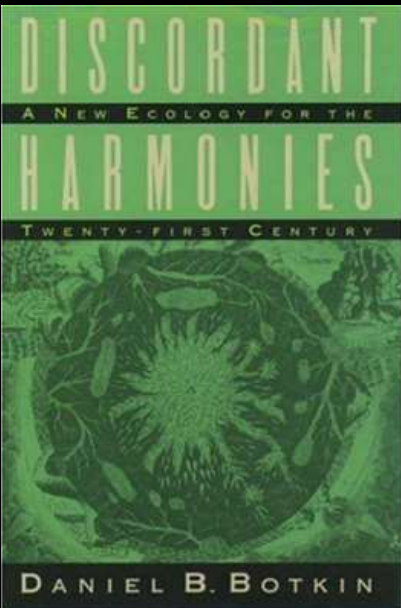




# Resilient Nature: Discordant Harmony and New Ecology

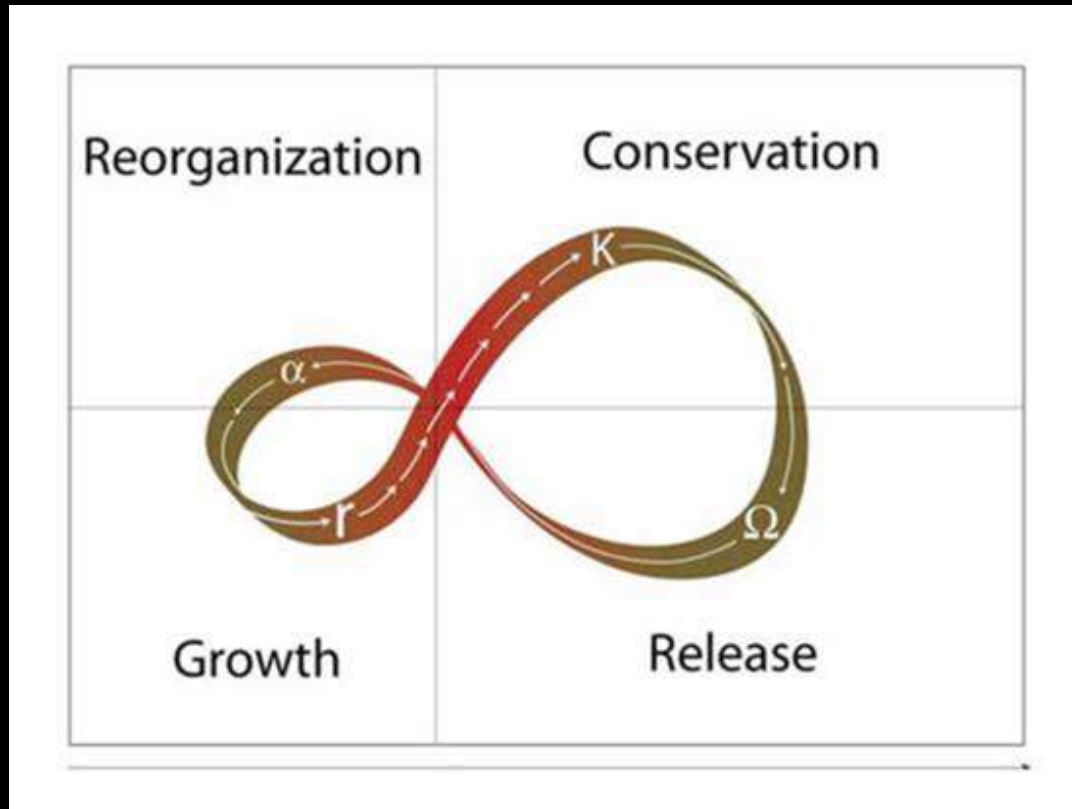
Kevin M. Anderson, Ph.D.  
Austin Water – Center for Environmental Research

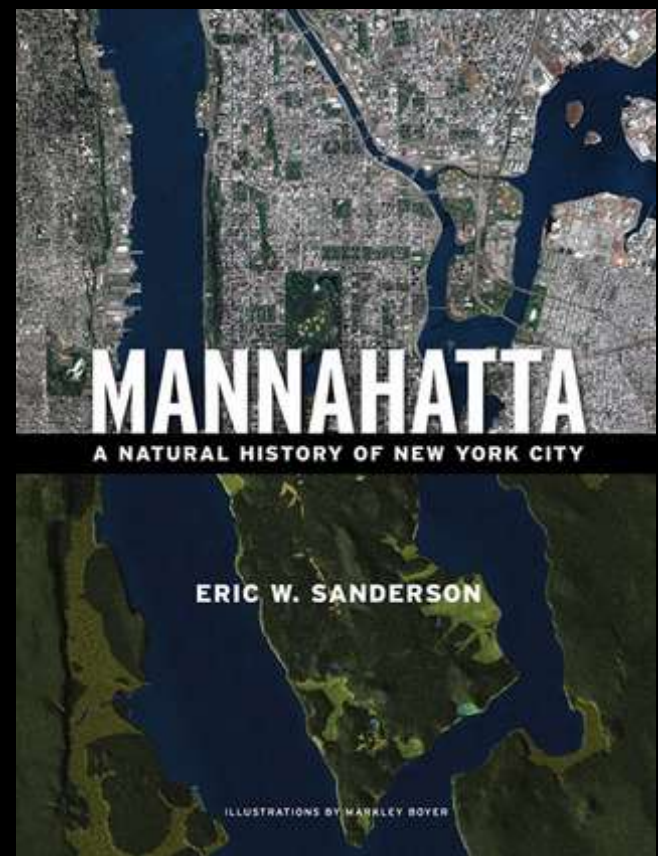


# Permanence and Change

Nothing Endures But Change

Heraclitus 540-480BC





## Retrospective Ecology, Historical Naturalness, and Change

“The Mannahatta Project began in 1999, when landscape ecologist Dr. Eric Sanderson moved to New York City to work for the Wildlife Conservation Society. Dr. Sanderson realized that, to fully appreciate the concrete landscape of streets and buildings that was his new home, he would have to “go back in time” to recreate the its ecology from the “ground up.””

Going back to 1609 allows us to see what New York City was before it was a city and to reimagine the city’s development in a way that would incorporate more of the natural cycles and processes (such as the hydrological cycle) that made the island the ecological gem that it was.”

# Permanence and Change

## Historical Naturalness – A Lament for A Lost Natural World

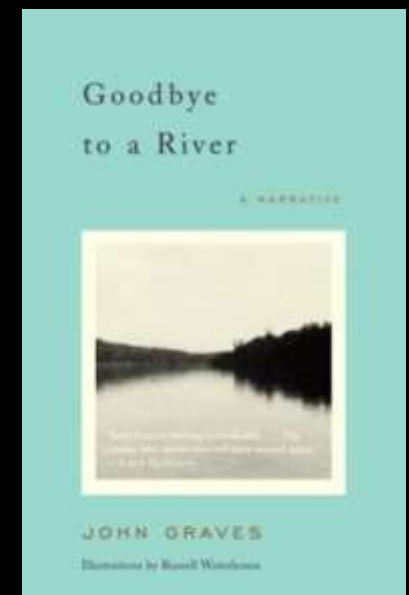
In recent decades it has become customary, and right I guess, and easy enough with hindsight, to damn the ancestral frame of mind that ravaged the world so fully and so soon.

What I myself seem to damn mainly though, is just not having seen it.

Without any virtuous hindsight I would likely have helped in the ravaging as did even most of those who loved it best.

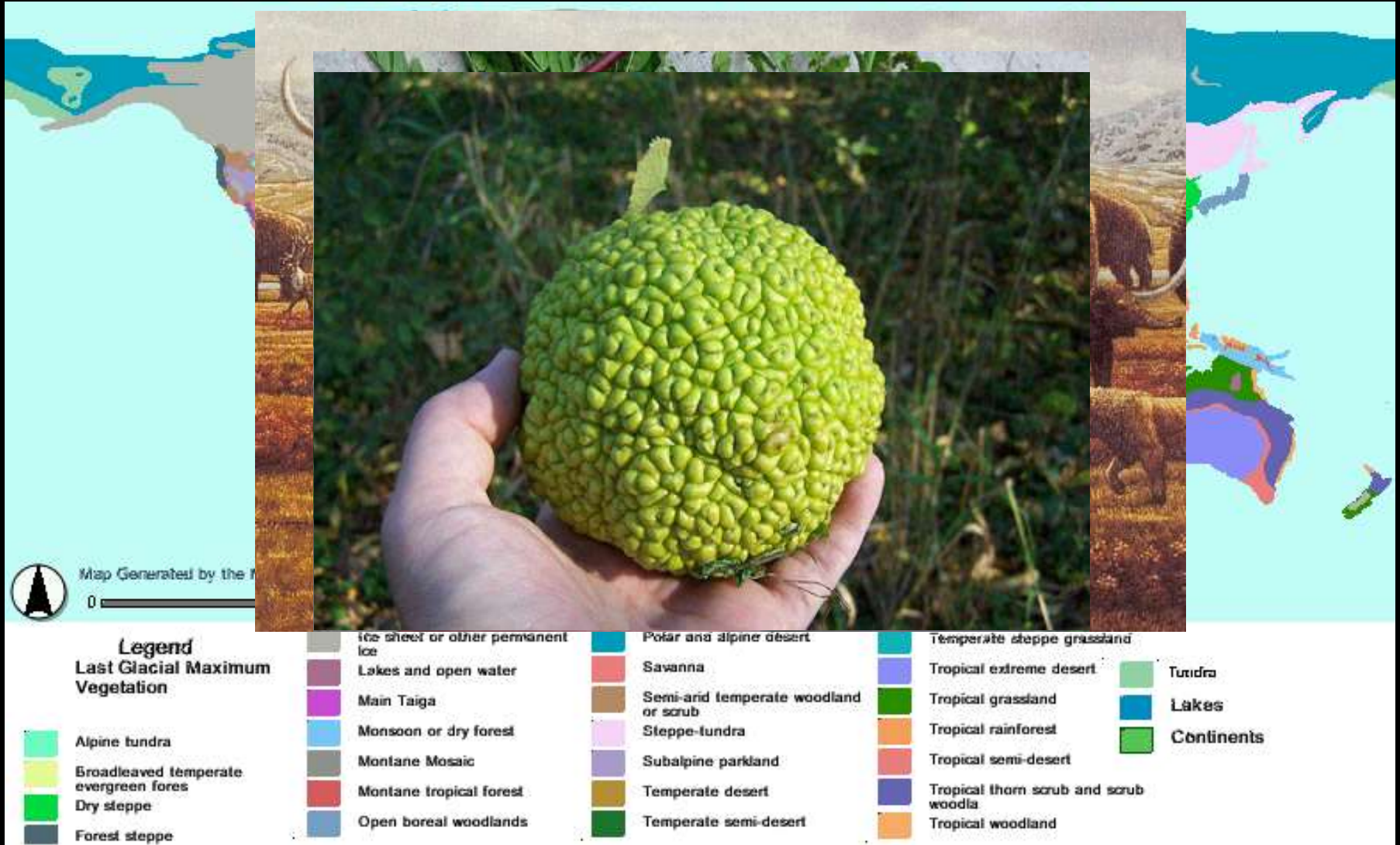
But God! To have viewed it entire, the soul and guts of what we had and gone forever now, except in books and such poignant remnants as small swift birds that journey to and from the distant Argentine, and call at night in the sky.

From *Self Portrait, with Birds: Some Semi-Ornithological Recollections* (1991)



# Which Historical Naturalness? Which “Entire”?

The Last Glacial Maximum (LGM) refers to a period in the Earth's climate history when ice sheets were at their maximum extension, between 26,500 and 19,000–20,000 years ago

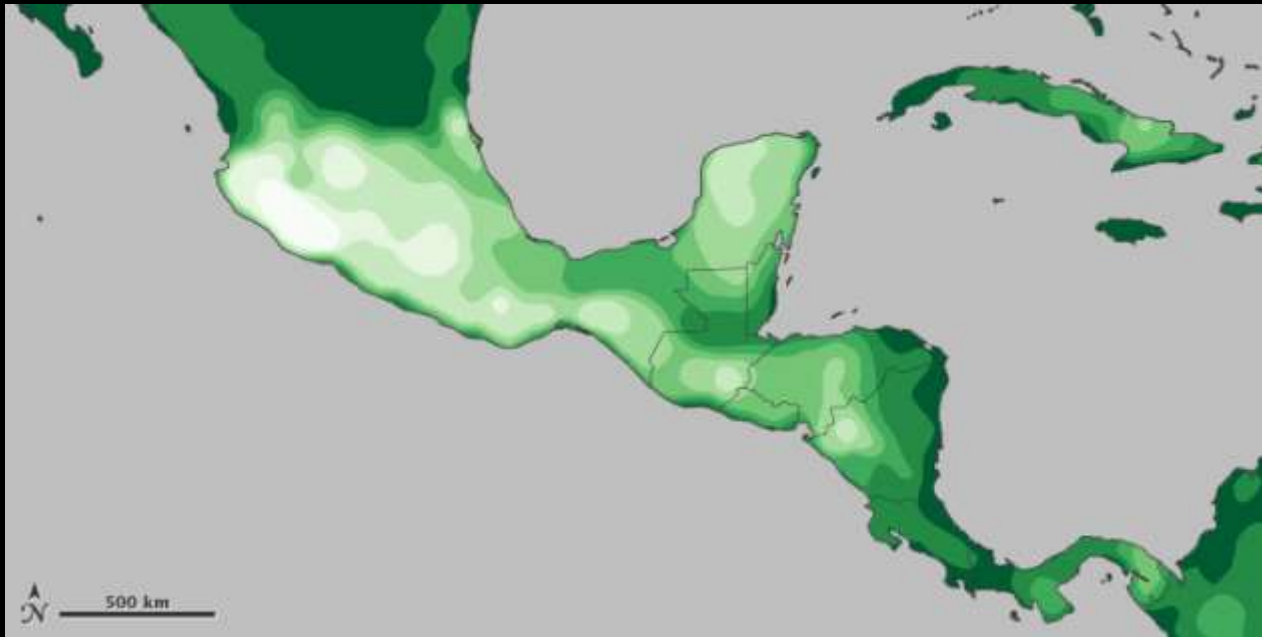


Anthropogenic  
Change

Central America  
950 A.D.



How little native forest (dark green) remained at the end of the Mayan period around 950 AD.  
By cutting down the forest, the Mayans changed their local climate.



## North America - Cahokia 1100 A.D.

“Anyone who traveled up the Mississippi in 1100 A.D. would have seen it looming in the distance: a four-level earthen mound bigger than the Great Pyramid of Giza...Cahokia was a busy port...Covering five square miles and housing at least fifteen thousand people. Cahokia was the biggest concentration of people north of the Rio Grande until the 18<sup>th</sup> Century.” *Mann, 1491*

When Monks Mound was being built, Cahokia was roughly the same size as London.

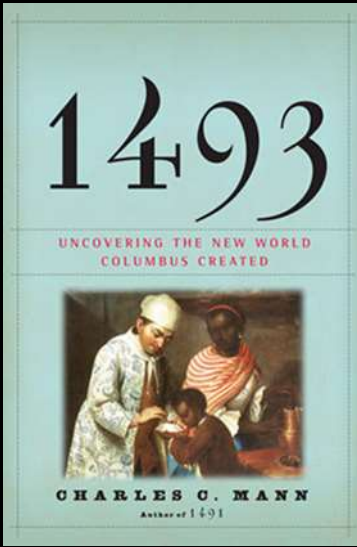
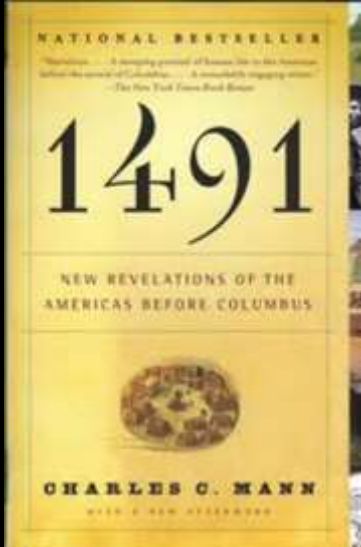




Cahokia mysteriously declined rapidly around 1300 A.D.

“To obtain fuel and construction material and to grow food, they cleared trees and vegetation from the bluffs to the east and planted every inch of arable land. Because the city’s numbers kept increasing, the forest could not return. Instead people kept moving further out to get timber, which then had to be carried considerable distances...Meanwhile...the city began to outstrip its water supply...”

Mann, 1491





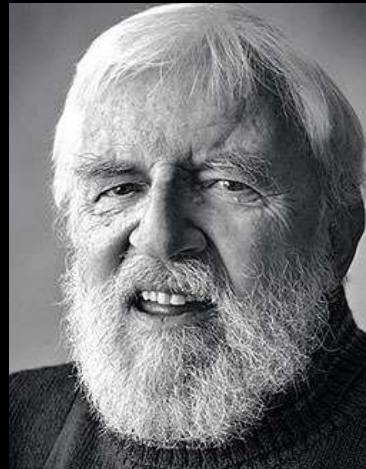
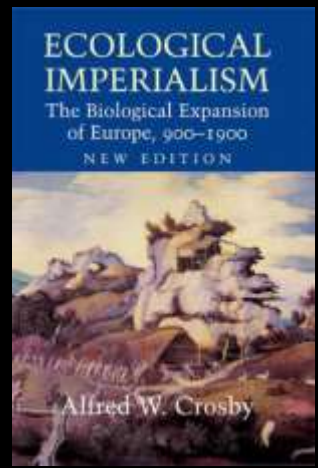
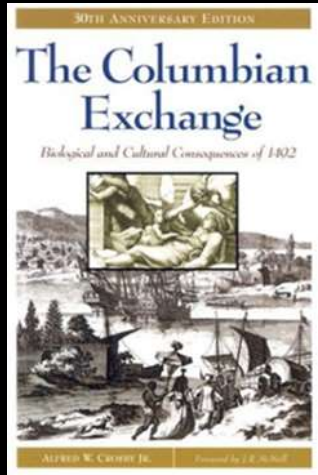
# European Arrival The Columbian Exchange

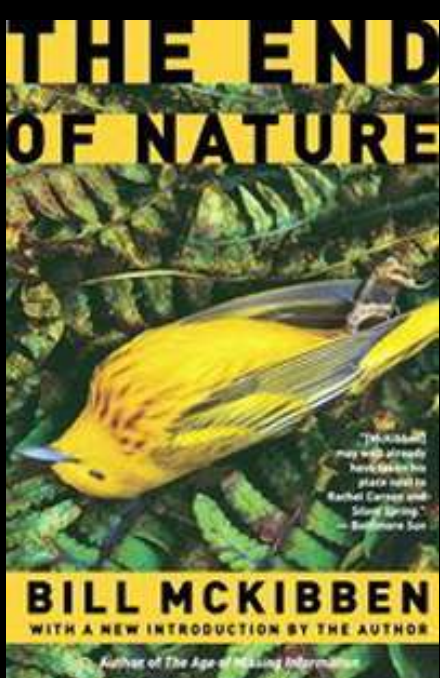
Hispaniola  
1492



# The Columbian Exchange

- Jamestown – rats, clover, bluegrass
- Endive and spinach escaped from colonial gardens and grew into impassable six foot thickets on the Peruvian coast
- Mint overwhelmed Andean valleys
- In the Pampas of Argentina Charles Darwin found hundreds of square miles strangled by feral artichoke in the 1830s.
- Darwin found that peach wood from invasive peach trees was the main supply of firewood for Buenos Aires.
- Peaches invade the Southeast – 1700s farmers worried that the Carolinas and Georgia would be a “wilderness of peach trees”





# Retrospective Ecology and Environmentalism

## The Lament - *The End of Nature* (1989)

"The idea of nature will not survive the new global pollution –

We have changed the atmosphere, and thus we are changing the weather, we make every spot on earth man-made and artificial.

We have deprived nature of its independence, and that is fatal to its meaning."

"There's no such thing as nature anymore—and there is nothing except us alone"

"Having lost its separateness, it loses its special power. Instead of being a category like God – something beyond our control – it is now a category like the defense budget or the minimum wage, a problem we must work out...one of the possible meanings of the end of nature is that God is dead."

Nature – Human Dualism

We are not part of nature.



# Permanence and Change

## Learning *to* Die *in the* Anthropocene

REFLECTIONS ON THE  
**END OF A CIVILIZATION**

Roy Scranton

"Scranton draws on his experiences in Iraq to confront the grim realities of climate change. The result is a fierce and provocative book."

—Elizabeth Kolbert, author  
of *The Sixth Extinction*

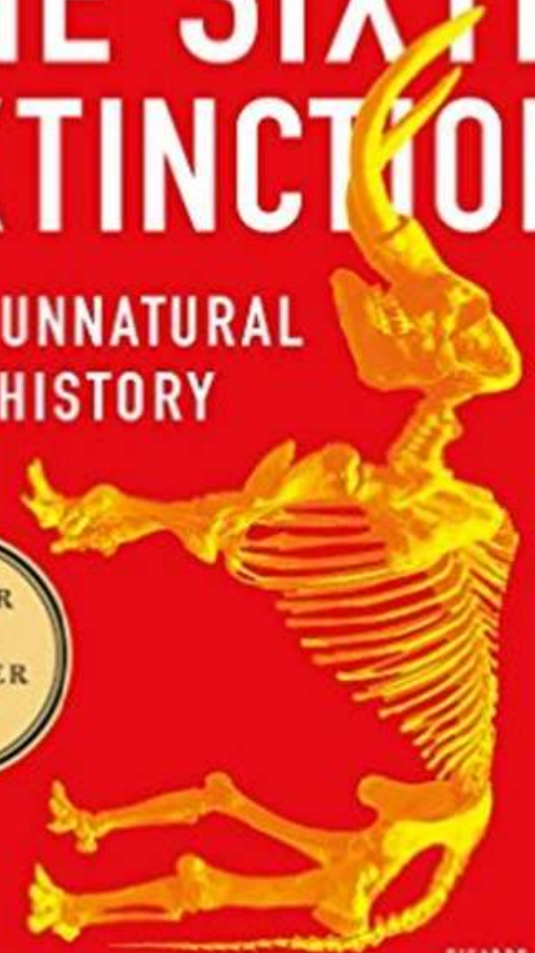


NEW YORK TIMES BESTSELLER

# THE SIXTH EXTINCTION

AN UNNATURAL  
HISTORY

WINNER  
of the  
PULITZER  
PRIZE



PICADOR

ELIZABETH KOLBERT

Author of *FIELD NOTES  
FROM A CATASTROPHE*

# Permanence and Change - The Concepts of Nature

- Apply to Parts of Whole, but Not the Whole
- True but Incomplete
- Retrospective, Historical Naturalness
- Prospective? Future? Change?

Wilderness

Pastoral

Urban Nature



# The Whole Ecology and Urban Nature

## Other Kinds of Nature - Improper Urban Nature

Nature flourishes through its own agency in neglected urban spaces and margins like vacant lots, garbage dumps, sewage ponds, unmaintained roadway and railway verges, derelict industrial tracts, abandoned buildings, overgrown urban creeks, crumbling walls, and other urban waste spaces.



# Types of Neglected Urban Spaces

## Wastelands - whole patches

- Vacant lots
- Dumpsites
- Industrial Wasteland
  - Brownfields
  - Greenfields
  - Quarries and Gravel Pits
- Urban Infrastructure Land
  - Power plants
  - Water treatment plants
  - Reservoirs
  - Wastewater treatment plants
  - Sewage ponds
  - Constructed wetlands
  - Stormwater retention structures
- Unusable Land - bits and pieces
  - Slopes, gullies, corners, fragments

## Margins – edges and ledges

- Urban waterways
- Canals, drainage channels
- Utility corridors
- Waysides
  - road waysides
  - railway verges
- Alleys – paved, unpaved, grass
- Walkways and pathways
- Fencelines
- Walls and ledges
- Pillars and bridge abutments



# The Problem of Urban Nature for Americans

## What it is and What it means

*The Cincinnati Arch: Learning from Nature in the City* (2004)

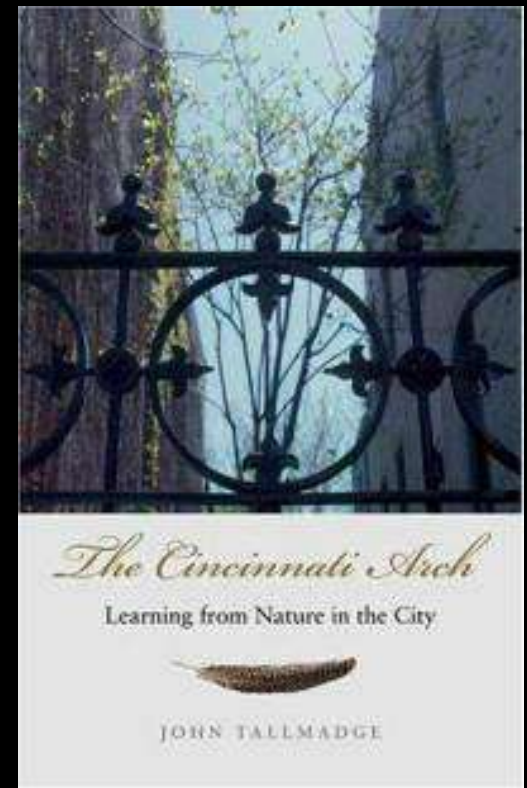
John Tallmadge

Urban nature is not sublime...There's too much sterility in the form of roofs and pavement, and, oddly enough, there's also too much wildness, too many weeds and wooded borders and tangled banks, not to mention vacant lots going to brush.

Of course, "wilderness" won't do to describe such landscapes either. Despite the degree of wildness, there's too much human impact, too many alien species, too few large animals to meet the legal and cultural criteria.

The fact is that urban landscapes are just too mixed up, chaotic, and confused to fit our established notions of beauty and value in nature.

Maybe it's not really nature at all, not a real ecosystem, just a bunch of weeds and exotics mixed up with human junk.





## What Kind of Nature?

“Maybe it’s not really nature at all, not a real ecosystem, just a bunch of weeds and exotics mixed up with human junk.” John Tallmadge, *The Cincinnati Arch*

What emerges in these urban wastelands is a hybrid type of nature both weedy and wild - the unintended product of human activity and Nature's unflagging opportunism, which I call

### Marginal Nature.



Marginal nature is neither pristine nor pastoral, but rather it is a new kind of nature whose ecological and cultural meaning is an open question.

# Marginal Nature

## The Wild Urban Woodlands of Waller Creek

Dynamic  
Self Organizing  
Tolerant of Disturbance  
New Combination of Species

But does not fit into traditional kinds of Nature...except as a problem to be remedied.



2005



2007



2009



2012

2017

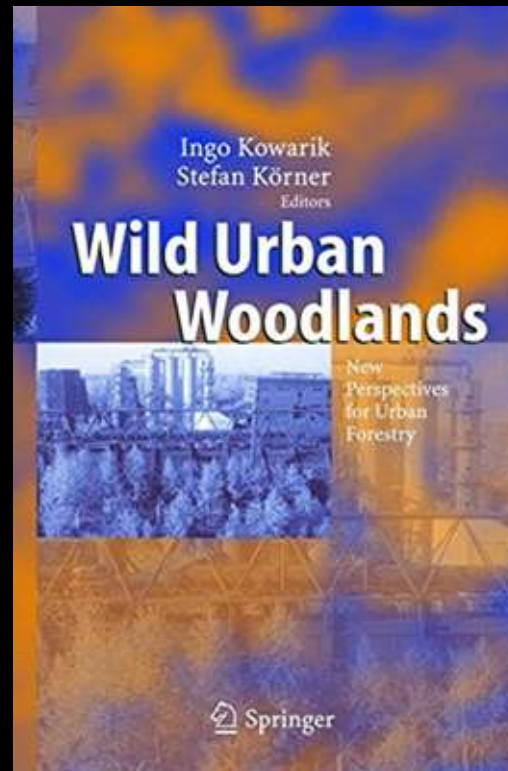
# Prospective Naturalness and Prospective Ecology The Wild Urban Woodlands of Waller Creek

## Prospective naturalness...

“the reference point is not an original condition of a natural landscape, but rather a condition defined based on the current site potential and the greatest possible degree of self-regulation.

From this perspective, therefore, the natural capacity for *process* is the central point, not a particular, retrospectively determined and often idealized, *picture* of nature.”

2005



2017



# Reassessing scientific approaches to naturalness

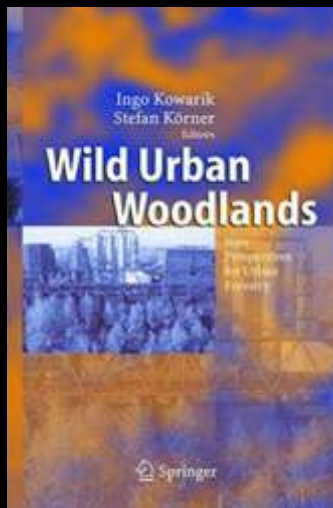
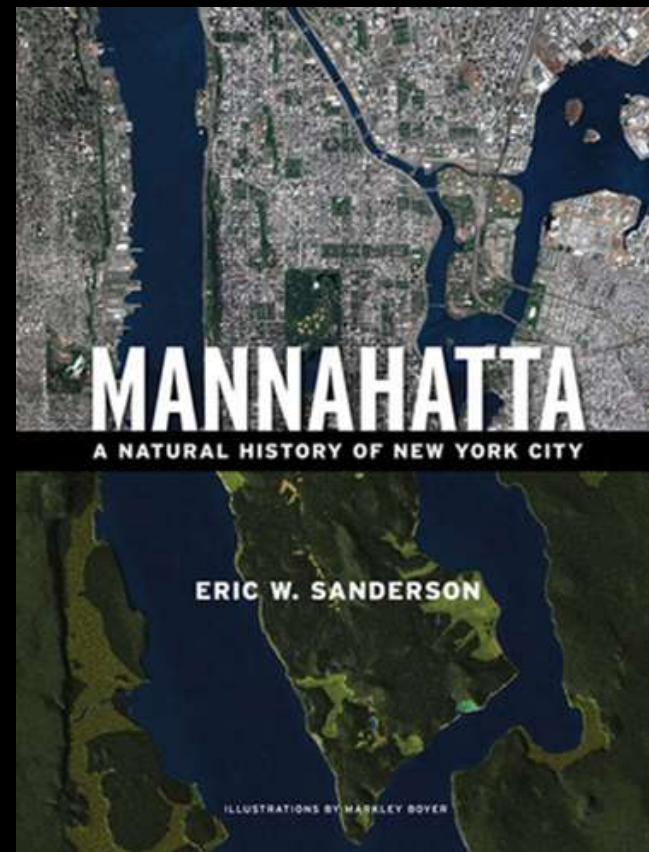
## Retrospective naturalness vs. Prospective naturalness

*Wild Urban Woodlands* Ingo Kowarik 2005

### Retrospective naturalness

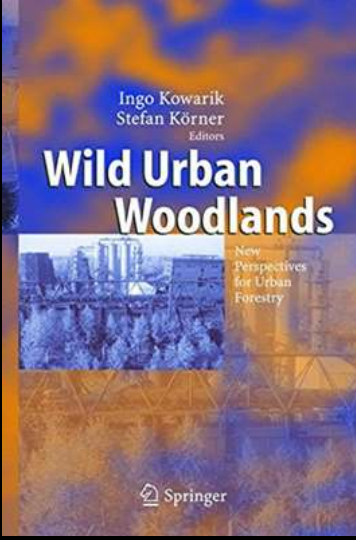
- The point of reference is pristine vegetation uninfluenced by humans. Based on the cultural history of the relevant area, the reference period may lie decades or a few millennia in the past.
- In the retrospective perspective of naturalness, remnants of pristine woodlands are most natural and woodlands used for forestry are at least semi-natural.
- This means that from the retrospective perspective the development back to nearly natural or natural woodlands can be analyzed well.

With the evaluation of new development of “wild” urban woodlands, however, the traditional concept of naturalness oriented toward historical comparisons runs aground.



# Prospective naturalness - Four Kinds of Nature

- 1. First Nature is the “original” nature (wilderness) - Natural Agency
- 2. Second Nature (pastoral) traditional or modern agriculture and forestry practices - meadows and pastures, crop fields, intensively managed forests, etc. – Cultural Agency
- 3. Third Nature - horticultural plantings, gardens, parks, street trees – Cultural Agency
- 4. Fourth Nature “New Wilderness” encompasses the natural development that occurs independently on neglected urban sites, without horticultural planning or design. This starts with cracks in sidewalks or in colonization of walls and buildings as “artificial cliffs” and leads to growth in abandoned areas and to impressive wild urban woodlands. - Natural and Cultural Agency



First

Second

Third



# The Concepts of Nature

- Apply to Parts of Whole, but Not the Whole
- True but Incomplete
- Retrospective, Historical Naturalness
- Prospective? Future? Change?
- “Maybe it’s not really nature at all, not a real ecosystem, just a bunch of weeds and exotics mixed up with human junk.”



Wilderness



Pastoral

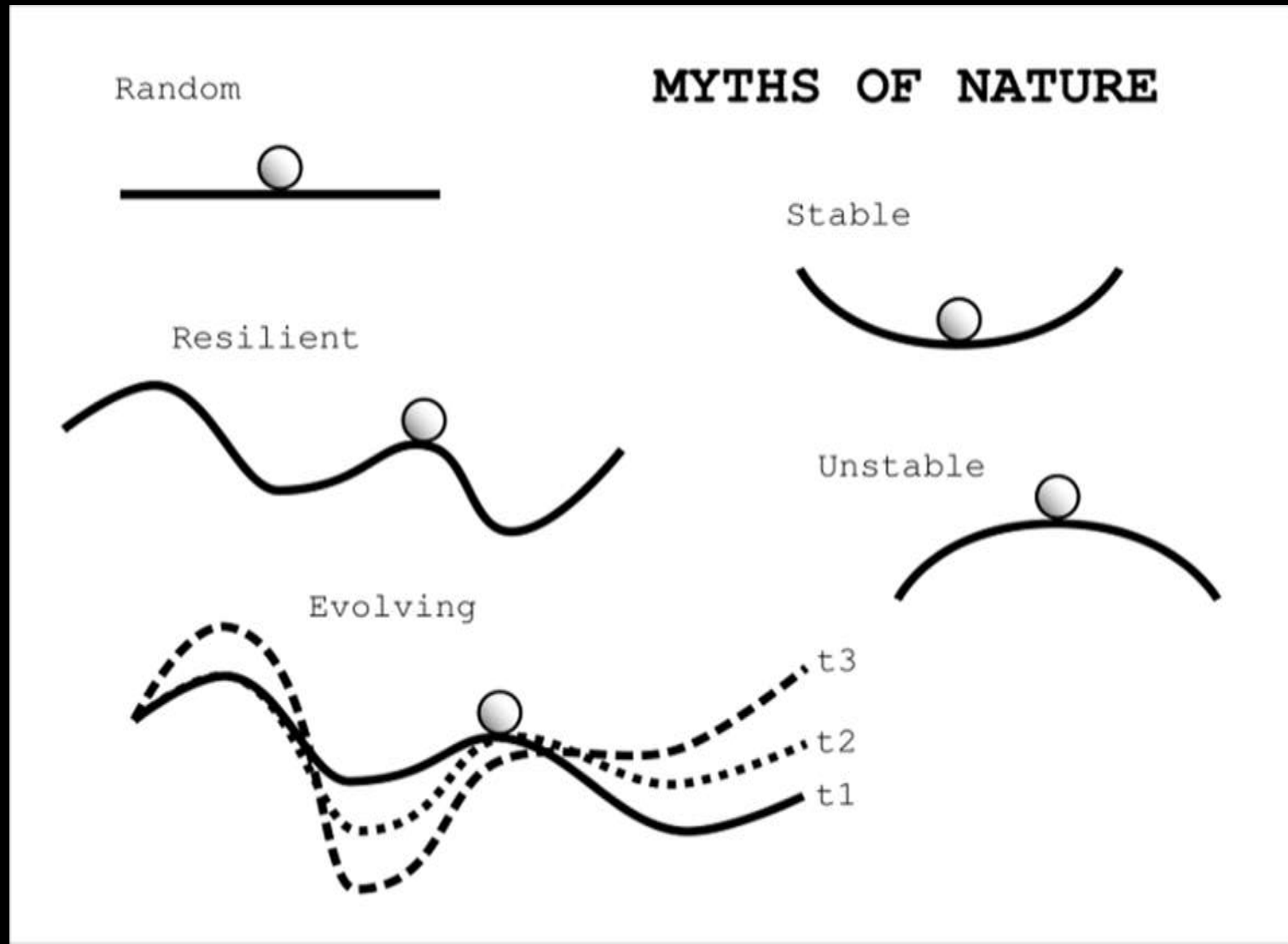


Urban Nature



# “Real Ecosystems” How does Nature work?

## A Brief History of the Science of Ecology

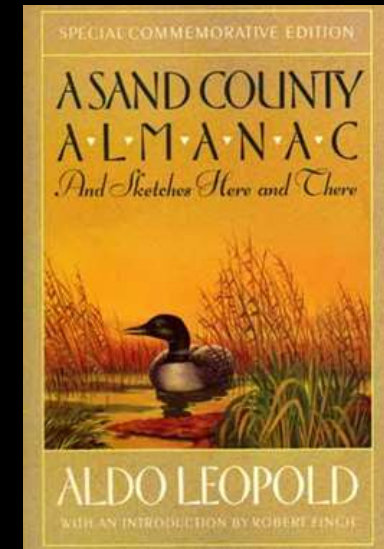
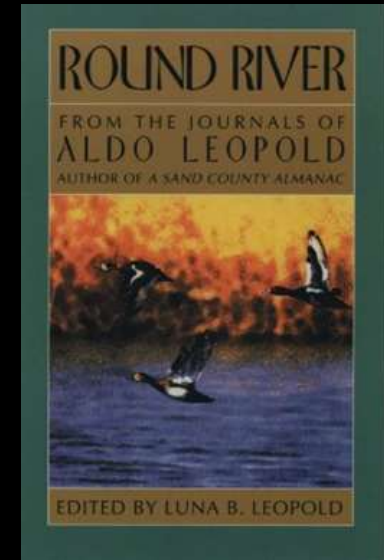


## Permanence and Change

Ecology is an infant just learning to talk, and, like other infants, is engrossed with its own coinage of big words.

Its working days lie in the future.

Aldo Leopold, *Round River* 1941





# Foundational Ideas of Ecology

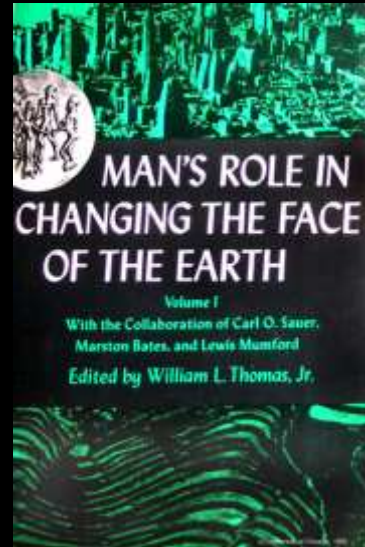
*Man and Nature, or, Physical Geography as Modified by Human Action* 1864  
George Perkins Marsh

"Man is everywhere a disturbing agent. Wherever he plants his foot, the harmonies of nature are turned to discord"

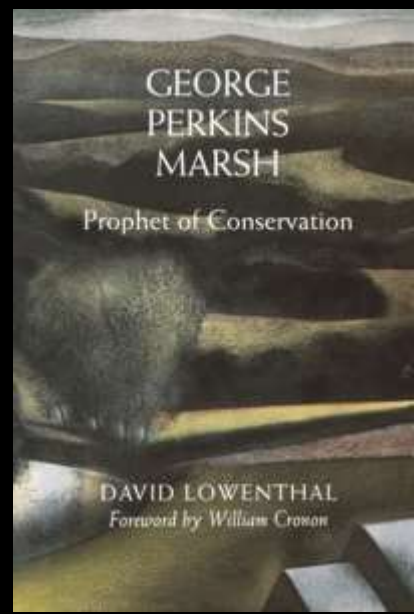
- Engendered worldwide awareness of the ill-effects of human agency, along with efforts to repair the damage and conserve the fabric of nature.
- Most noteworthy was Marsh's stress on the unforeseen and unintended consequences, as well as the heedless greed of technological enterprise.
- Wallace Stegner "the rudest kick in the face that American initiative, optimism and carelessness had yet received."



1801-1882



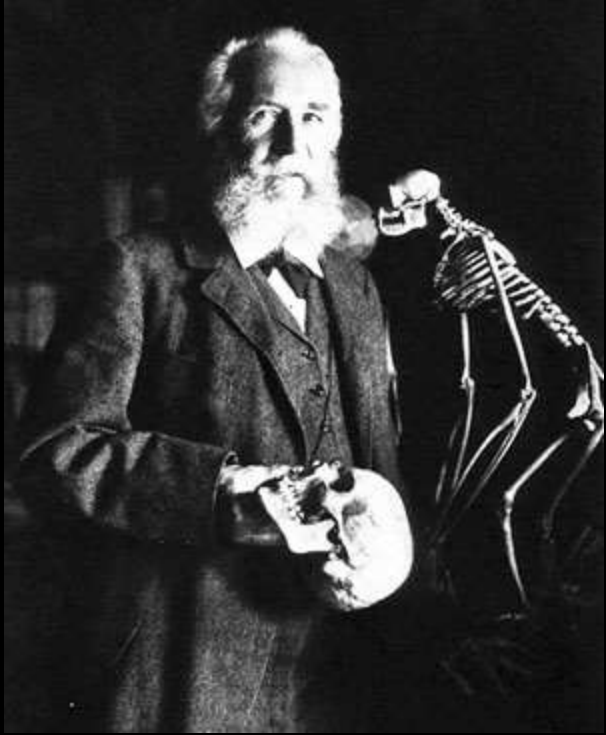
1956



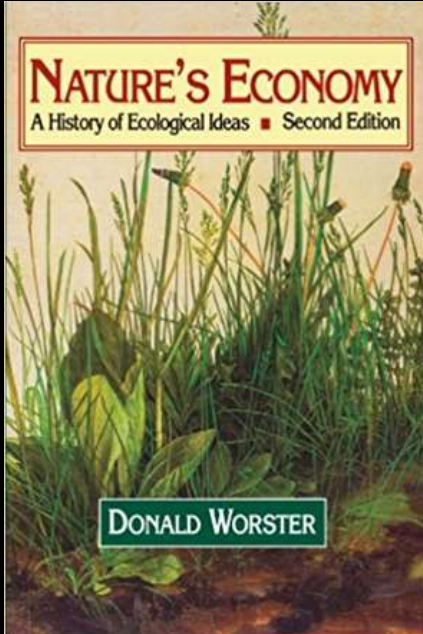
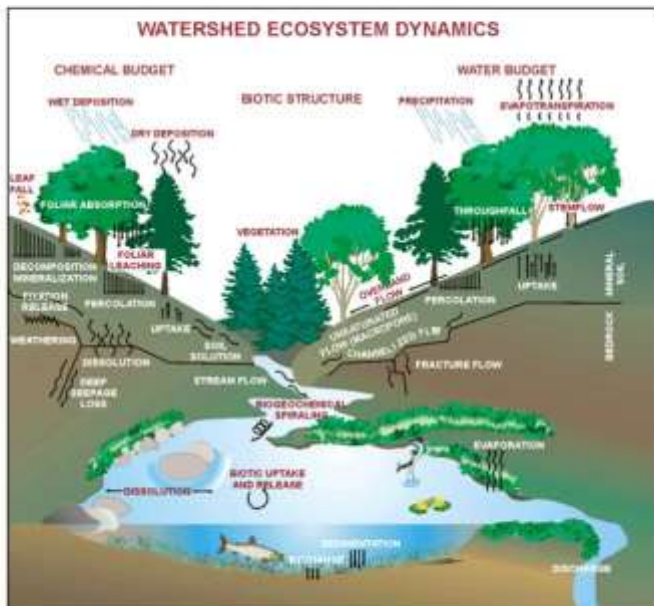
Naming a new Science – Ecology - 1866  
Organisms and their Environment  
Ernst Haeckel (1834–1919)

“By ecology we mean the body of knowledge concerning the economy of nature —the investigation of the total relations of the animal both to the inorganic and to its organic environment”

The word comes from the Greek oikos, meaning “household,” “home,” or “place to live.” Thus, ecology deals with the organism and its environment.



### Ecosystem – Biotic and Abiotic

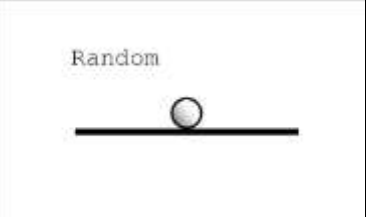
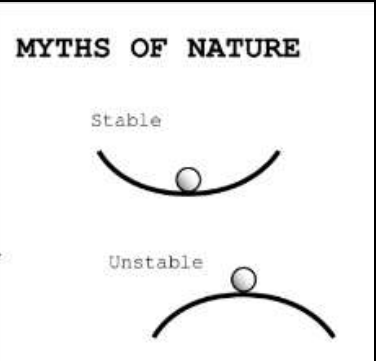


# How Does Nature Work? – Equilibrium and Succession

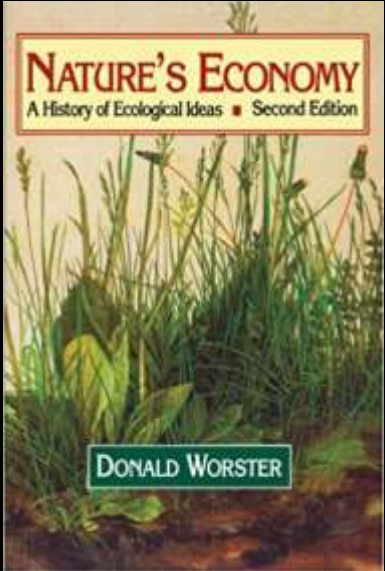
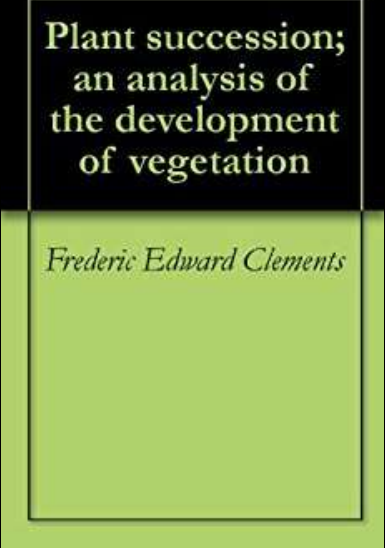
Frederic Clements 1874-1945

*The Development and Structure of Vegetation* (1904)

*Plant Succession* (1916)



- Vegetation is dynamic
- Succession and climax stage
- Monoclimax – any region of Earth can have only one mature stage based on climate
- Assumes a natural state with no human interference – natural equilibrium
- “Nature’s course, he contended, is not an aimless wandering to and fro but a steady flow toward stability that can be exactly plotted by the scientist.” Worster



# Food Web, Trophic Levels, Invasion Ecology

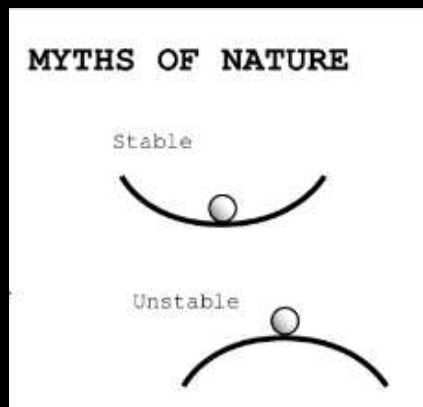
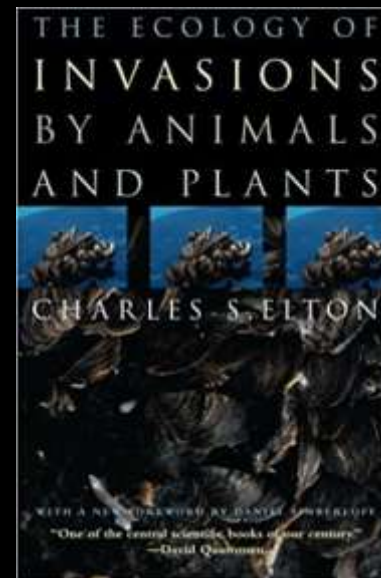
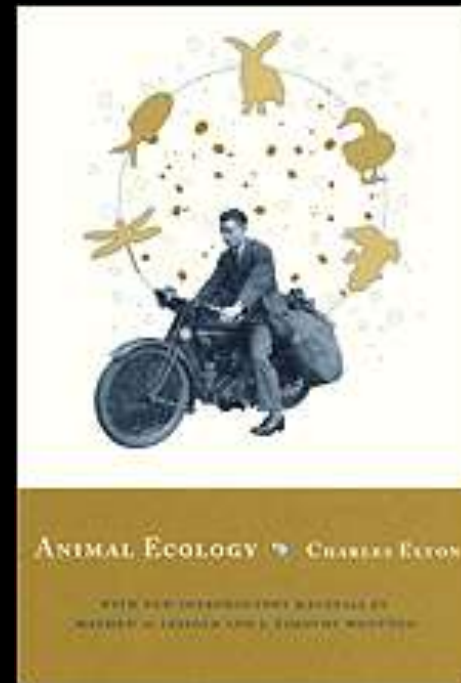
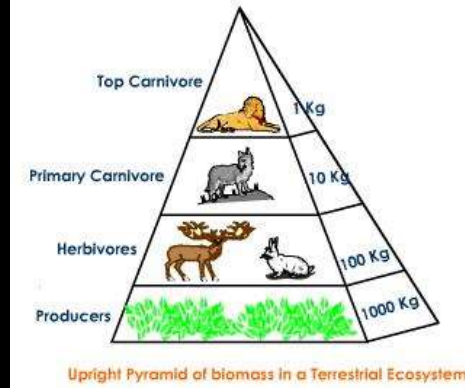
Charles Elton 1900-1991

## *Animal Ecology* (1927)

- Community Structure – an economy of nature
- Food chain, food web
- Plants = producers, Animals = consumers (reducers, decomposers)
- Niche – the status or occupation of an organism in a community
- One species to one niche (competition)

## *The Ecology of Invasions* (1958)

- Invasion Biology – Invasive Species
- DIH – the Diversity-Invasibility Hypothesis
- More Biodiversity Less Likely to be Invaded
- (all niches filled)
- Disturbance is the prerequisite for invasion



# Ecosystem, Stability, and the Equilibrium Paradigm

Eugene Odum

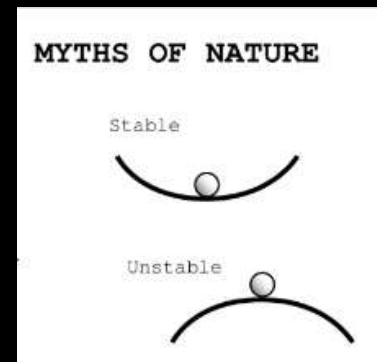
*Fundamentals of Ecology* (1953)

- The law of organic nature is to bring order and harmony out of chaotic materials of existence
- Nature is a series of balanced ecosystems – the basic functional unit of ecology, and so a need for a unified theory of the ecosystem [a pond, a watershed, a meadow]
- Rather than climax stage he used “mature ecosystem” – the ecosystem was often disturbed but fluctuated around a single homeostatic point = health = stability/equilibrium
- Humans the Great Disrupters



By the 1960s, these scientific beliefs are questioned...

1. But is an ecosystem a reality or an abstraction?
2. Are ecosystems inherently stable?
3. How does disruption fit in?
4. How do the great disrupters – Humans - fit in?



## Permanence and Change

*The Balance of Nature: Ecology's Enduring Myth* 2009

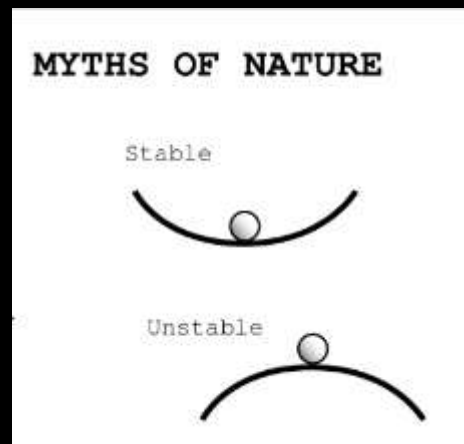
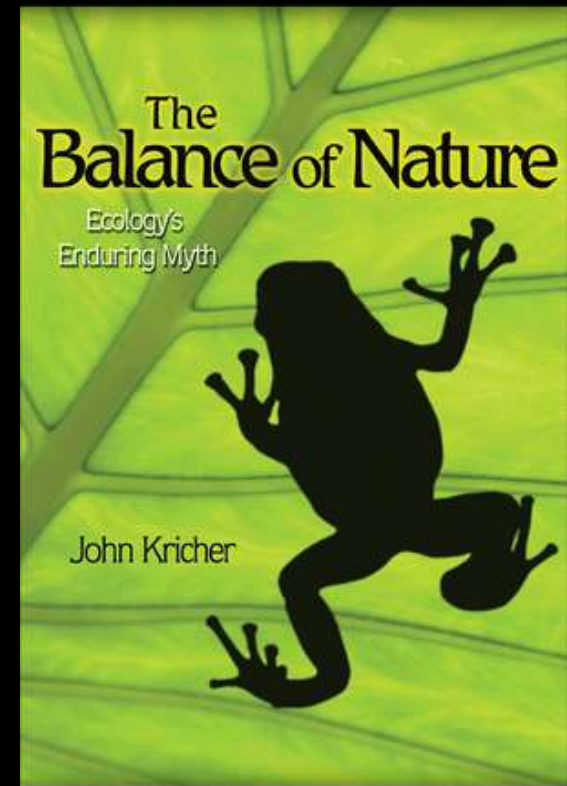
John Kricher

“The existence of a balance of nature has been a dominant part of Western philosophy since before Aristotle.

But the science of ecology and evolutionary biology together demonstrate that there is no balance of nature—not today and not at anytime in Earth's long history.

The paradigm is based on belief, not data; it has no scientific merit.

Nature is constantly in flux varying in scales of space and time, and most of that flux is due entirely to natural causes. At this time of extraordinary human influence on Earth's ecosystems and biota, I argue that it is essential for humanity to understand how evolution occurs and why ecology is far more dynamic than static.”



Nothing Endures But Change  
Heraclitus 540-480BC



# The “new ecology” post-Odum - No inherent stability

Robert May

*Stability and Complexity in Model Ecosystems* (1973)

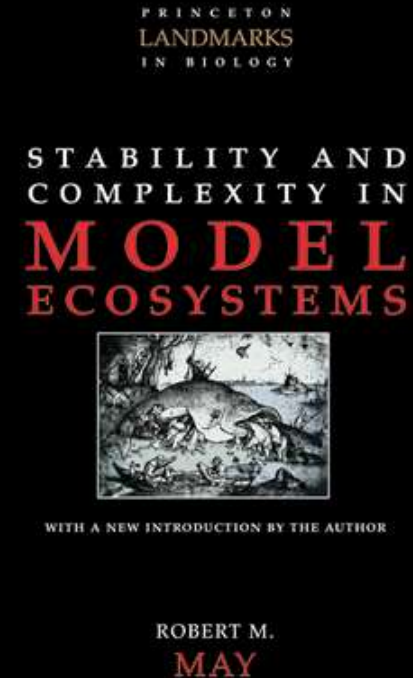
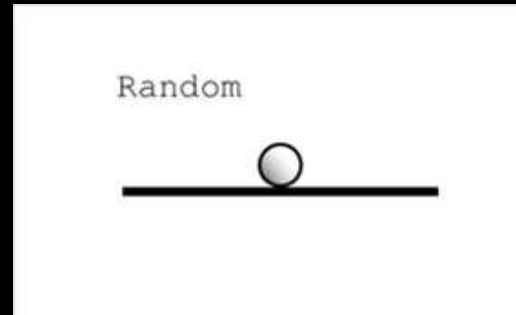
- Mathematical models demonstrate that the more species there were, the more fragile the ecosystem
- Chaos theory and complexity, “Confronted with disturbances beyond their normal experience” complex systems like rainforests tended to crumple.

The new ecology emphasizes

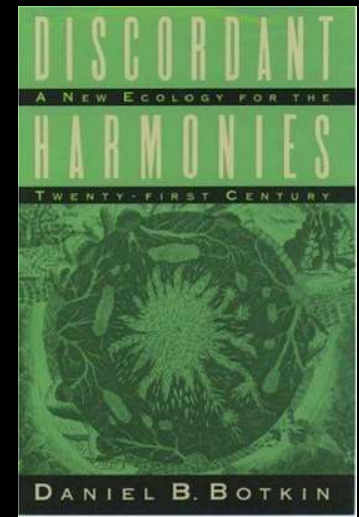
- Disequilibria
- Instability
- Chaotic fluctuations

in ecosystems both “natural” and human impacted

If 20th-century ecology was marked by an infatuation with balance, then our era is one of disturbance, disruption, non-equilibrium, chaos, and randomness. – Daniel Botkin



1990



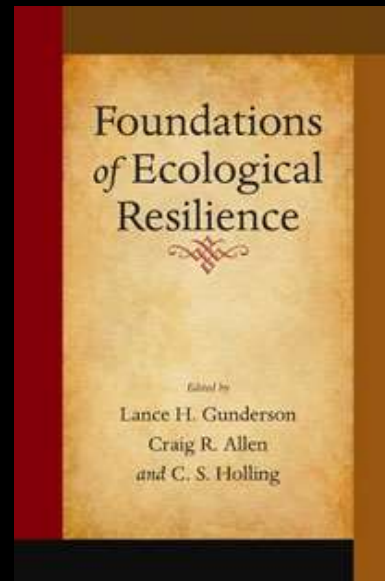
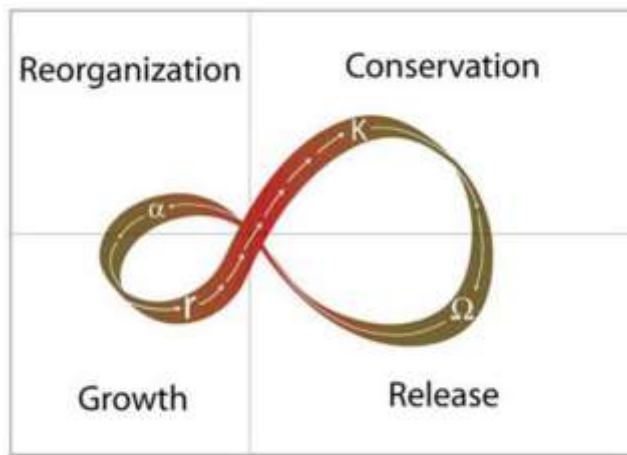
# The New Ecology of Change - Ecological Resilience

## How does Nature persist amidst change?



- The general meaning of resilience, derived from its Latin roots 'to jump or leap back', is the ability to recover from or adjust easily to misfortune or change.
- The concept of resilience in ecological systems was first introduced by the Canadian ecologist C.S. Holling in order to describe the persistence of natural systems in the face of changes in ecosystem variables due to natural or anthropogenic causes.

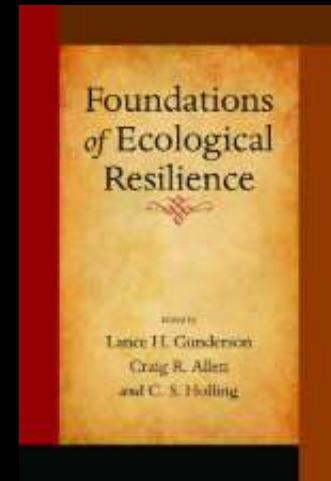
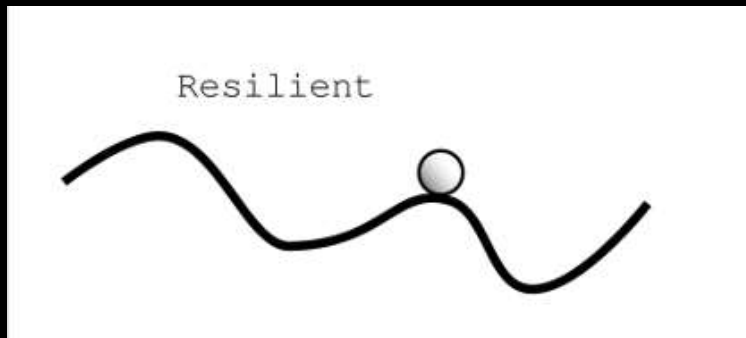
Holling, C.S. (1973). "Resilience and stability of ecological systems". Annual Review of Ecology and Systematics 4: 1–23.





## Resilience and Adaptive Management – Permanence and Change

- ...the ability to absorb disturbances, to be changed and then to reorganize and still have the same identity (retain the same basic structure and ways of functioning).
- As resilience declines the magnitude of a shock from which an ecosystem cannot recover gets smaller and smaller.
- Ecosystem resilience is the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes.
- A resilient ecosystem can withstand shocks and rebuild itself when necessary.



"Resilience" as applied to ecosystems has three defining characteristics:

- The amount of change the system can undergo and still retain the same controls on function and structure
- The degree to which the system is capable of self-organization
- The ability to build and increase the capacity for learning and adaptation = evolve

## Structured Change – The Adaptive Cycle

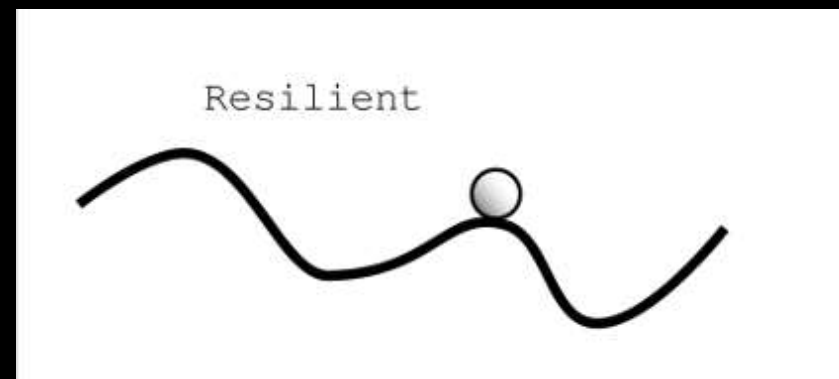
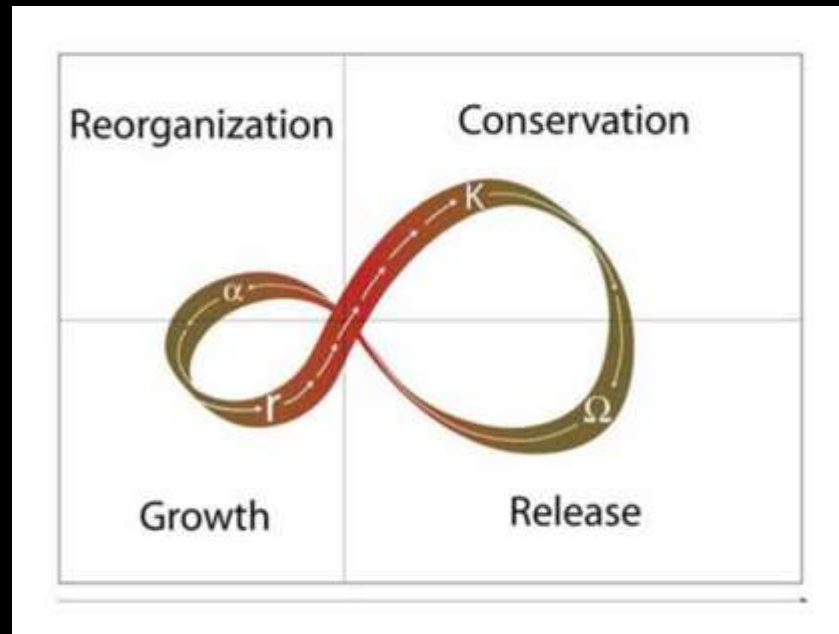
An adaptive cycle that alternates between long periods of aggregation and transformation of resources and shorter periods that create opportunities for innovation, is a fundamental unit for understanding complex systems from cells to ecosystems.

Growth - where species and systems grow and diversify to exploit new opportunities and develop entirely new ecological ways of being.

Conservation - where climax species are tightly connected and organized, and systems stabilize into mature, often hierarchically nested systems, where there is little or no room for innovation or growth.

Release (the “backside” of the mobius strip) - where mature systems destabilize and collapse, and become increasingly discontinuous and chaotic which opens the field for...

Reorganization – where systems return in completely new ways, which creates a new field of conditions and possibilities for the next growth phase



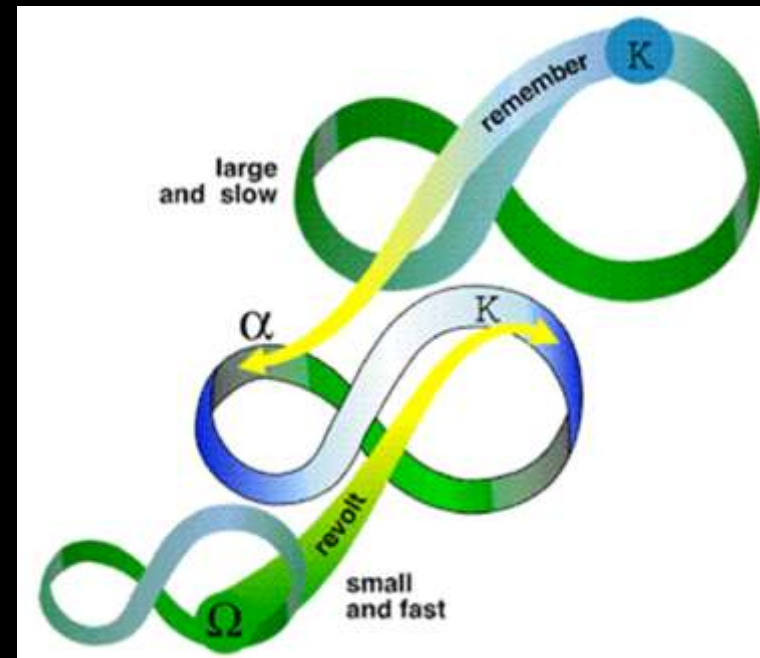
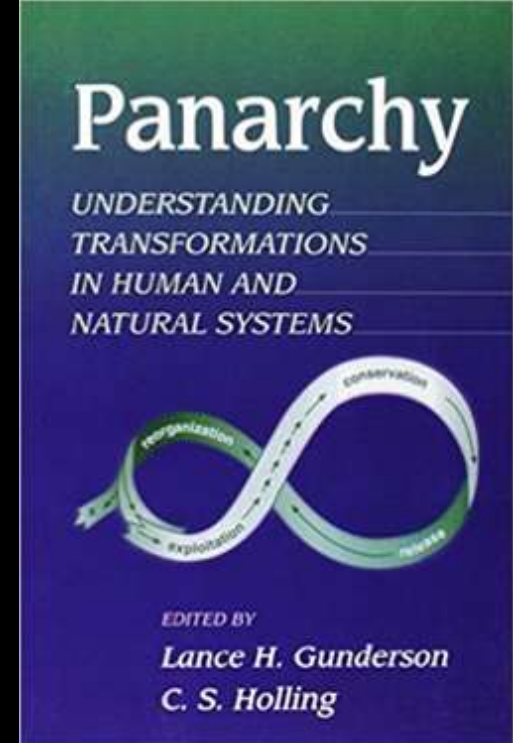
Three distinct kinds of change

1. Incremental change in the r and K phases, which are smooth and fairly predictable;
2. Abrupt change in the transitions from K through  $\Omega$  and  $\alpha$ ;
3. Transformational learning, meaning change involving several panarchical levels

# Resilience, Panarchy, and Adaptive Evolution

## A Theory of Permanence and Change

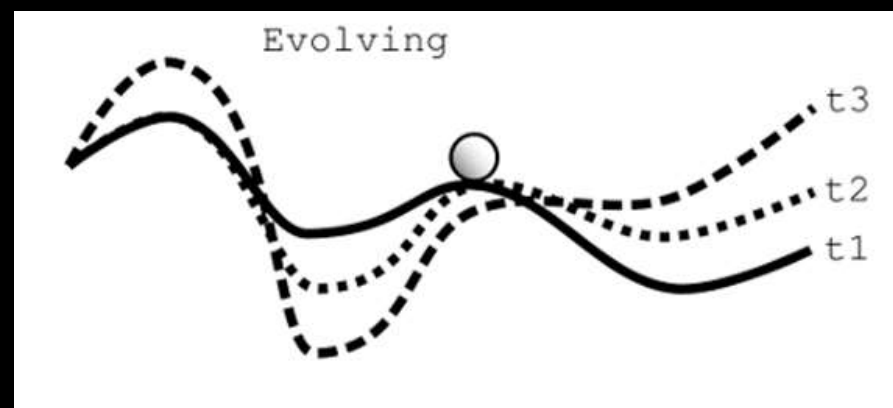
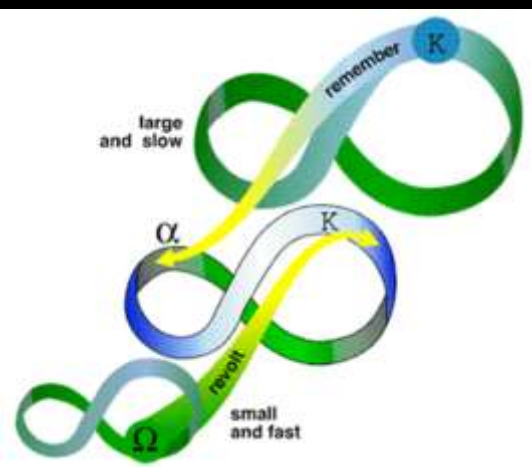
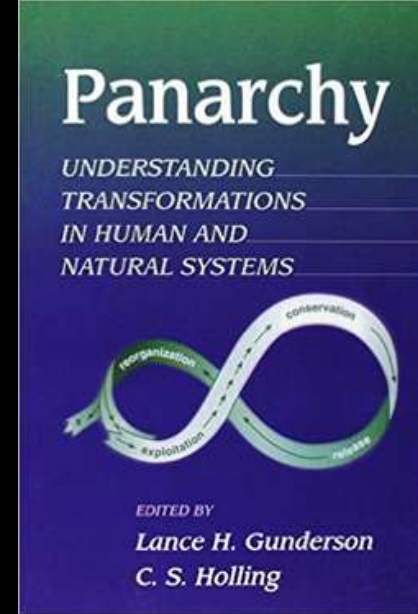
- This interacting set of hierarchically structured scales has been termed a "panarchy"
- 'Panarchy' is a term that "explains the evolving nature of complex adaptive systems" Human and Natural systems - Socioecological systems
- No socioecological system can be understood or managed by focusing on it at a single scale. All systems exist and function at multiple scales of space, time and social organization, and the interactions across scales are fundamentally important in determining the dynamics of the system at any particular focal scale.
- The panarchy framework connects adaptive cycles in a nested hierarchy. Ecological and social-ecological systems form nested sets of adaptive cycles. The larger, slower cycles generally constrain the smaller, faster ones and maintain system integrity
- The essential focus of Panarchy is to rationalize the interplay between change and persistence, between the predictable and unpredictable.



# New Myth of Nature: Evolving Nature

## A Myth of Permanence and Change

- Panarchy is a new narrative or myth of evolving nature, hinted at by the name of the Greek god of nature - Pan - whose persona also evokes an image of unpredictable change.
- Unintended consequences - Change is not always for the good - Pan has a destabilizing role that is captured in the word panic, directly derived from one facet of his paradoxical personality.
- His attributes are described in ways that resonate with the attributes of the four phase adaptive cycle; as the creative and motive power of universal nature, the controller and arranger of the four elements - earth, water, air and fire.



# New Nature - Novel Ecosystems

- Assemblages of species in a given area that have not previously occurred.
- They lack historically natural analogs
- Novel ecosystems are not really all that novel, except in their species composition.
- We need to develop a new ecology that is not prejudiced by the human-nature dualism.

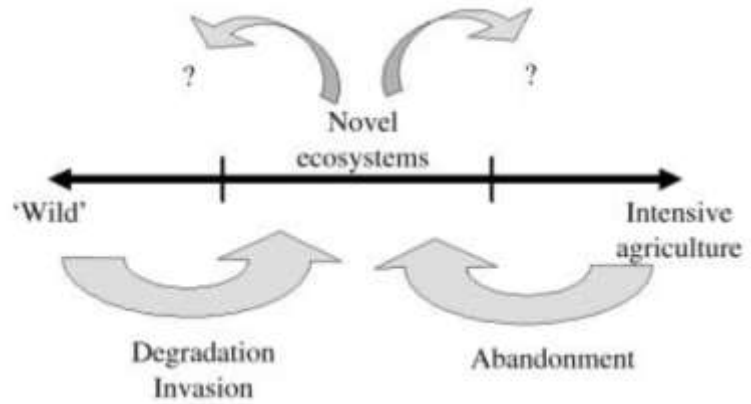
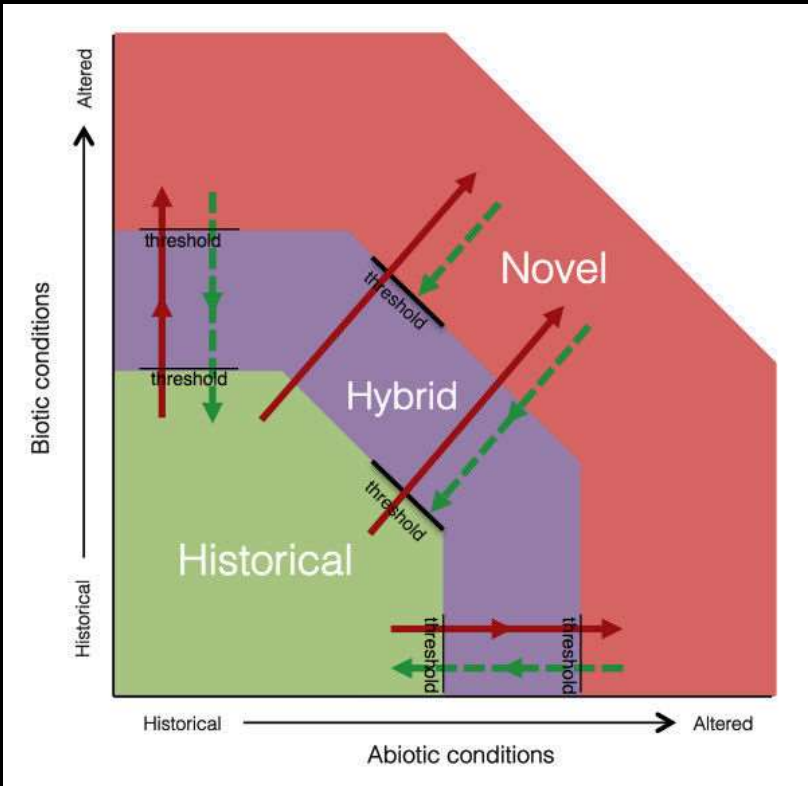
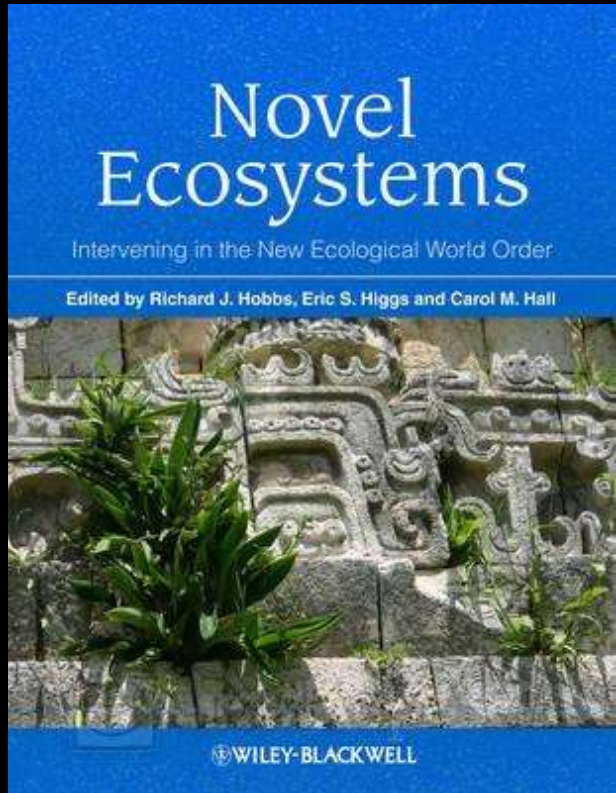


Figure 1 Novel ecosystems arise either from the degradation and invasion of 'wild' or natural/seminal systems or from the abandonment of intensively managed systems.



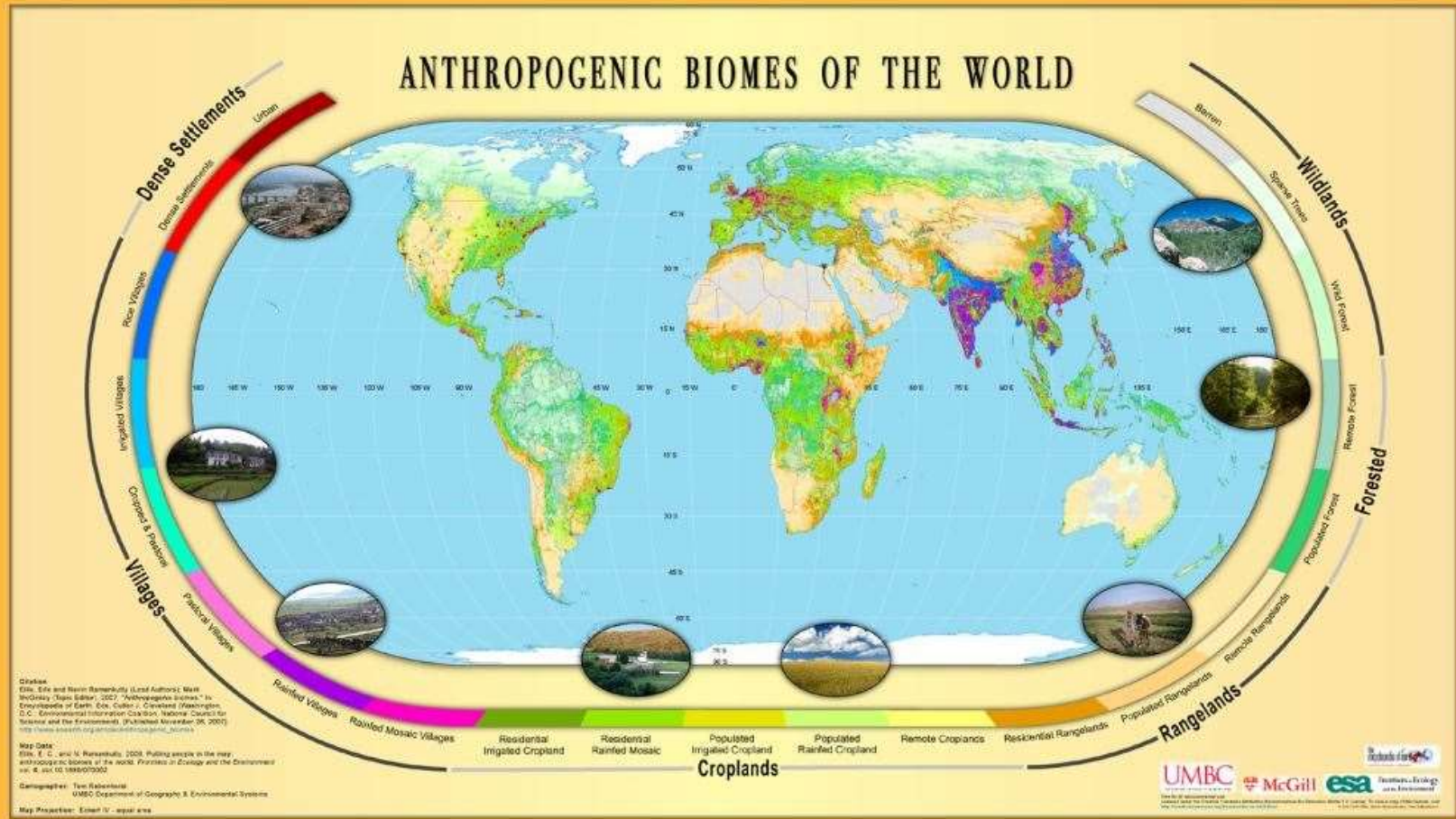
# Envisioning the Changing Socioecological Earth Humans as part of Nature

## Anthropogenic Landscapes, or "Human Landscapes"

<http://ecotope.org/> Dr. Erle Ellis

## Anthropogenic Biomes ("Anthromes")

## The globally-significant types of anthropogenic landscapes



# The New Narrative of Nature - Resilience Ecology

## Managing Socio-Ecological Systems

### Adapting to change – not a stable state

The basic concepts are:

- non-linearity, alternate regimes and thresholds
- adaptive cycles
- multiple scales and cross-scale effects - "panarchy"
- adaptability
- transformability
- general versus specified resilience

<https://www.resalliance.org>



The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends.

Our vision is a world where the diversity of life thrives, and people act to conserve nature for its own sake and its ability to fulfill our needs and enrich our lives.



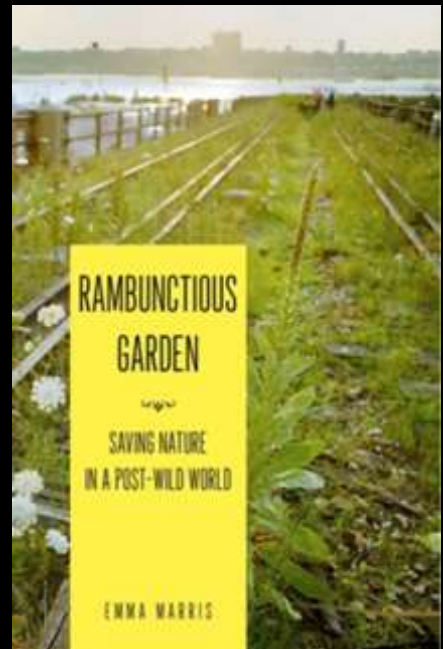
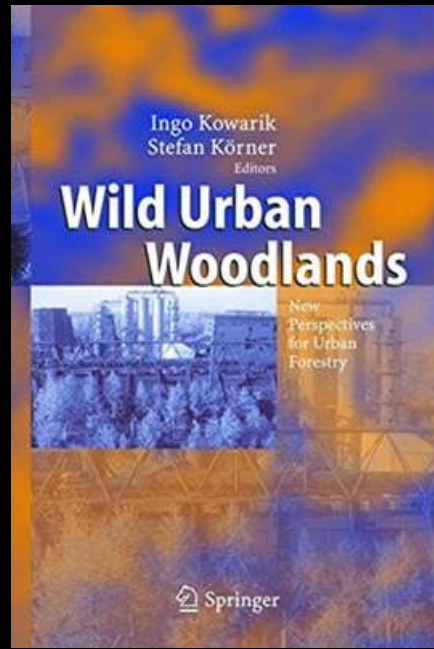
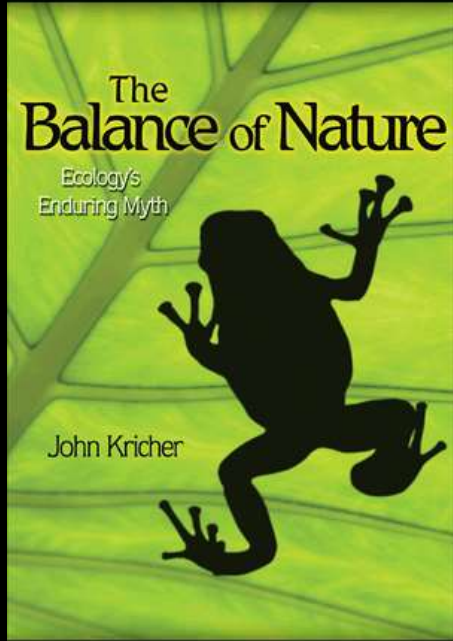
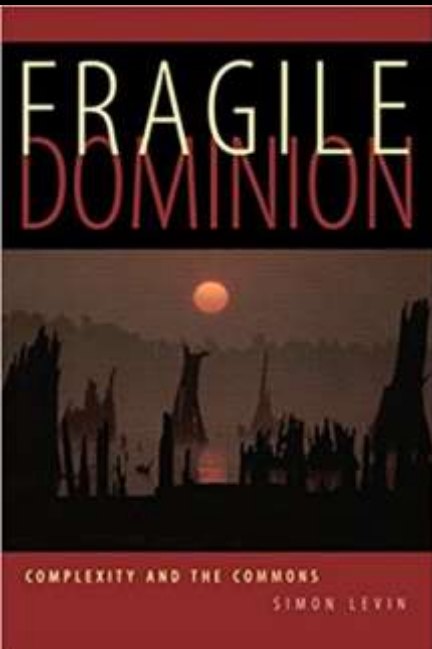
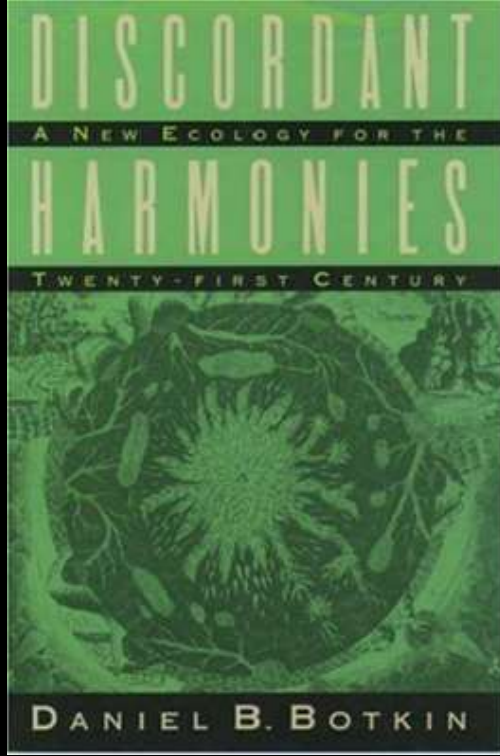
# New Nature

## New Metaphors of Change and Permanence

“Clearly, to abandon a belief in the constancy of undisturbed nature is psychologically uncomfortable...

The way to achieve a harmony with nature is first to break free of old metaphors and embrace new ones so that we can lift the veils that prevent us from accepting what we observe, and then to make use of technology to study life and life-support systems as they are.”

Botkin, *Discordant Harmonies*

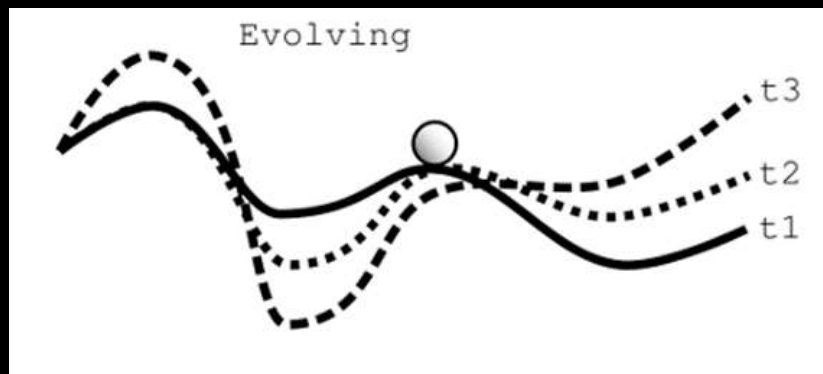
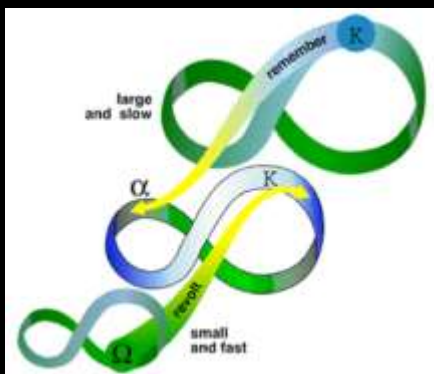
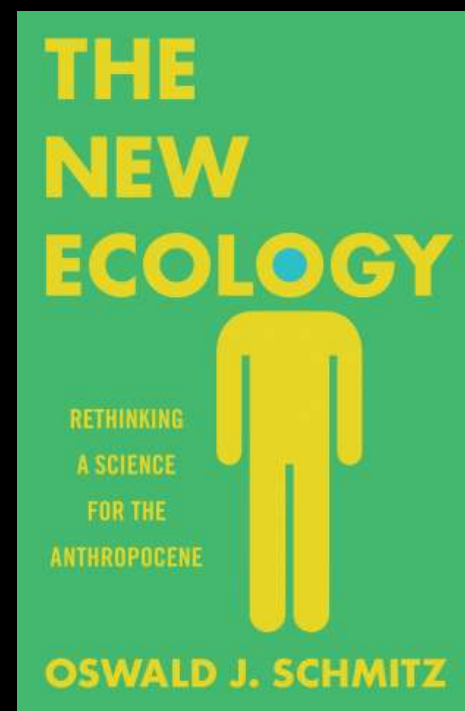
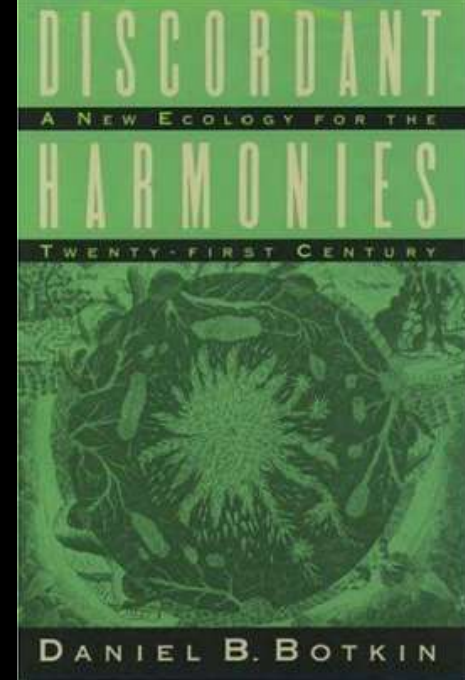




# Discordant Harmonies

- Begin to observe nature as it is, not as we imagine it to be.
- Nature in the 21<sup>st</sup> Century will be a nature that we make; the question is the degree to which this molding will be intentional or unintentional, desirable or undesirable.
- If nature in the twenty-first century will be a nature that we make, then the guide to action is:
  1. our knowledge of living systems and our willingness to observe them for what they are,
  2. our commitment to conserve natural areas,
  3. to recognize the limits of our actions, and
  4. to understand the roles of metaphor and myths in our perceptions of our surroundings.

– Daniel Botkin



# Permanence and Change

Nothing Endures But Change

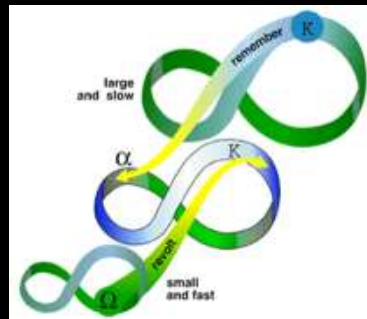
Heraclitus 540-480BC

“the reference point is not an original condition of a natural landscape, but rather a condition defined based on the current site potential and the greatest possible degree of self-regulation.

From this perspective, therefore, the natural capacity for *process* is the central point, not a particular, retrospectively determined and often idealized, *picture* of nature.”

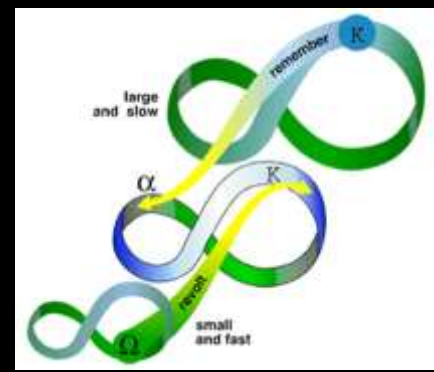
2005

2017



# The Concepts of Nature

- Apply to Parts of Whole, but Not the Whole
- True but Incomplete
- Retrospective, Historical Naturalness
- Prospective? Future? Change?



Resilient Nature

Wilderness



Pastoral



Urban Nature





**Center for  
Environmental  
Research** at Hornsby Bend



## Nature In The City Podcast

<http://austineconetwork.com/nature-in-the-city/>



**Development** CITY OF AUSTIN  
SERVICES DEPARTMENT

**Community Tree  
Preservation Division**