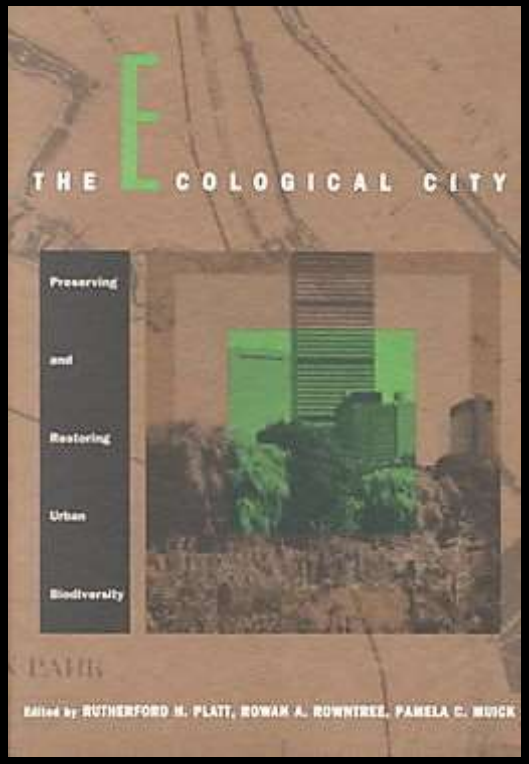
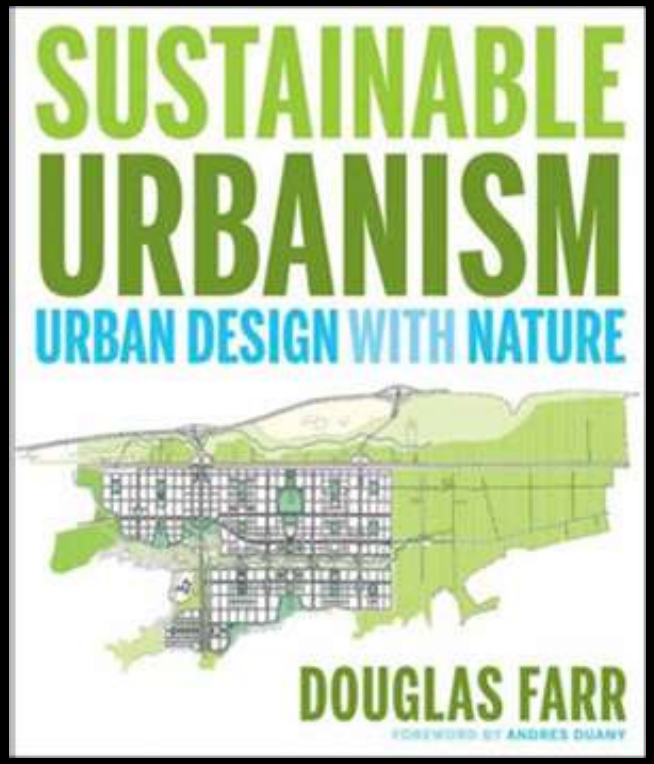
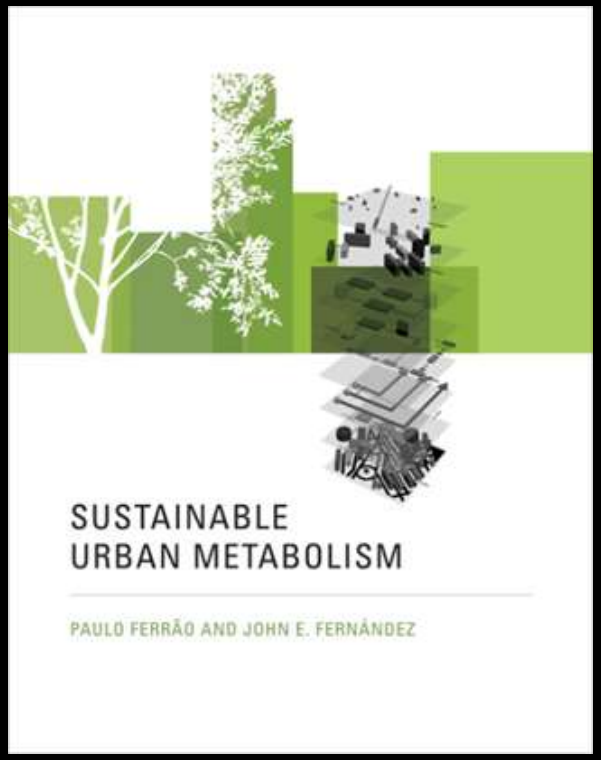
Center for Environmental Research at Hornsby Bend

Austin WATER

The Ecological City: Sustainability, Ecology, and Urban Metabolism

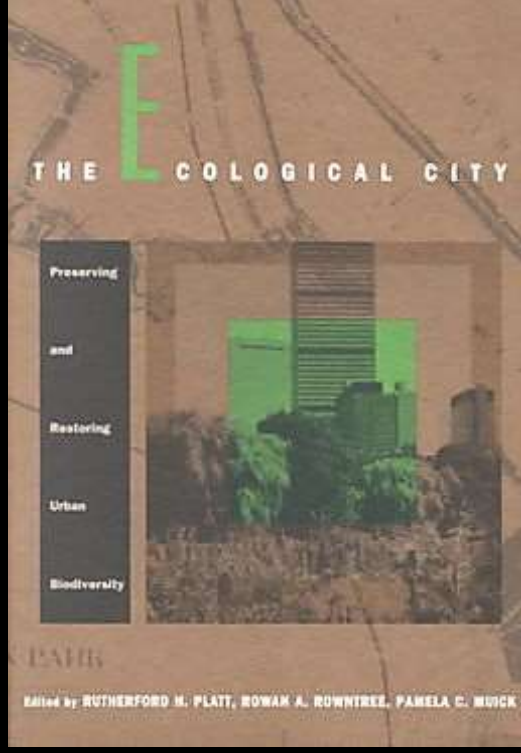






Kevin M. Anderson, Ph.D.
Austin Water – Center for Environmental Research

The Ecological City



Sustainability - Are 21st Century cities sustainable?

Urban Metabolism - Inputs and Outputs = Equilibrium?

Ecology and Nature – The Science of How Nature Works

- Are cities good for Nature?
- Is Nature good for cities?
- Are cities part of Nature? (What kind of Nature includes Cities?)

The Urban Nature Narratives

Narrative of Redemptive Urban Nature – Nature and Culture
Narrative of Restorative Urban Nature – Ecology and Urban Design
Narrative of Functional Urban Nature – Science, Engineering, Management

The Ecological City

- Nature and Culture
- Socioecological
- Sustainable?

Urban Nature

- What it is
- Where it is
- What it does
- What it means

Narratives of Urban Nature

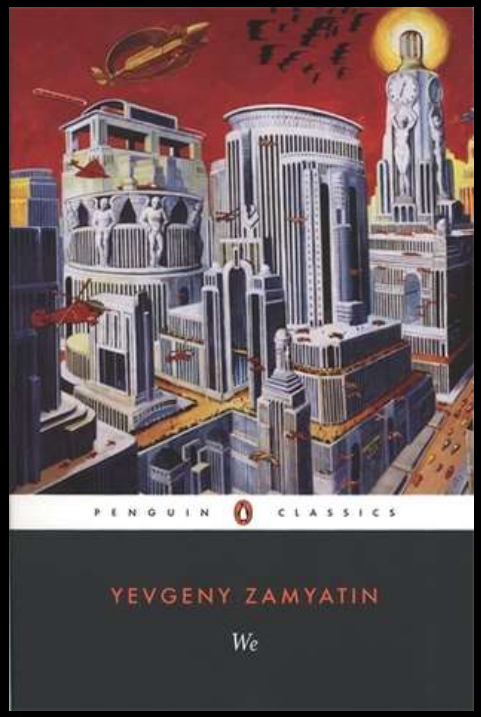
- Redemptive
- Restorative
- Functional

What it means - The City and Wild Nature

Oh, how great and divinely limiting is the wisdom of walls. This Green Wall is, I think, the greatest invention ever conceived.

Man ceased to be a wild animal the day he built the first wall; Man ceased to be a wild man only on the day when the Green Wall was completed, when, by this wall <u>we isolated our machine-like, perfect world from the irrational, ugly world of trees, birds, and beasts</u>.

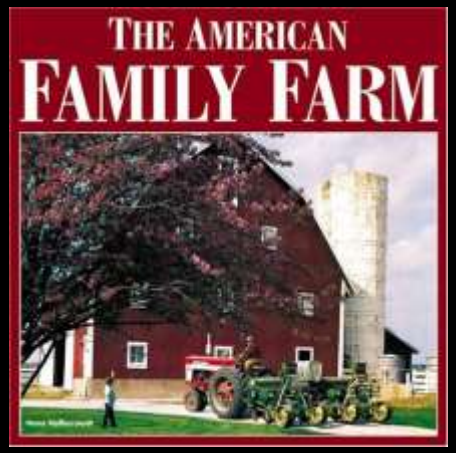
- Eugene Zamyatin, *We* (1921)



The American Myth of Nature

In the United States, the kinds of nature that we celebrate are <u>wilderness and pastoral landscapes</u>.

They are the foundation of the American myth of nature from which we assess the value of nature in America.



What it means - The Problem of Urban Nature

- In American cities, we perceive nature in the urban landscape filtered through a conceptual framework that prejudges its ecological and cultural value.
- Our understanding of what constitutes good urban nature in American cities is shaped by culturally dominant metaphors of nature.

Wilderness

Pastoral

Urban Nature?

The Problem of Urban Nature for Americans

What it is and What it means

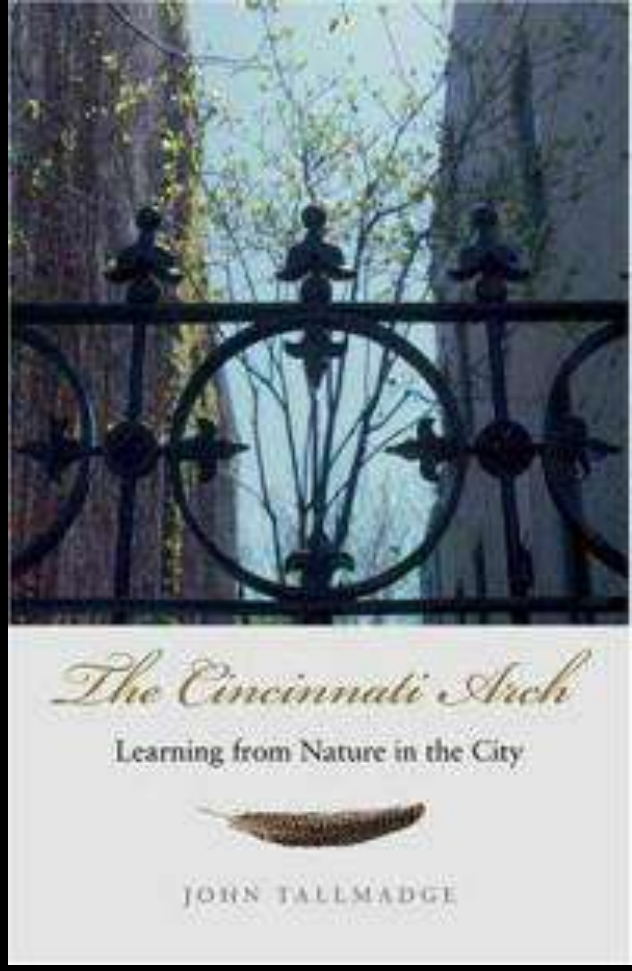
The Cincinnati Arch: Learning from Nature in the City (2004)
John Tallmadge

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.

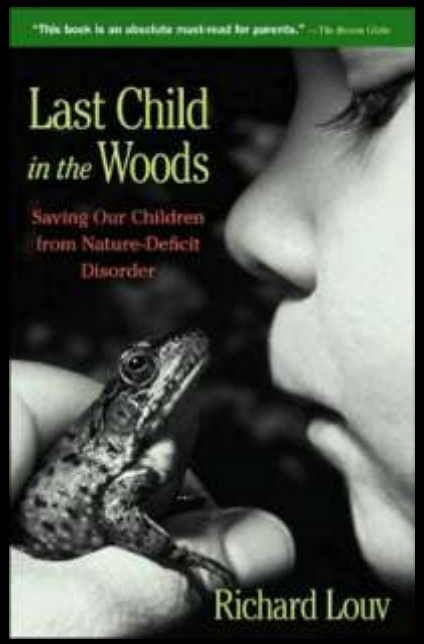
Of course, "wilderness" won't do to describe such landscapes either. Despite the degree of wildness, there's too much human impact, too many alien species, too few large animals to meet the legal and cultural criteria.

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.



The Narrative of Redemptive Urban Nature



What it means - The Wild and The Pastoral Imported

- Nature redeems Culture - The narrative of redemptive urban nature uses the Transcendentalist concept of nature as a tonic for body and spirit which is deliberately incorporated into urban design.
- Space for nature is created to provide natural recreational spaces for physical health and to allow contact with officially sanctioned nature for mental health.

Where it is – the Proper Places for Nature in the City

- The proper places - wildlands, preserves, parks, and gardens established for imaginative urban landscapes of wild nature and pastoral nature.
- The further presupposition is that unmanaged urban nature is degradation in need of redemption through human urban design and management.

WILDLAND CONSERVATION DIVISION

EAST AUSTIN Urban Farm Tour

Urban Nature - What it is and What it does

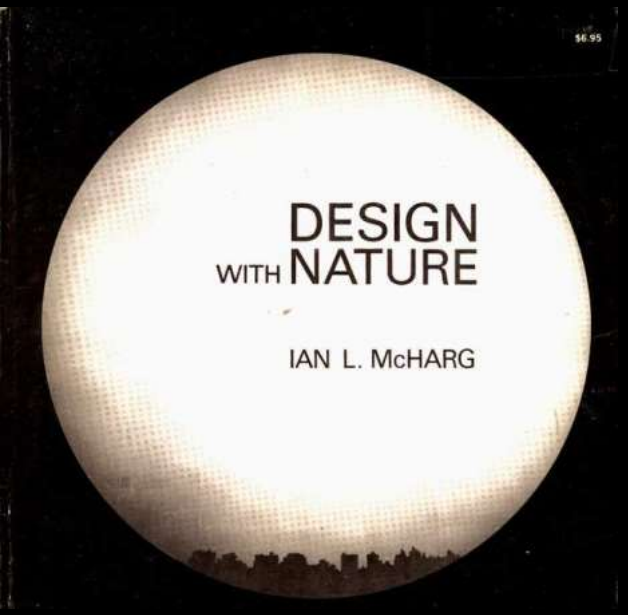
The Narrative of Restorative Urban Nature and the Ecological City

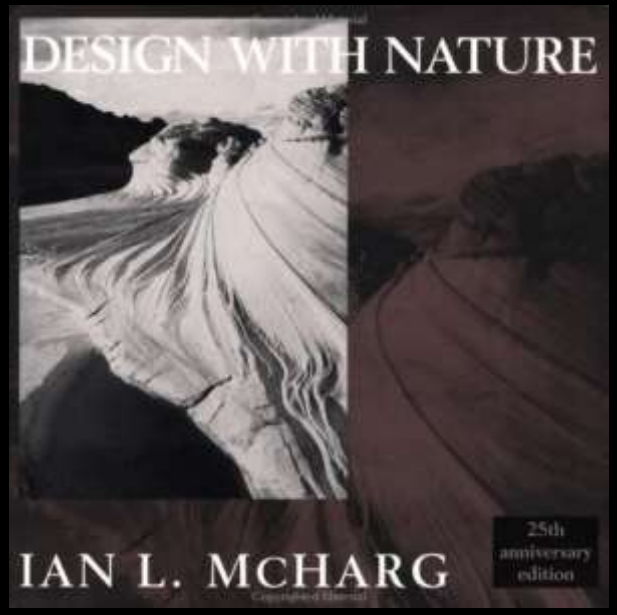
Version 1 - Architecture and Urban Design/Planning

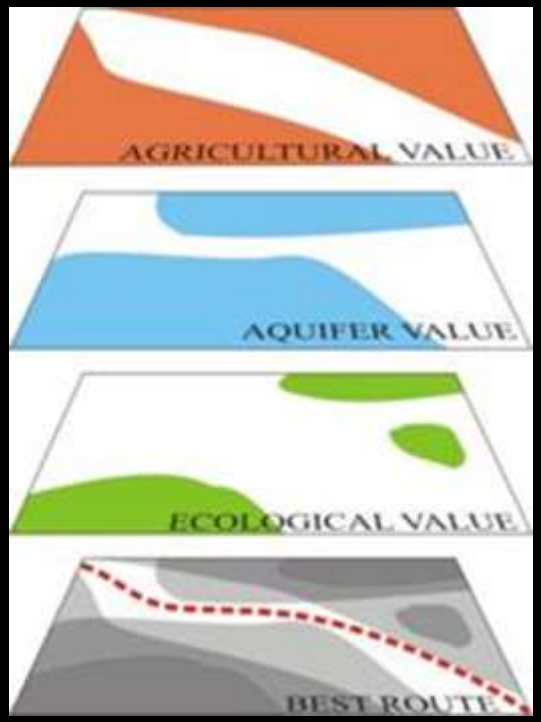
- This urban design version of the restoration narrative emerges from a positive view of cooperation with nature and pastoral ideals of improvement of nature.
- It, also, presupposes that urban nature is degradation which can be restored through urban design and planning.
- It is based on a scientific, mechanistic manipulation of nature for human ends to produce a sustainable urban landscape overlaid with a “green” aesthetic.

Design with Nature 1969

- Ian L. McHarg (1920 - 2001) was born in Clydebank, Scotland and became a landscape architect and a writer on regional planning using natural systems.
- He was the founder of the department of landscape architecture at the University of Pennsylvania in the United States.
- His 1969 book *Design with Nature* pioneered the concept of ecological planning. It continues to be one of the most widely celebrated books on landscape architecture and land-use planning.
- McHarg's method produces a pattern diagram that identifies the best route for a road





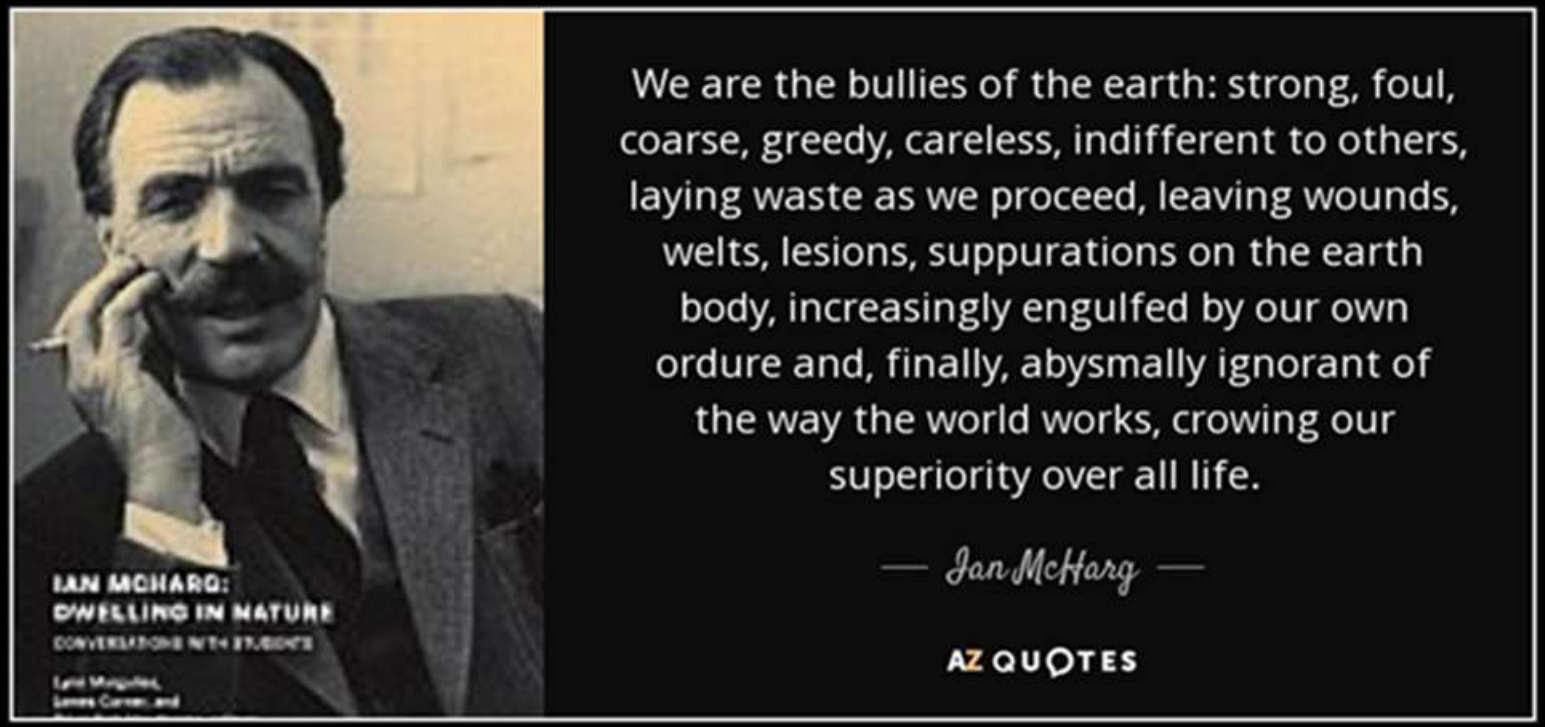


What it means

Narrative of Restorative Urban Nature – Design with Nature

- McHarg presupposes that "the city is a pathological environment" which can be restored to ecological sustainability through design and planning.
- Humans are the problem
- Ecology – nature in the city - is the solution

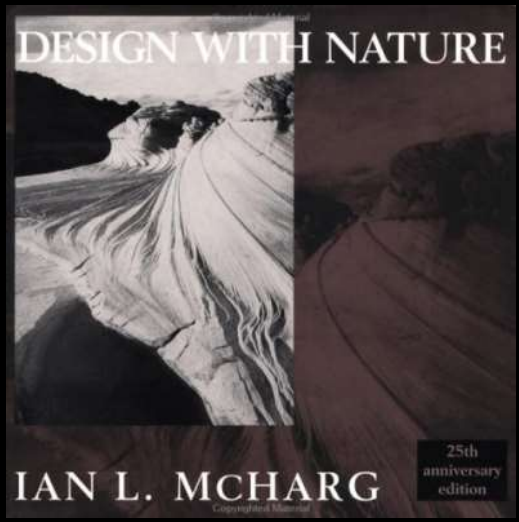
- *Design with Nature*
  - –prioritized incorporating nature throughout the urban landscape
  - –promoted "landscape architecture as the instrument of environmentalism."

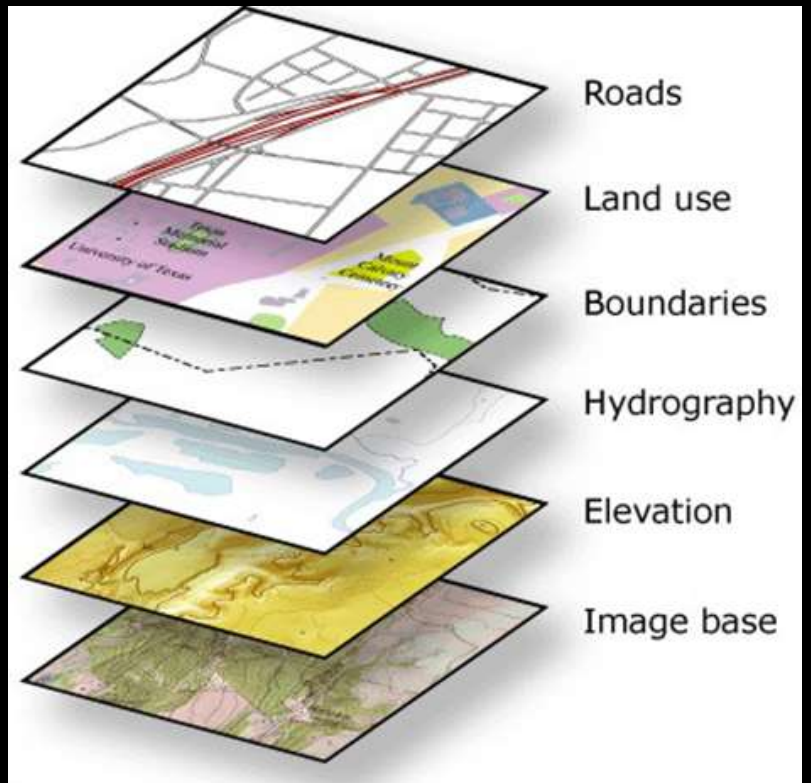


Design with Nature and Science

McHarg insisted that urban design should -

- Find its "rules" in nature.
- Those rules emerged from the scientific study of nature = Ecology.
- Ecology – the <u>Science of How Nature Works</u>.
- Ecologists provide "not only an explanation, but also a command."





A 'Design with Nature' approach to community design means…

- Develop compact, complete communities
- Increase transportation options
- Reduce the loads on water, waste and energy systems
- Protect and restore urban 'green' space
- Strive for a lighter 'hydrologic footprint'
- Achieve higher levels of stream, wetland and lake protection

Criticism – Privileging of "Ecology" – Anne Spirn

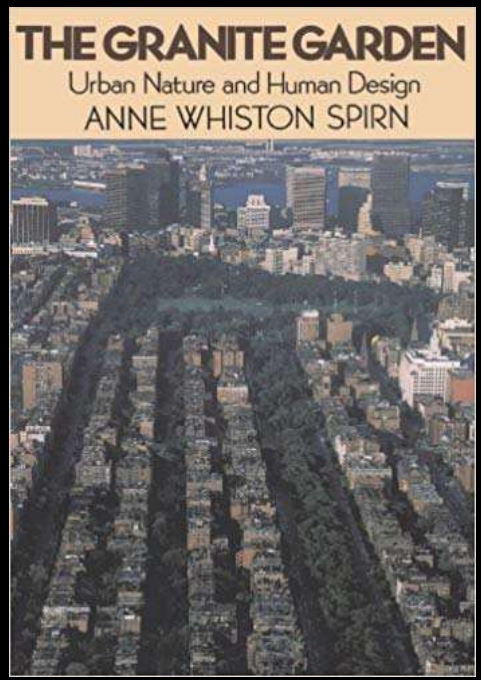
McHarg conflates,

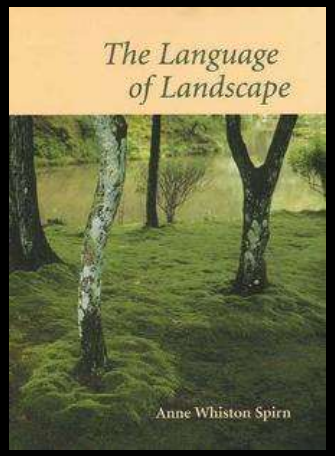
- ecology as a science [a way of describing the world]
- ecology as a cause [a mandate for moral action]
- ecology as an aesthetic [a norm for beauty]

"It is important to distinguish the insights ecology yields as a description of the world, on the one hand, from how these insights have served as a source of prescriptive principles and aesthetic values, on the other."

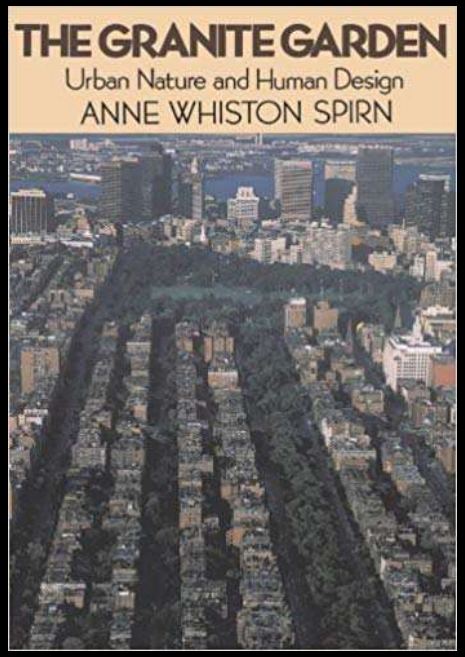
Anne Spirn "Ian McHarg, Landscape Architecture, and Environmentalism" 2000

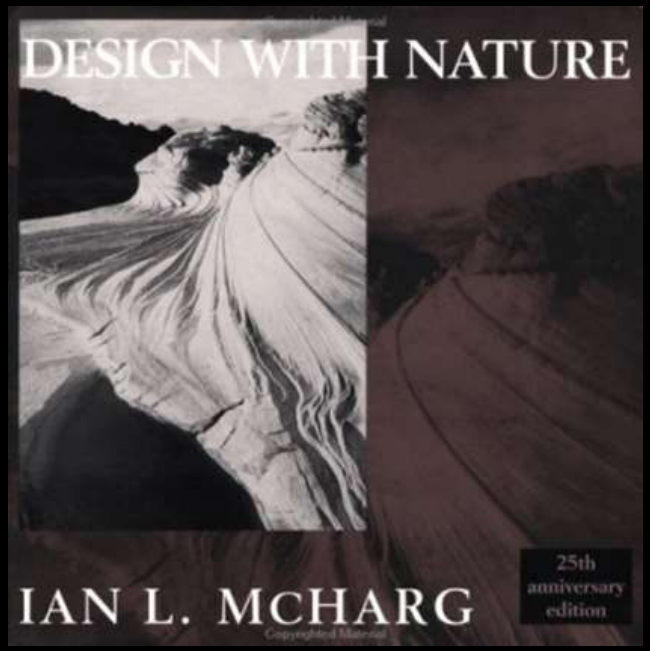
Anne Spirn - "<u>The city must be recognized as part of nature and designed accordingly</u>. The city, suburbs, and surrounding countryside must be viewed as a single, evolving system within nature…Nature in the city must be cultivated, like a garden, rather than ignored or subdued."
The Granite Garden 1984

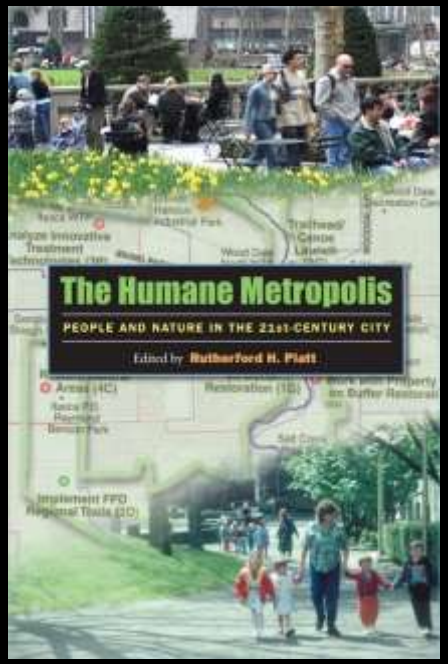


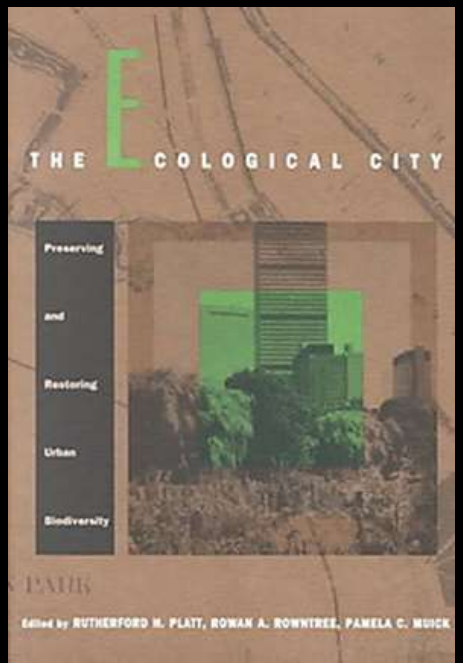


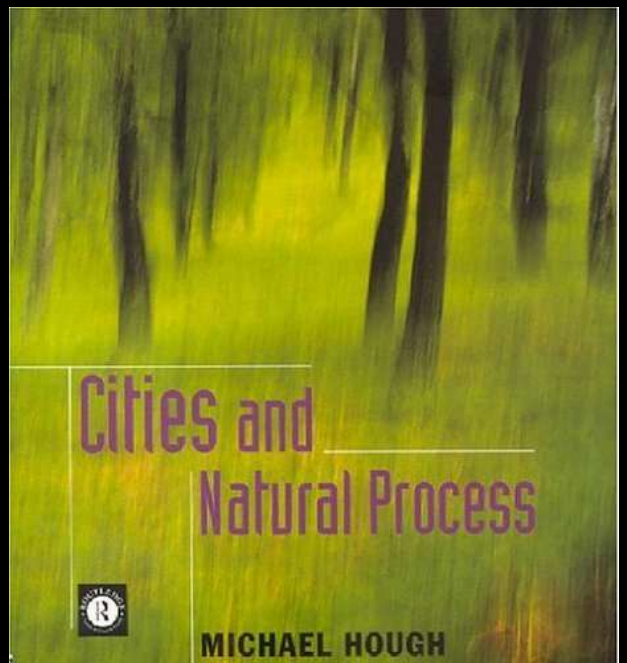
Restorative Urban Nature and Urban Design



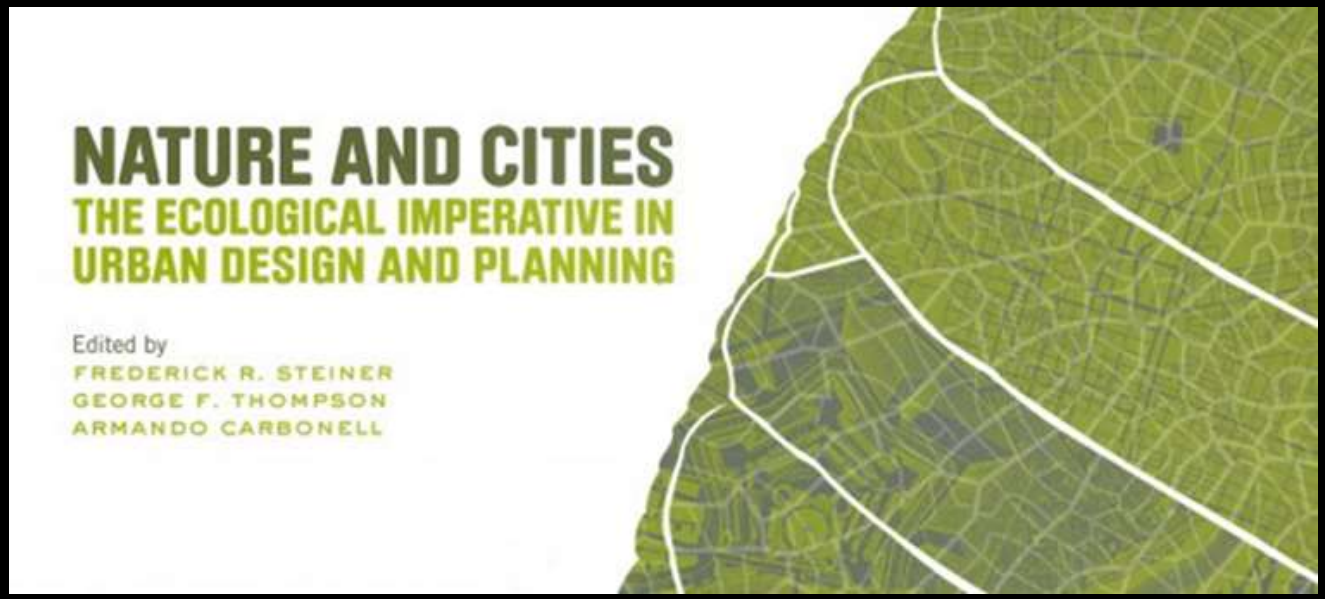


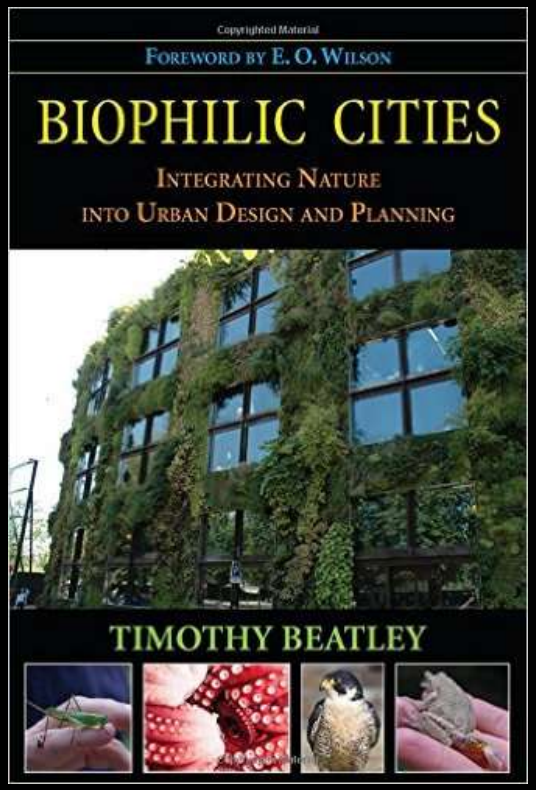


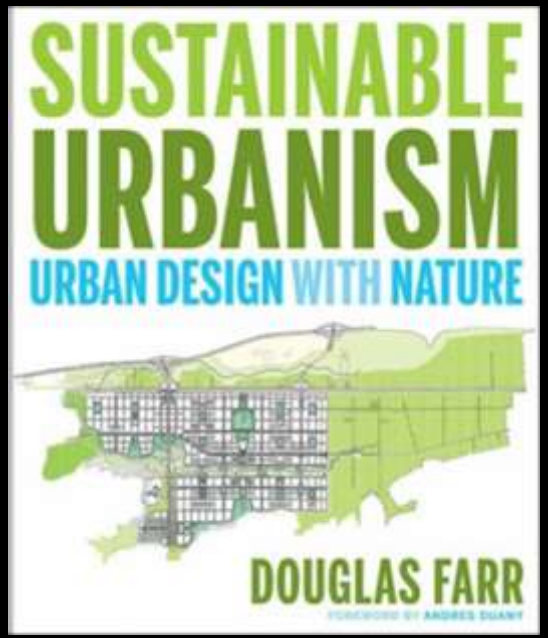




Restorative Urban Nature, Urban Design, and Sustainable Cities







Urban Nature - What it is and What it does

The Narrative of Restorative Urban Nature and the Ecological City

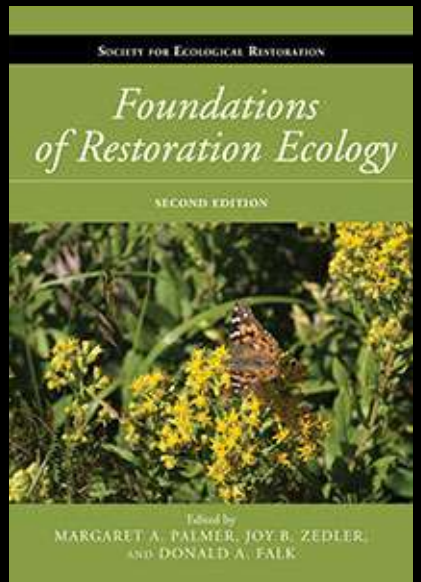
Version 2 – Restoration Ecology and Conservation Biology

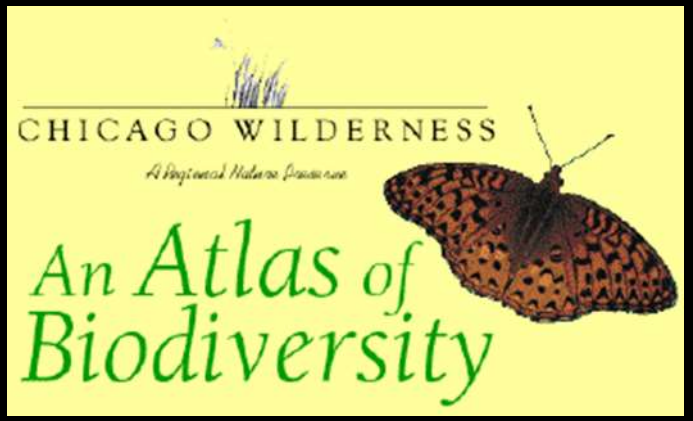
Restoration Ecology - The restoration narrative has another version which emerged in the 1980s focused on the recovery of native historical habitats through the restoration of these habitats in urban landscapes.

Restoration ecology developed alongside conservation biology with the goal of not just to conserve remnant historical habitats and species but to actively restore native ecosystems.

Socioecological Science – Good Nature and Bad Nature

SER
SOCIETY FOR ECOLOGICAL RESTORATION





The Nature Conservancy
Protecting nature. Preserving life.®

What it is? Degraded Nature in American (Urban) Ecology

Perceptions of American Biologists, Ecologists, and Environmentalists

Ecology "in" cities – "Bizarre" - A weedland community of inappropriate 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."

(Urban growth) replaces the native species that are lost with widespread "weedy" nonnative species. This replacement constitutes the process of biotic homogenization that threatens to reduce the biological uniqueness of local ecosystems.

Michael L. McKinney, "Urbanization, biodiversity, and conservation". *Bioscience* 52(10), (2002), 883–890.

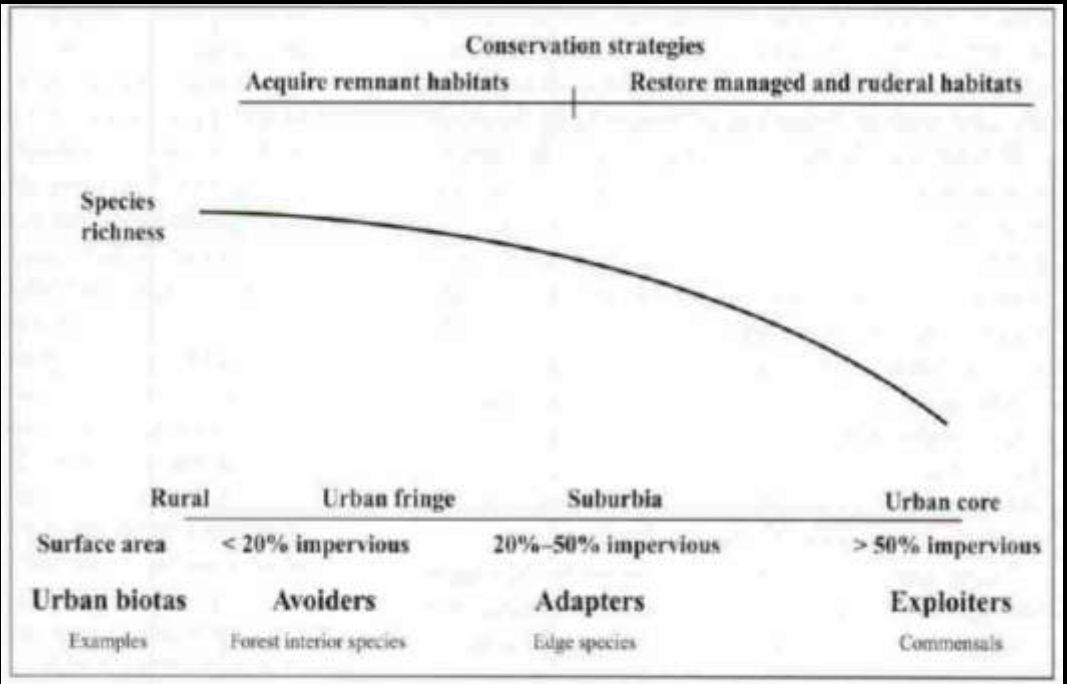
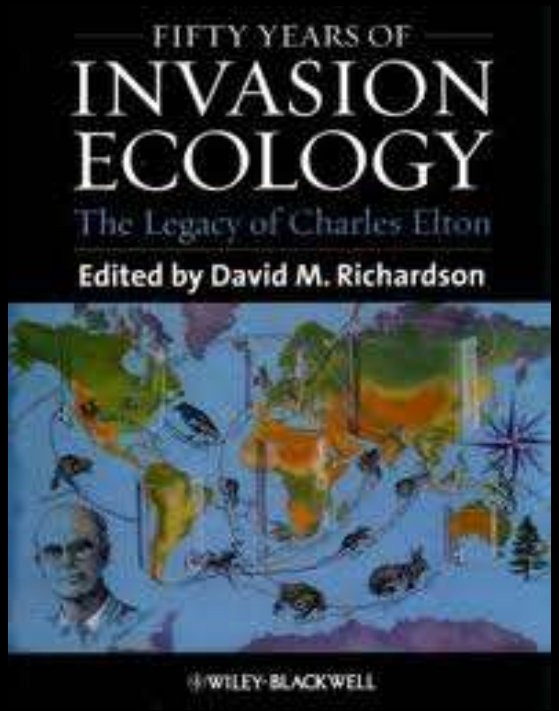


Figure 2. Urban–rural gradient. This is a very generalized and simplified depiction of changes in surface area, species richness, and composition, as compiled from a number of sources discussed in the text. Two basic conservation strategies with respect to urban sprawl are shown at the top.



Defending Native Biodiversity - In this “scientific” version of the narrative of restorative urban nature, the trangressive weeds - non-native species - must be eradicated because they are disruptive aliens.

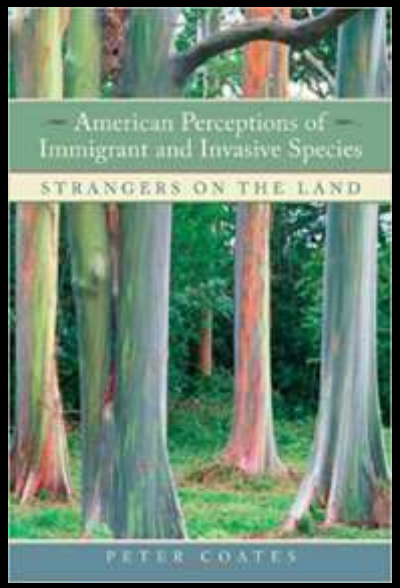
The most controversial of these aliens are called “invasive species”.

Invaders of Texas

a Citizen Science Program to Detect and Report Invasive Species

“Invaders of Texas” website was created by the Lady Bird Johnson Wildflower Center as a tool for mobilizing the public “to control the spread of unwanted invaders” and the program mobilizes “citizen scientists” to defend the homeland.

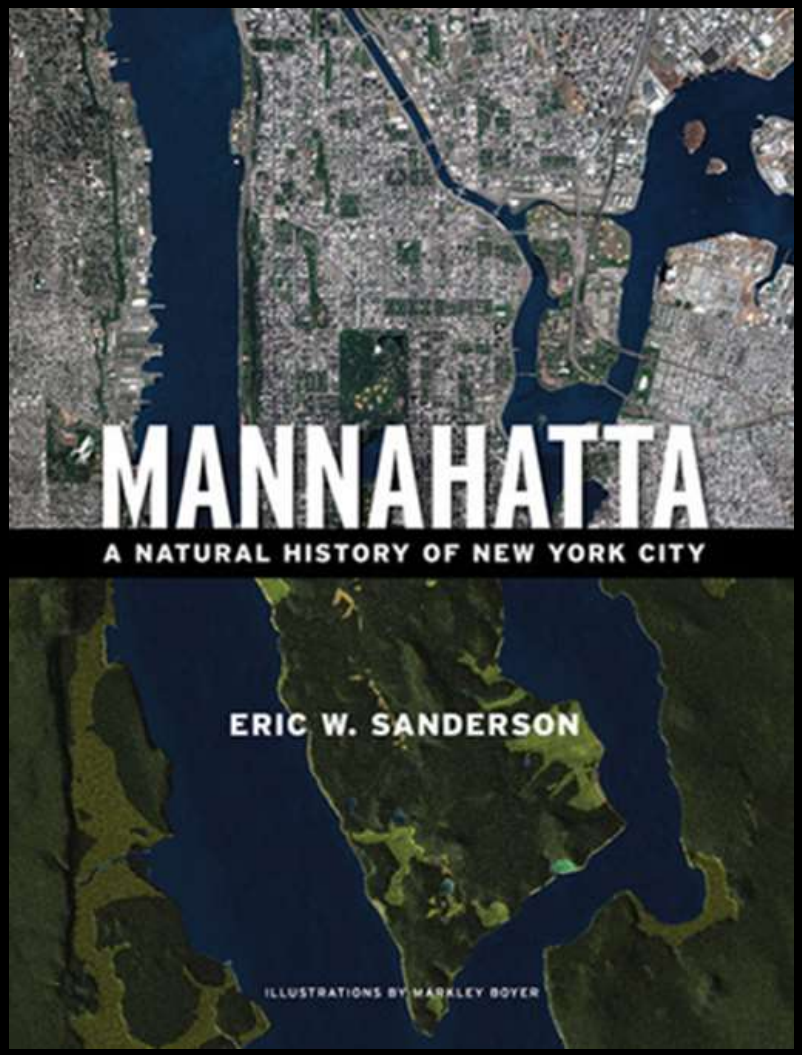
Good Urban Nature = Native Nature
Bad Urban Nature = Non-native “Invasive” Species

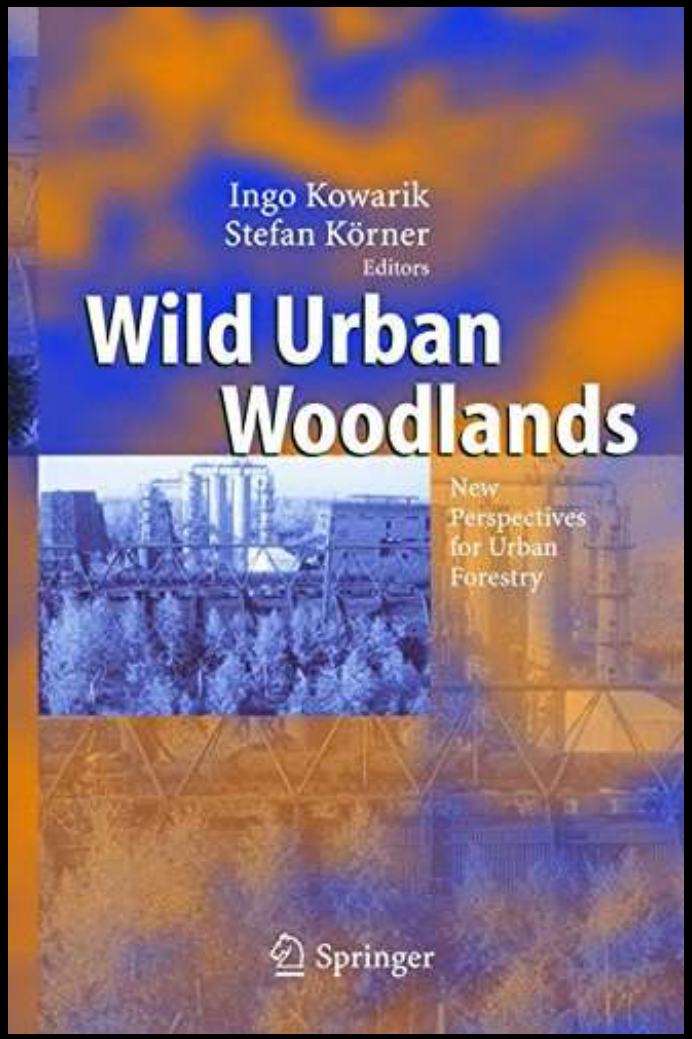


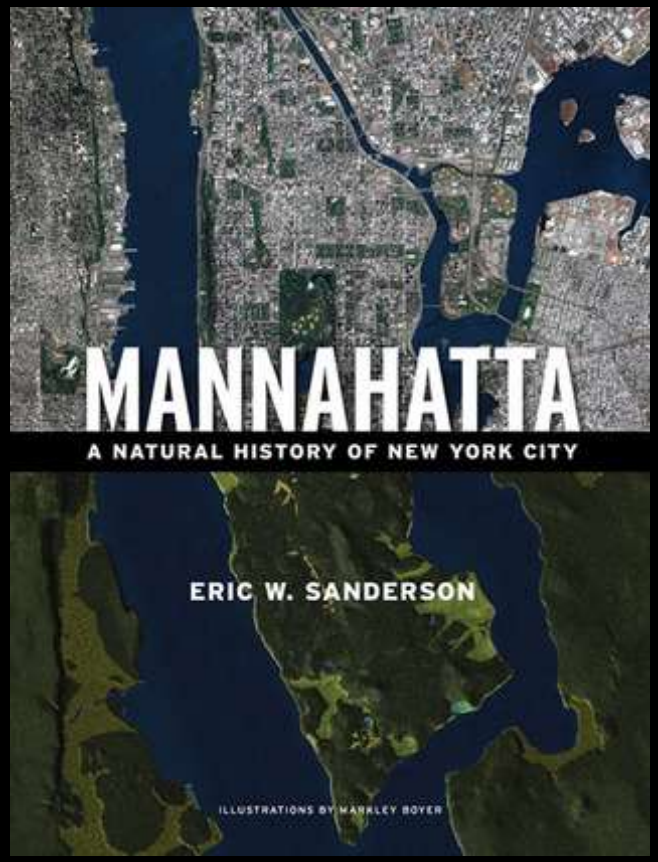
21st Century Ecology and the City

The Problem of Scientific Knowledge, Historical Naturalness, and Urban Nature

Retrospective Ecology vs. Prospective Ecology



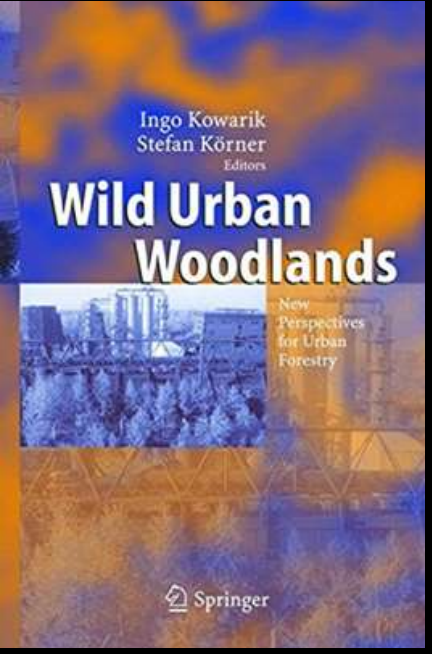


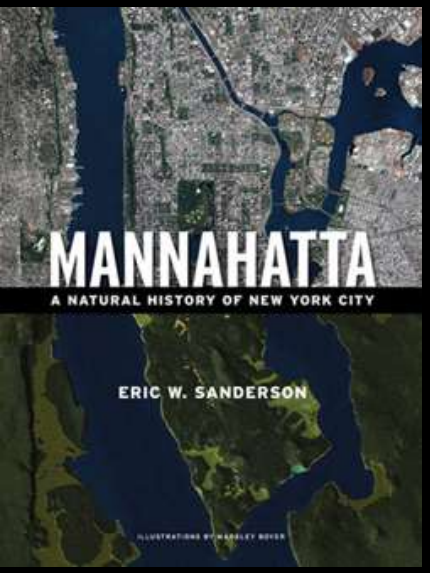


Retrospective Ecology, Historical Naturalness, and American Urban Ecology

"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."





Reassessing scientific approaches to naturalness in urban ecology
A European Perspective

Retrospective naturalness vs. Prospective naturalness

Wild Urban Woodlands Ingo Kowarik 2005

Retrospective naturalness

- The point of reference is therefore, 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 – A list of "native species"
- From the retrospective perspective the development back to nearly natural or natural woodlands composed of historical native species can be analyzed well.

Prospective Naturalness
However, with the evaluation of new development of "wild" urban woodlands the traditional concept of naturalness oriented toward historical comparisons runs aground.

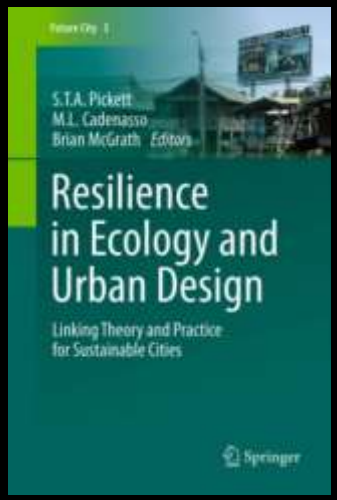
How Does Nature Work? Relentlessly forward…(Evolution)

What do We Manage for?
Prospective Naturalness, Urban Ecology, and Process
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.

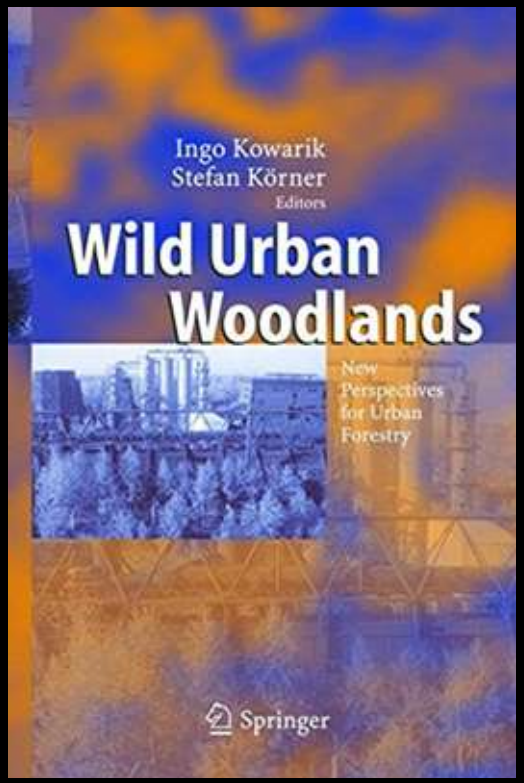
From this perspective, therefore, the natural capacity for *process* is the central point, not a particular, retrospectively determined and often idealized, *picture* of nature."



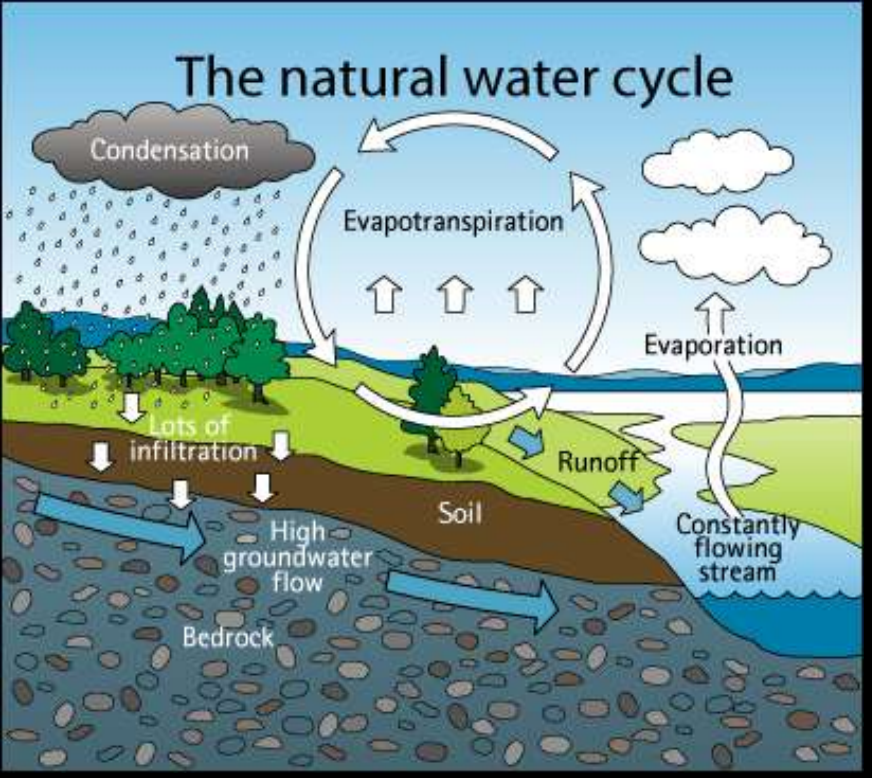
Functionality

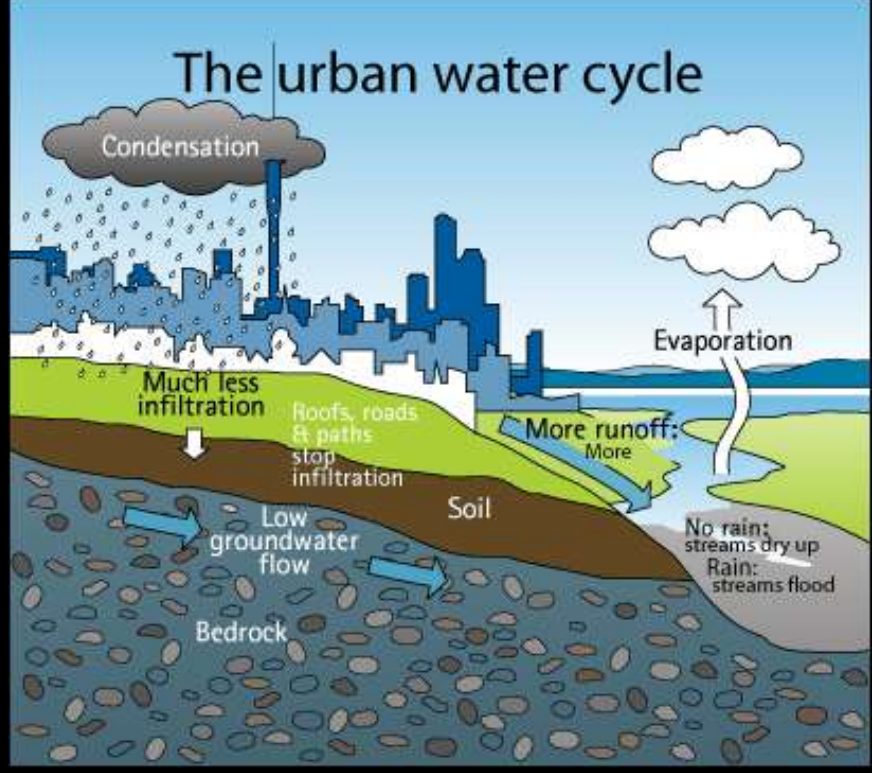
Resilience

2005



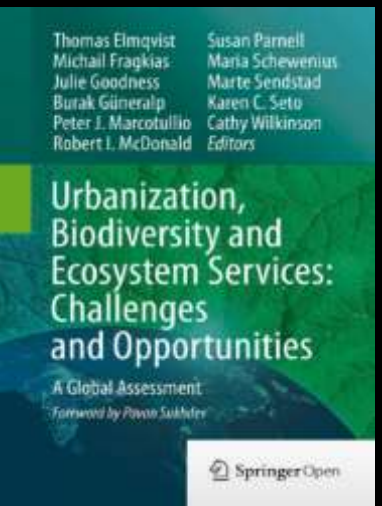
2017

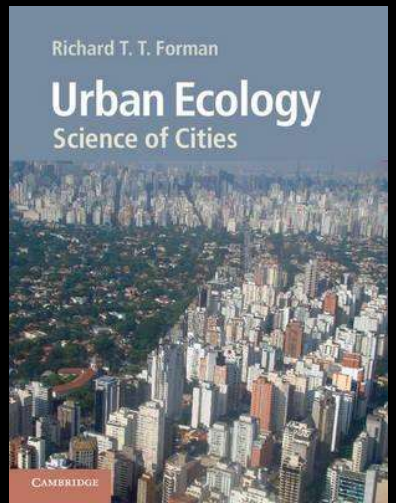


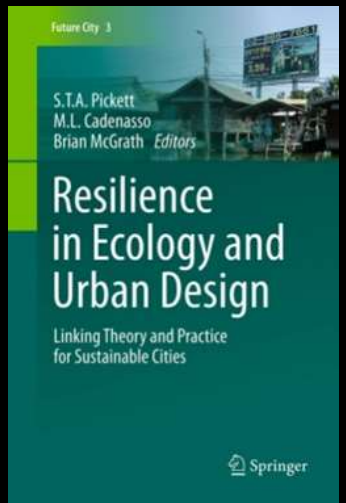


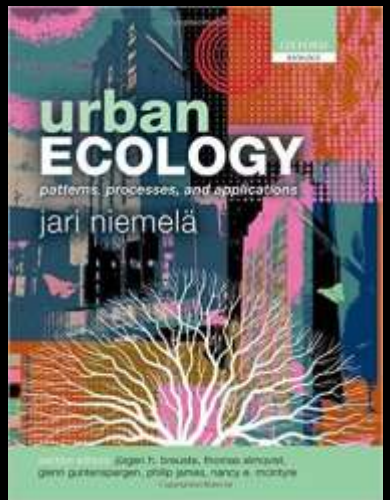
Process and Functionality – The Narrative of Functional Urban Nature

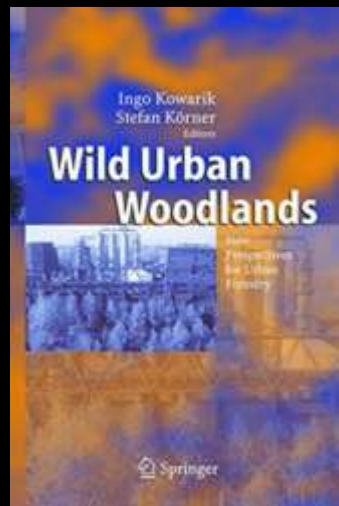
The Ecological City - Science, Engineering, and Urban Environmental Management











Narrative of Functional Nature - Urban Ecology

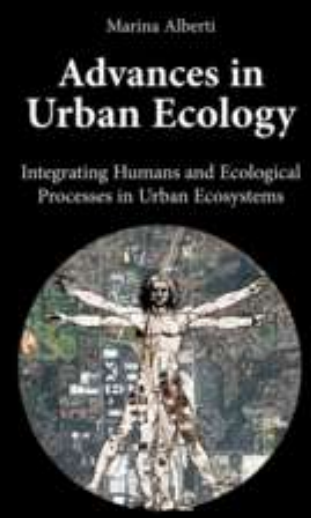
Science and Environmental Management

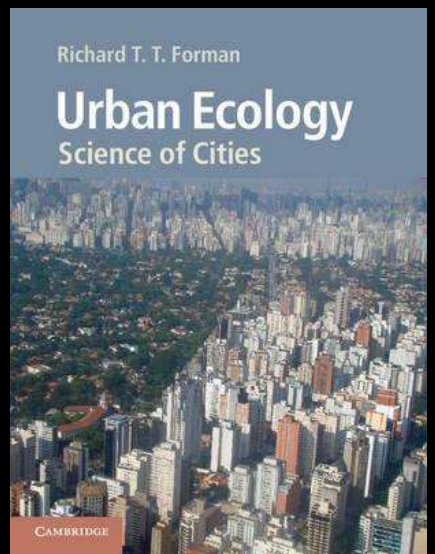
Cities as part of Nature - Cities as Ecosystems

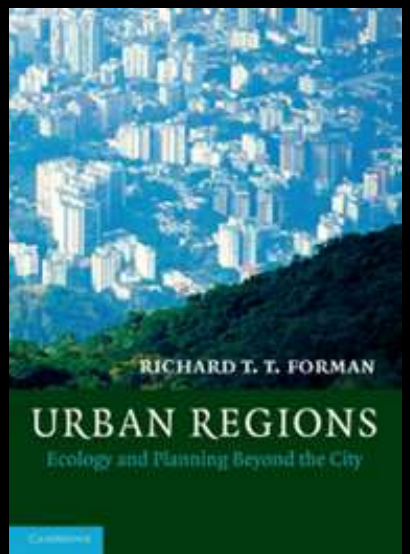
Ecosystem Processes and Cycles - Flows and Relationships - Nonlinearity

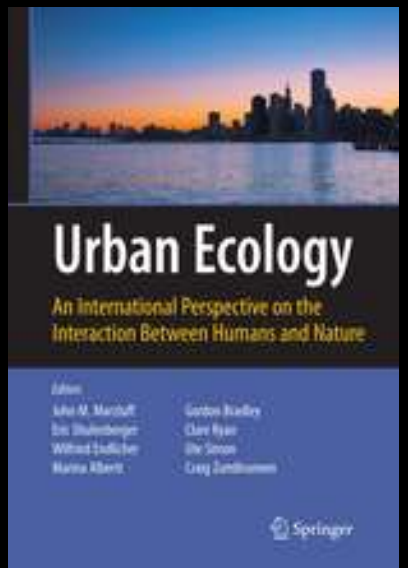
the natural capacity for *process* is the central point, not a particular, retrospectively determined and often idealized, *picture* of nature

- Science - The study of urban ecosystem functionality
- Management - The restoration of urban ecosystem functionality
- The ecology 'in' -> 'of' cities









Narrative of Functional Urban Nature - The Idea of Urban Metabolism

Engineering and Environmental Management

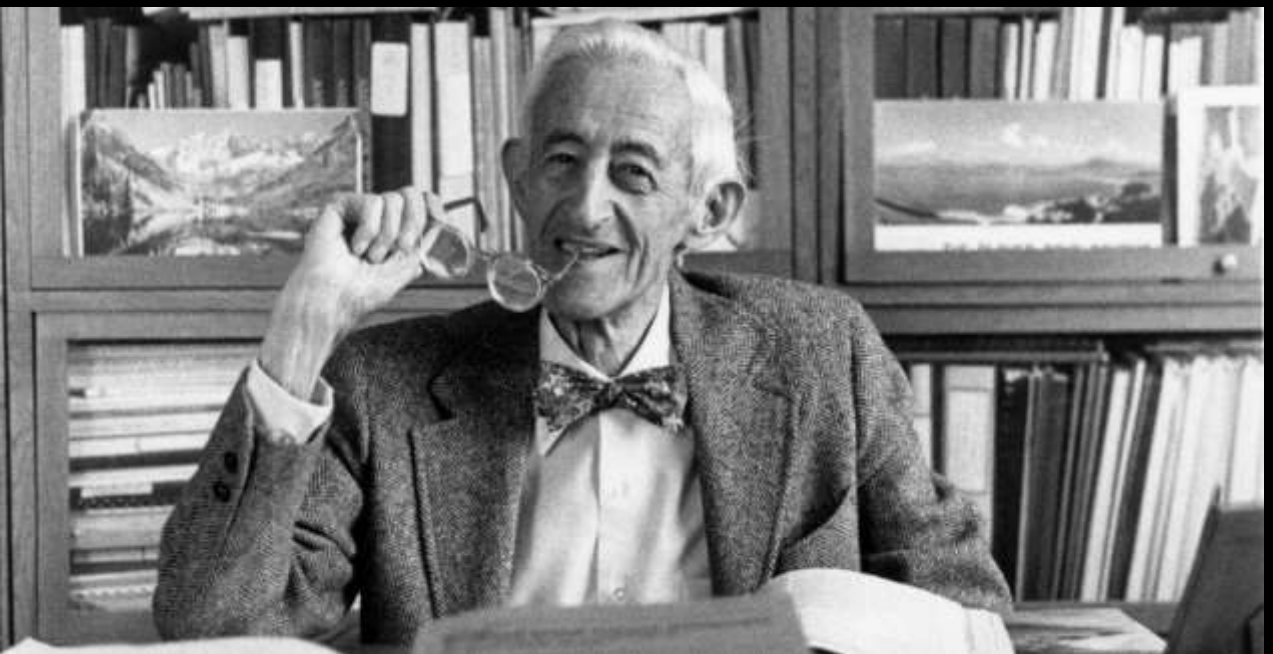
Cities as Material Systems

Process and Functionality – Inputs and Outputs – Linearity

The metabolic requirements of a city can be defined as the materials and commodities needed to sustain the city's inhabitants at home, at work and at play…The metabolic cycle is not completed until wastes and residues of daily life have been removed and disposed of with a minimum of nuisance and hazard.

- Abel Wolman "The metabolism of cities" *Science* (1965)

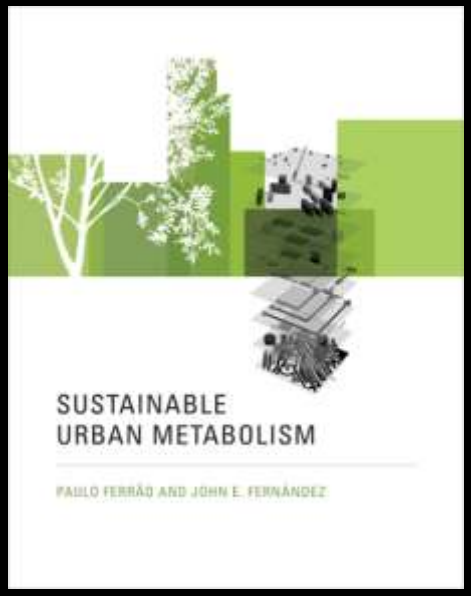
Urban Sustainability = Equilibrium = Homeostasis



Urban Metabolism – The Earth as an "urban system"

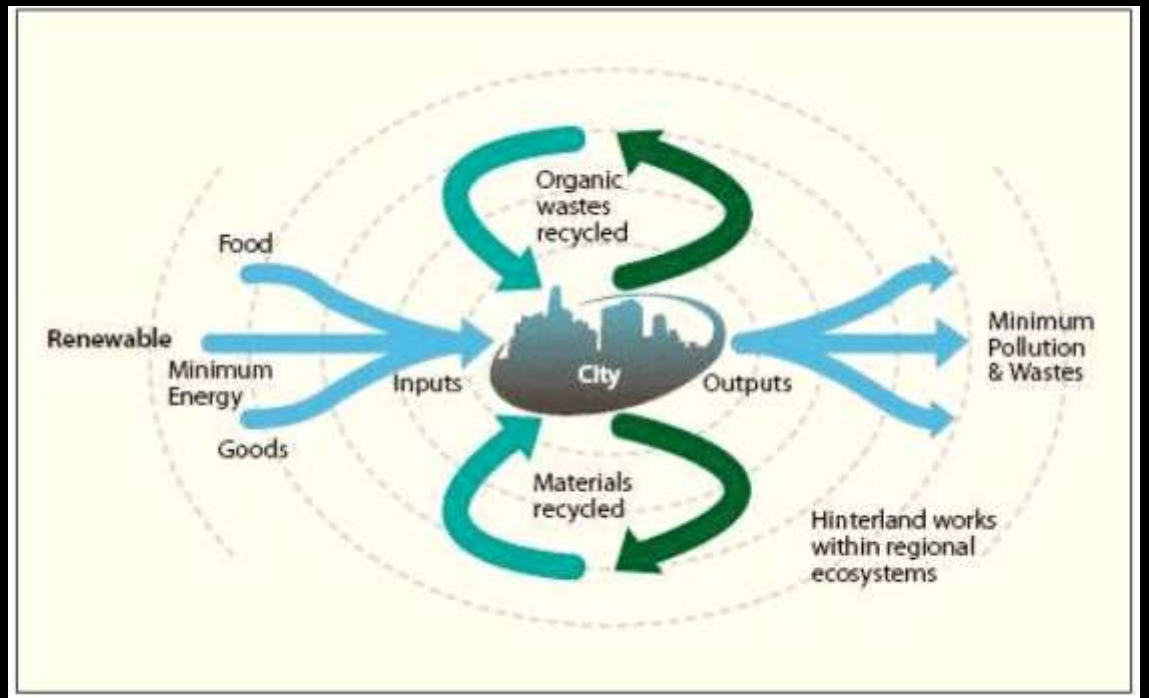
Environmental Engineering

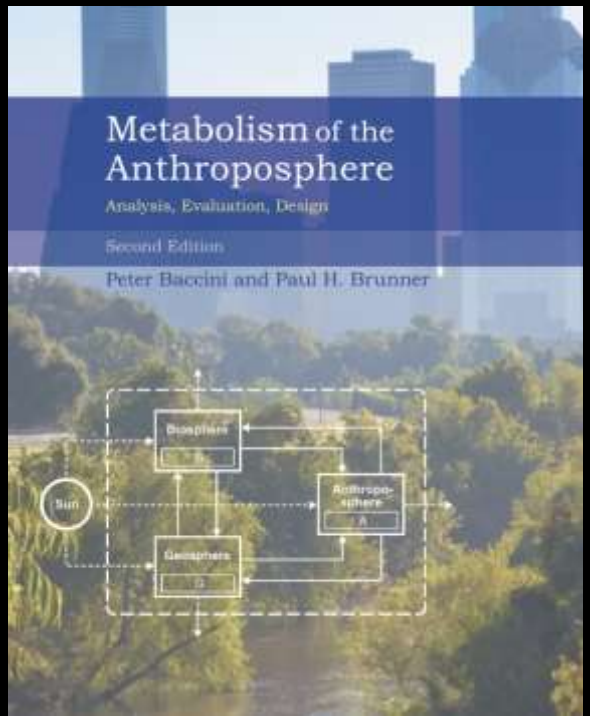
Process and Functionality



This global network of urban systems, including ecosystems, is the anthroposphere; the physical flows and stocks of matter and energy within it form its metabolism.

The characterization of these flows and the relationships between anthropogenic urban activities and natural processes and cycles defines the urban metabolism.





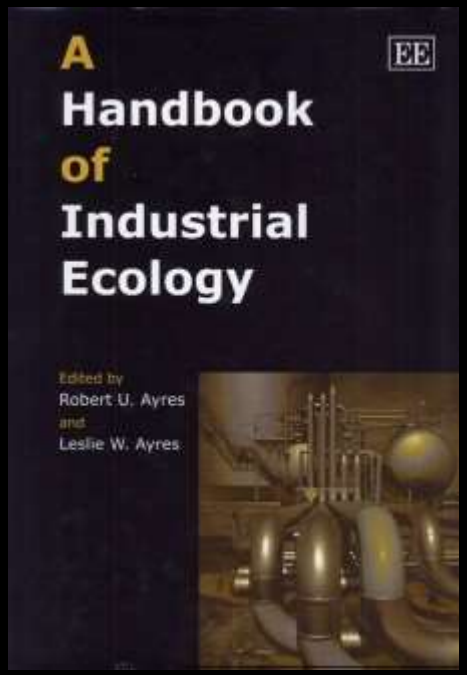
Industrial Ecology and the Earth as an "industrial ecosystem"

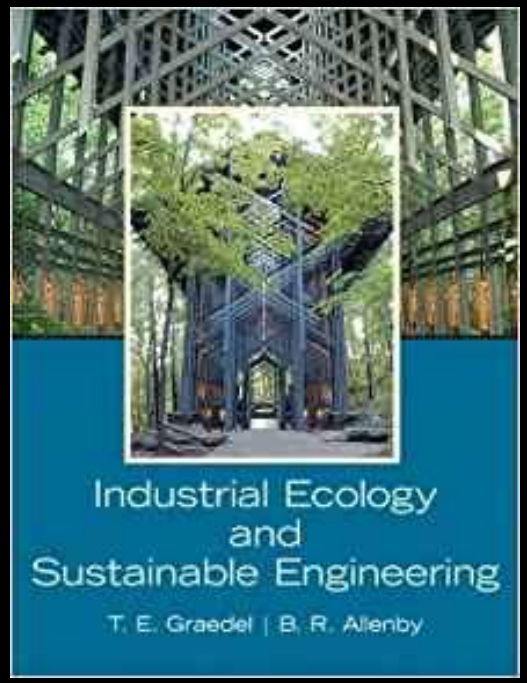
Process and Functionality

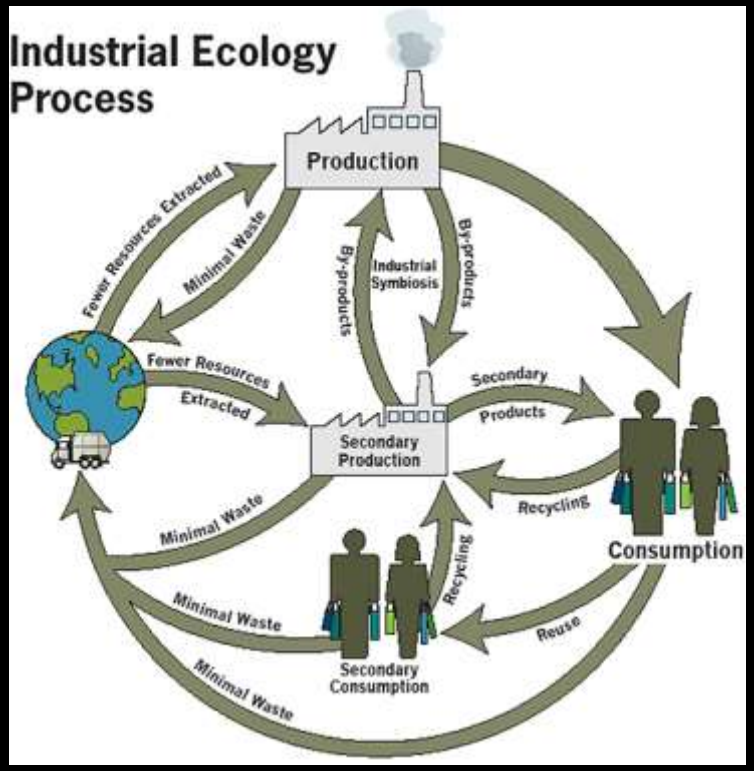
Industrial ecology (IE) is <u>the study of material and energy flows through industrial systems</u>.

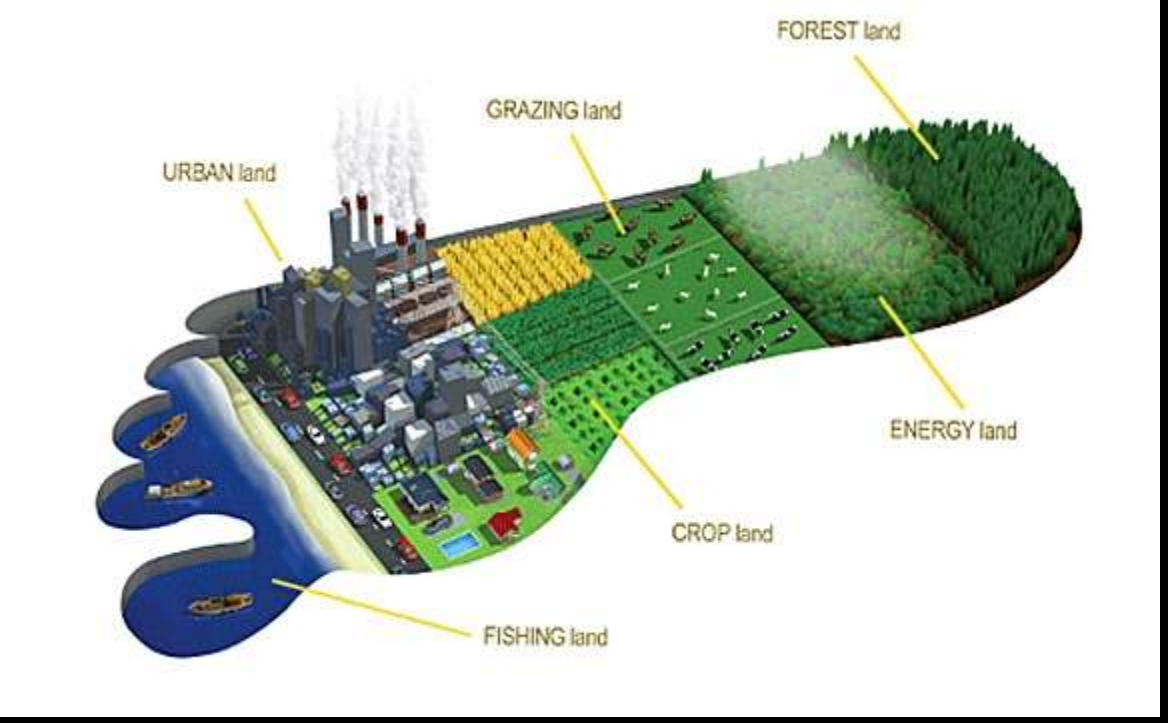
The global industrial economy can be modelled as a network of industrial processes that extract resources from the Earth and transform those resources into commodities which can be bought and sold to meet the needs of humanity.

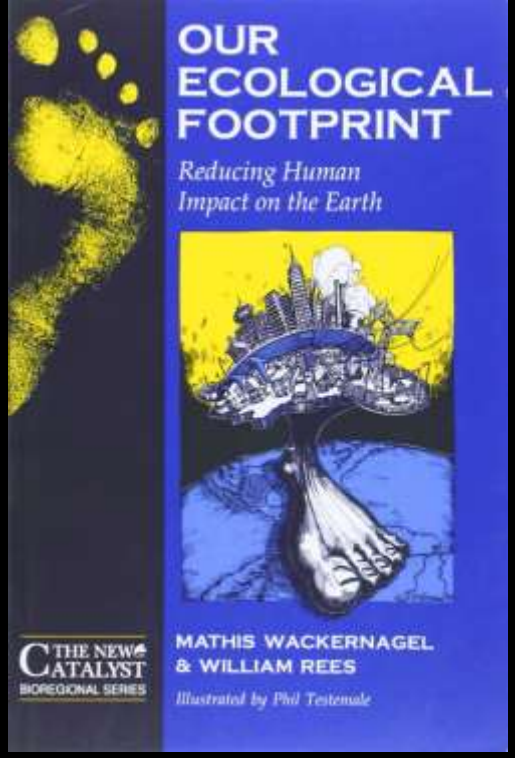
Balance Inputs and Outputs = Sustainable Industry



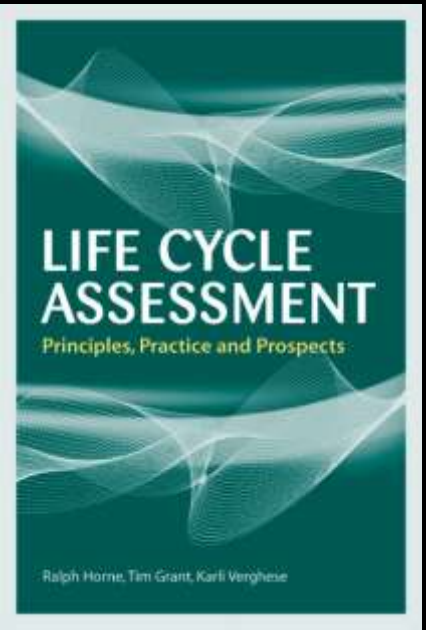


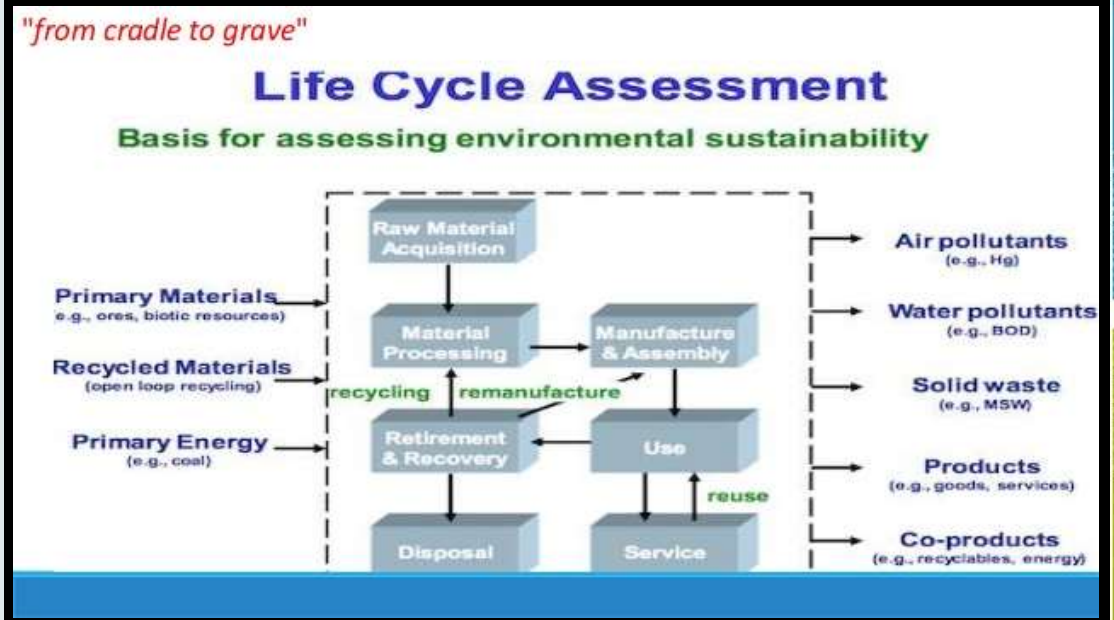


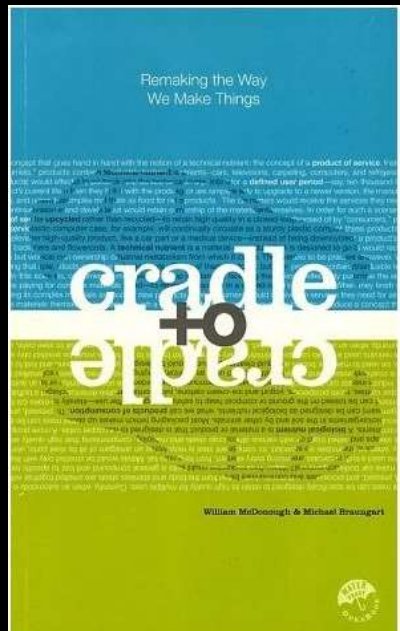




Measuring and Mimicking Natural Cycles







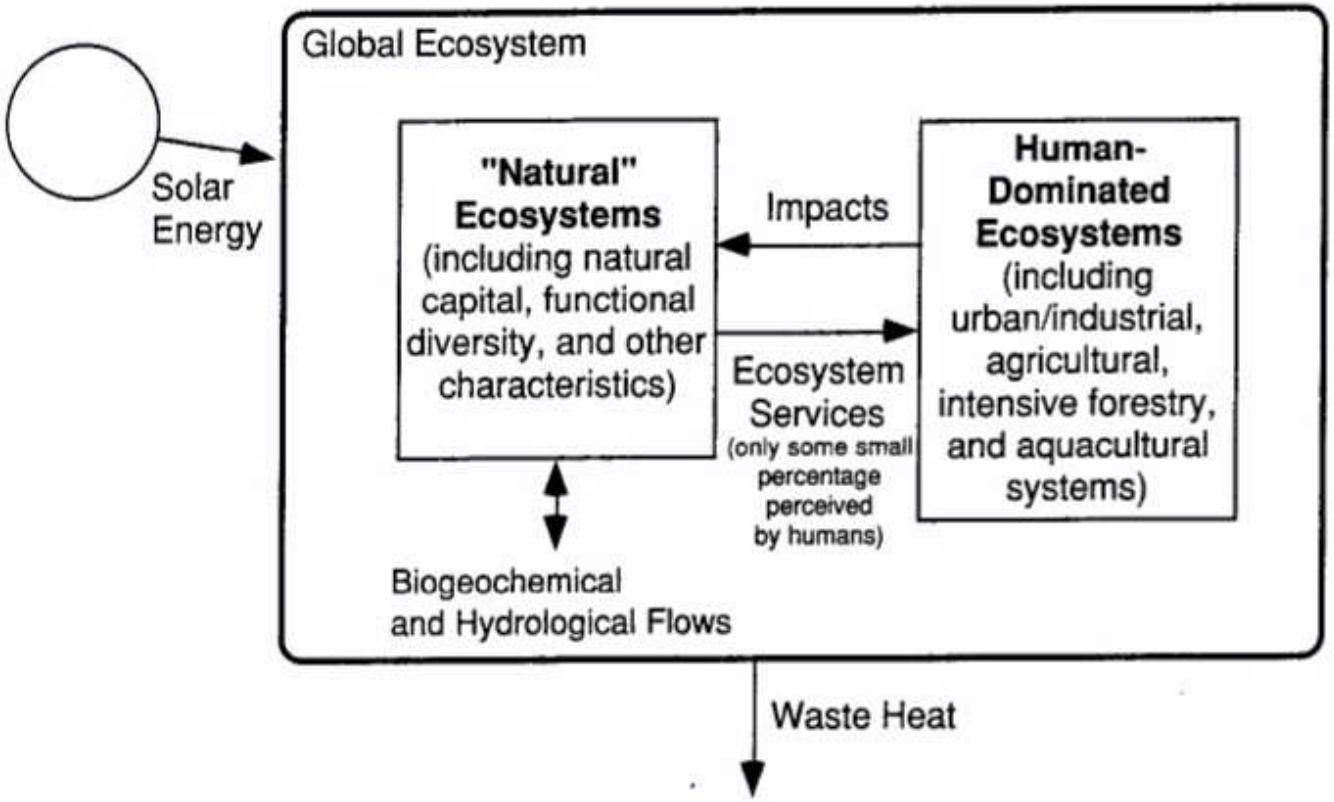
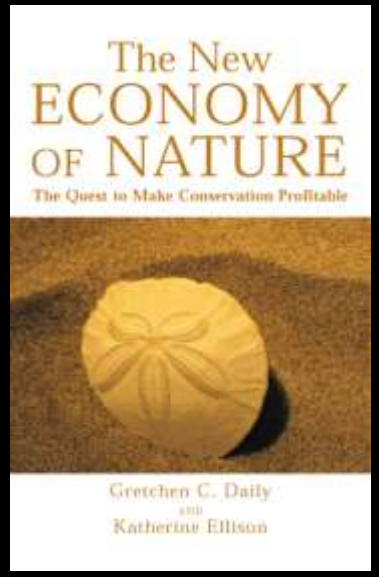


Figure 4.1. Human-dominated ecosystems are parts of the overall global system. Ecosystem services are essential for the development and well-being of human society, but only a fraction of this work is covered by market prices or perceived by humans.

From Daily, *Nature's Services* 1997



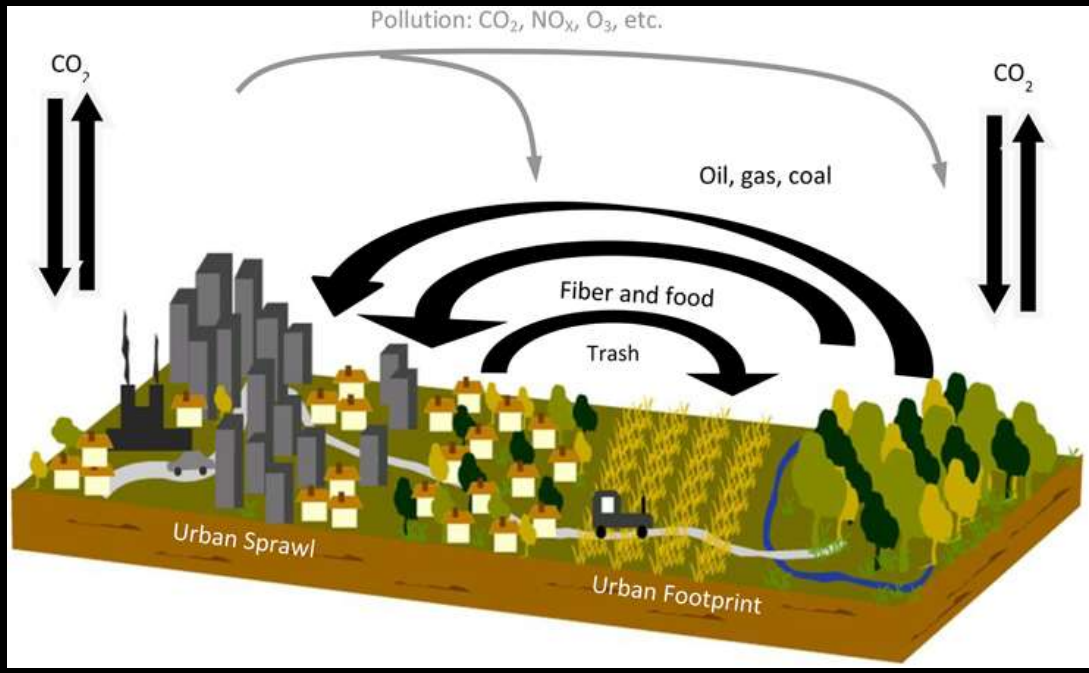
What Nature does (for humans)

Ecosystem Services - Socioecological Systems and Human-Nature Symbiosis

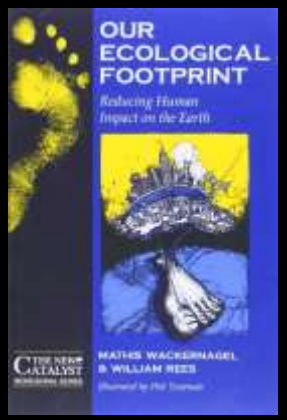
What Nature Does - Ecosystem Cycles and Services

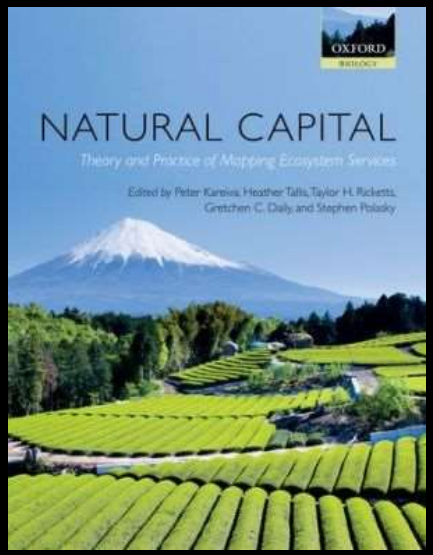
Mimic What Nature Does

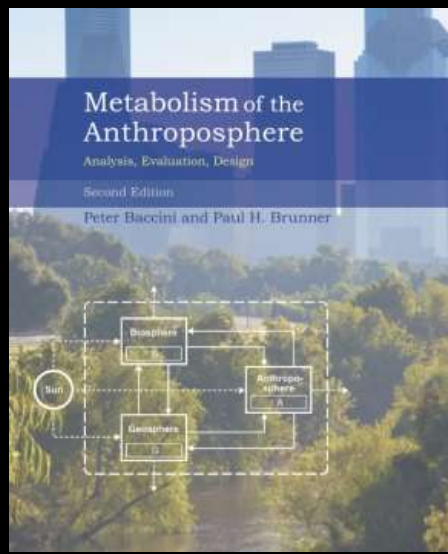
Sustainability = Balance



- ✓ Maintenance of atmosphere
- ✓ Protection from ultraviolet rays
- ✓ Regulation of climate
- ✓ Maintenance of genetic diversity
- ✓ Purification of air and water
- ✓ Detoxification and decomposition of wastes
- ✓ Generation of soil and renewal of soil fertility
- ✓ Pollination of vegetation
- ✓ Control of agricultural pests
- ✓ Dispersal of seeds
- ✓ Translocation of nutrients







The Sustainability Concept - To Live in Balance with Nature

Stability over Time

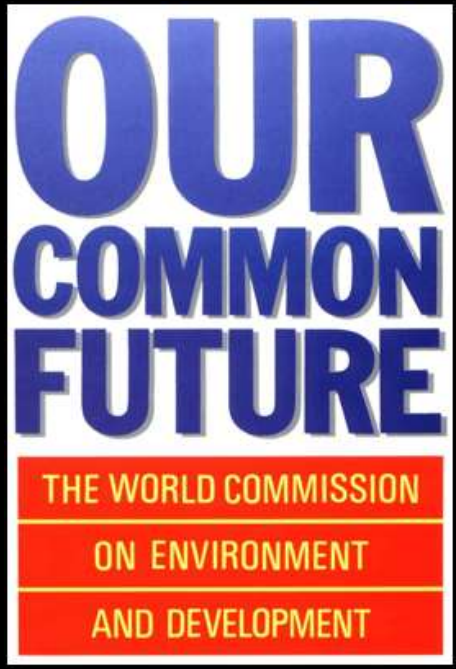
Environment - Economy - Equity

Sustainability – Equilibrium - maintaining a stable state

Our Common Future, also known as the *Brundtland Report*, from th United Nations World Commission on Environment and Developme was published in 1987.

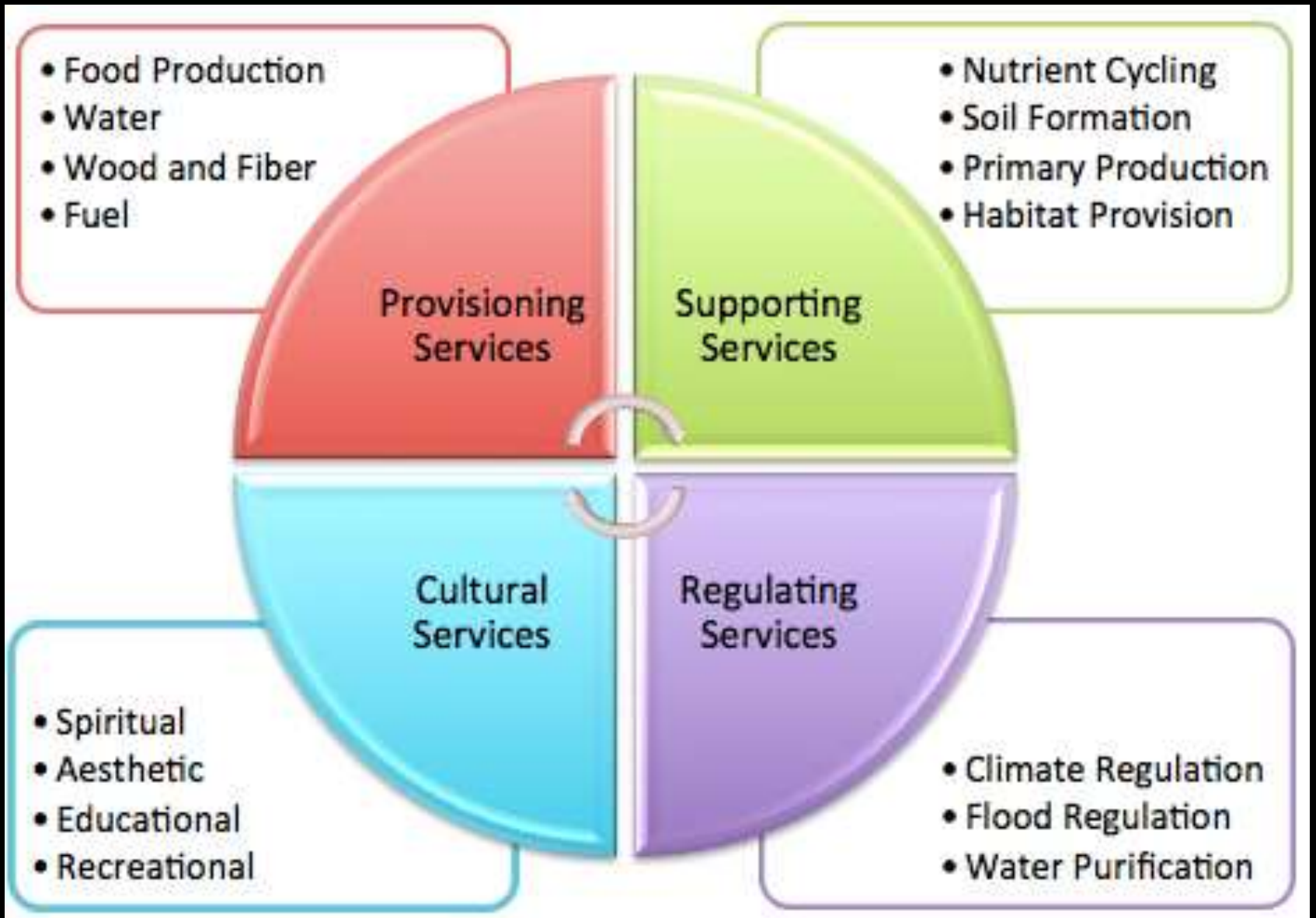
Sustainable development is defined in the report as:

"development that meets the needs of the present without compromising the ability of future generations to meet their own needs."



Sustainability – To Live in Balance with Nature – Stability over Time

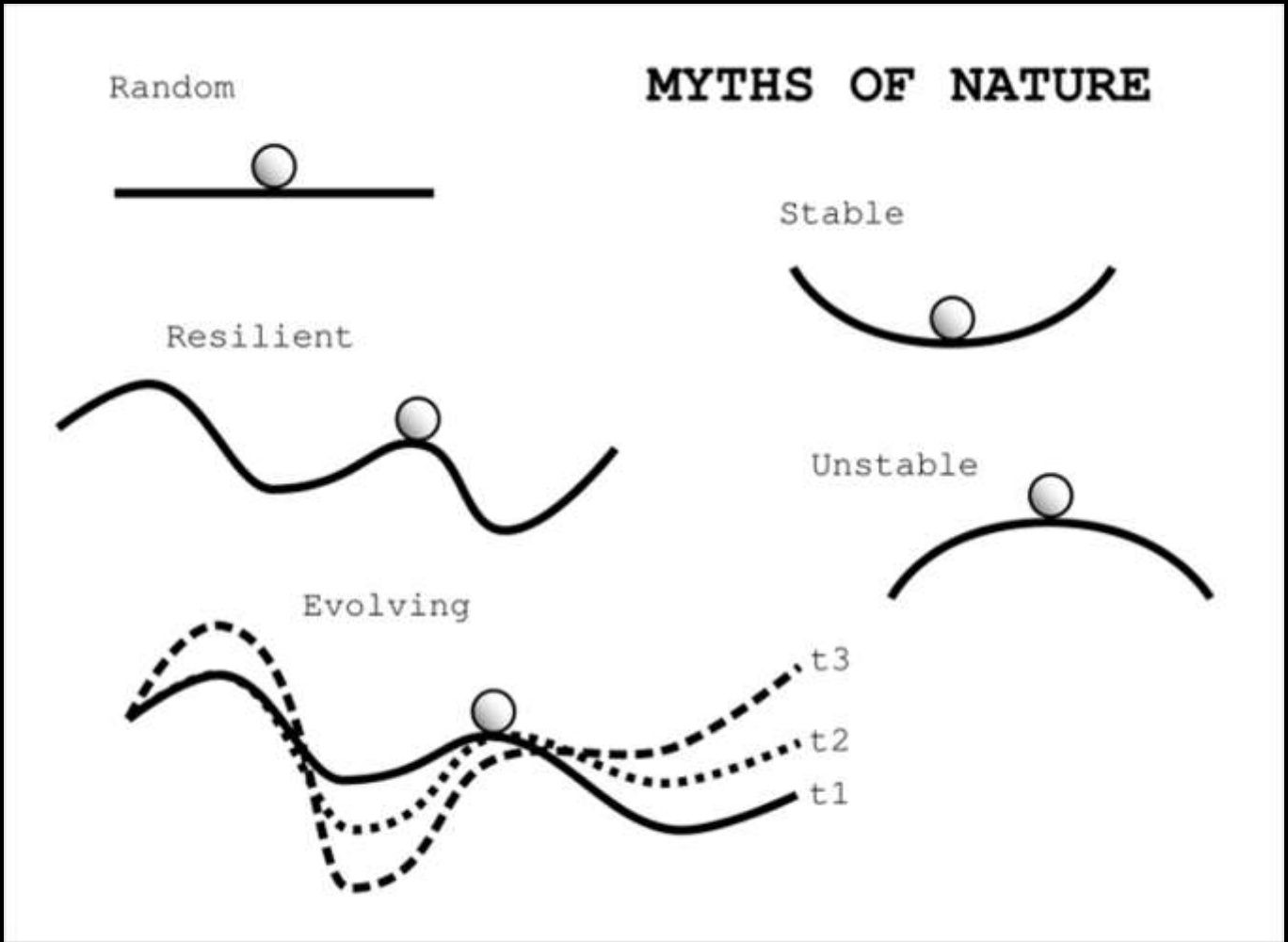
How Nature Works?



Source: Millenium Ecosystem Assessment, 2005.

The New Ecology
How does Nature work?
What It Does? Balance? Stability?

A Brief History of the Science of Ecology



Harmony vs. Disharmony

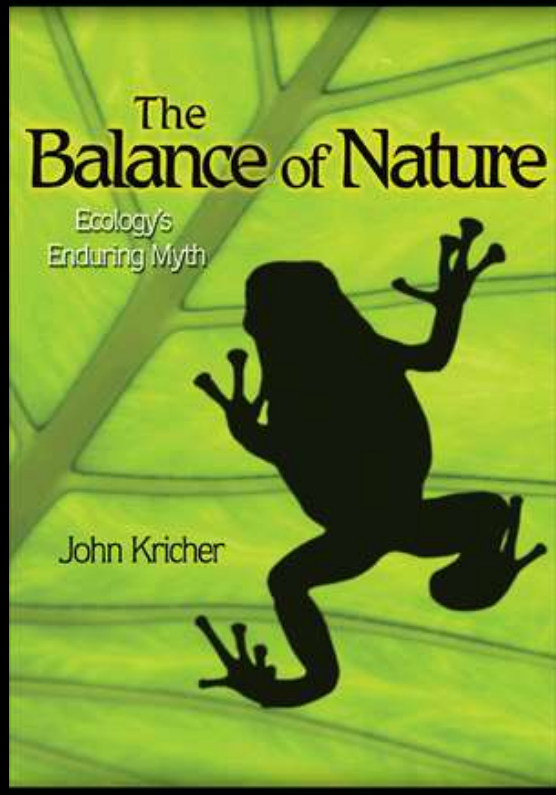
"The existence of a balance of nature has been a dominant part of Western philosophy since before Aristotle.

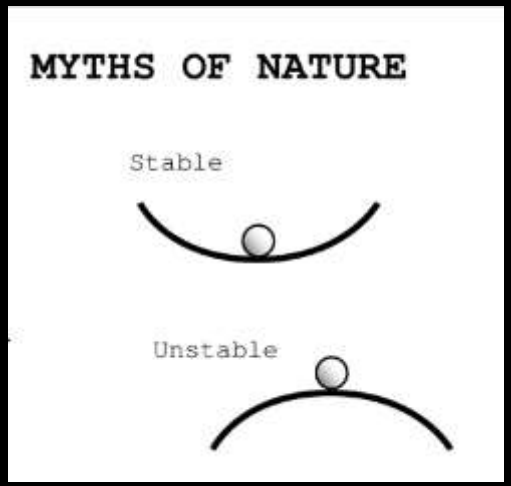
But the science of ecology and evolutionary biology together demonstrate that there is no balance of nature—not today and not at anytime in Earth's long history.

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."

The Balance of Nature: Ecology's Enduring Myth 2009
John Kricher





How Does Nature Work?
The New Ecology - No inherent stability

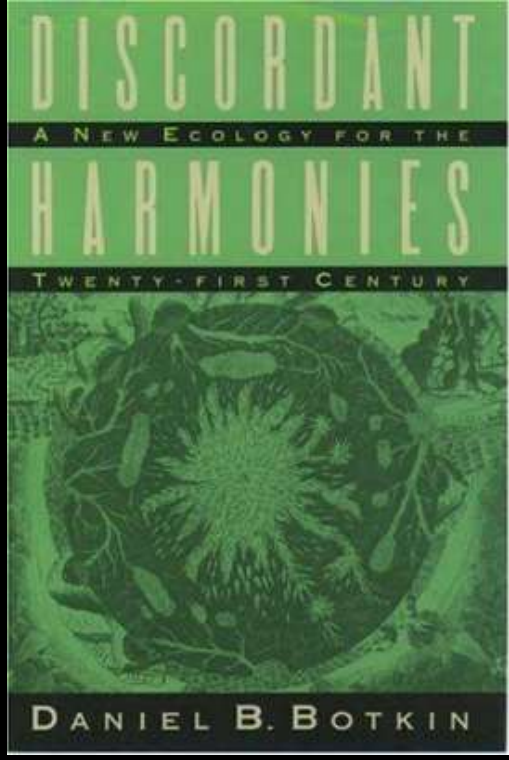
The new ecology emphasizes

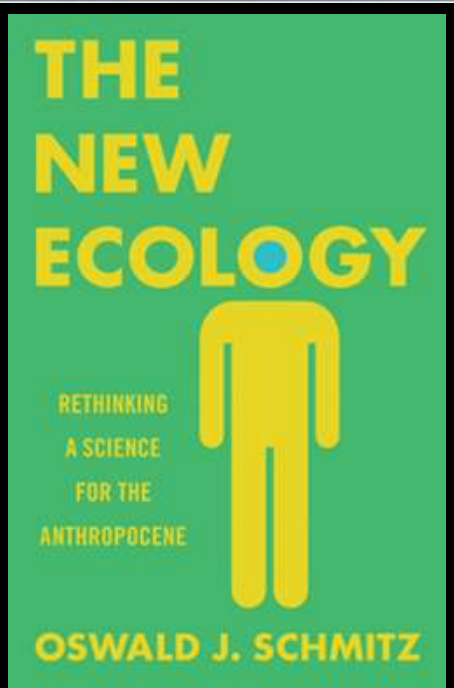
- Disequilibria
- Instability
- Chaotic fluctuations

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

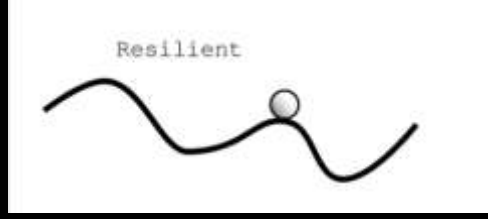
"Clearly, to abandon a belief in the constancy of undisturbed nature is psychologically uncomfortable…The way to achieve a harmony with nature is first to break free of old metaphors and embrace new ones so that we can lift the veils that prevent us from accepting what we observe, and then to make use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

– Daniel Botkin 1990





The New Ecology of Change - Ecological Resilience

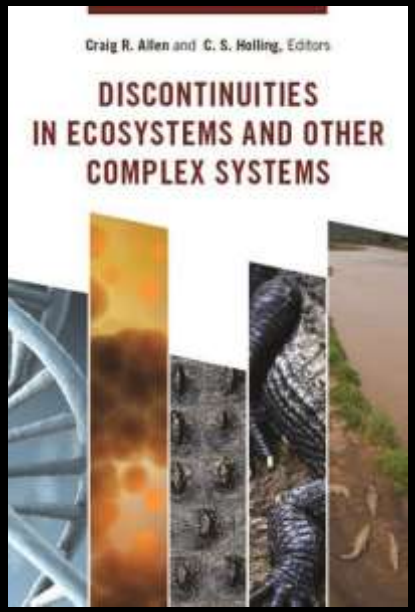


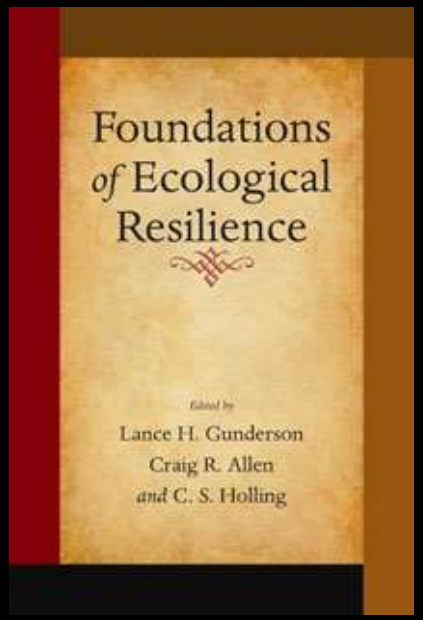
Balance vs. Disequilibrium
Permanence vs. Change

"to discern the constancy of phenomena in the midst of apparent changes."

- 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.
- 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.

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





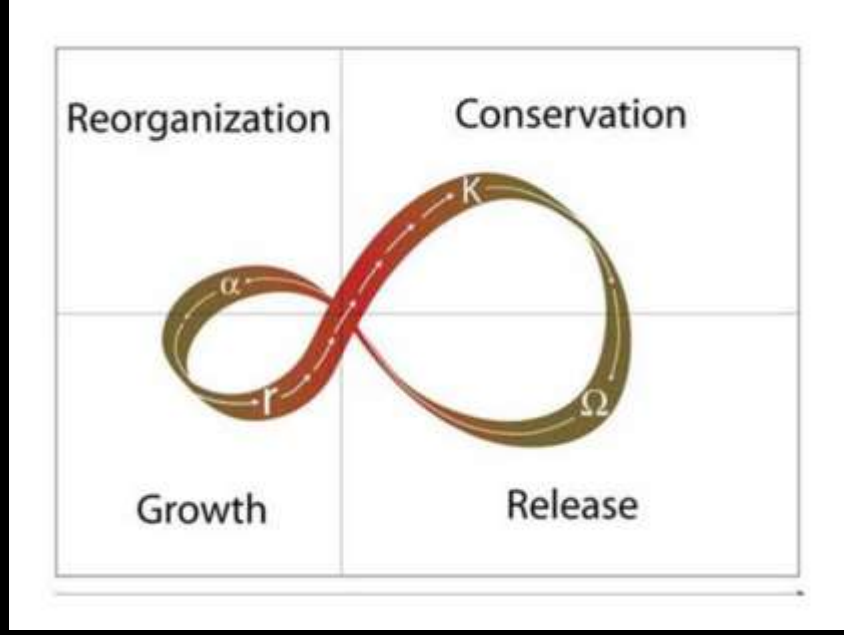
Structured Change – The Adaptive Cycle

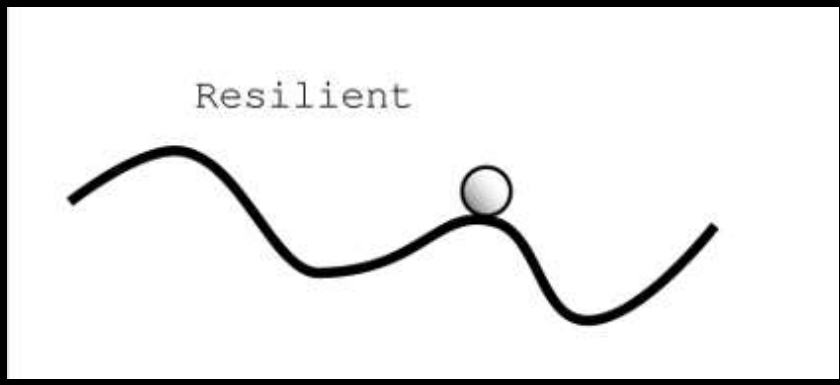
<u>Growth</u> - where species and systems grow and diversify to exploit new opportunities and develop entirely new ecological ways of being.

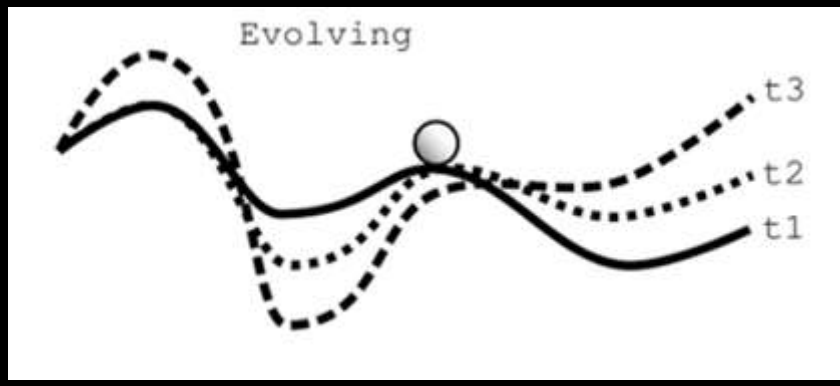
<u>Conservation</u> - where climax species are tightly connected and organized, and systems stabilize into mature, often hierarchically nested systems, where there is little or no room for innovation or growth.

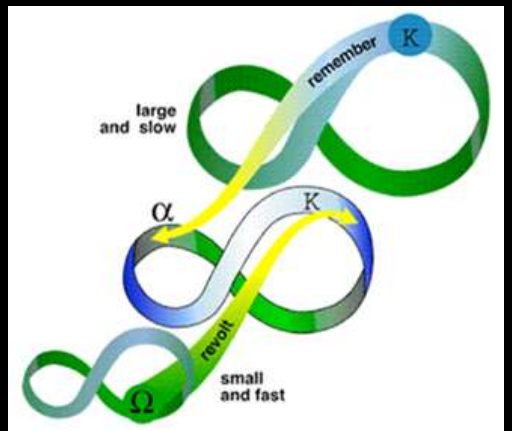
<u>Release</u> (the "backside" of the mobius strip) - where mature systems destabilize and collapse, and become increasingly discontinuous and chaotic which opens the field for…

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





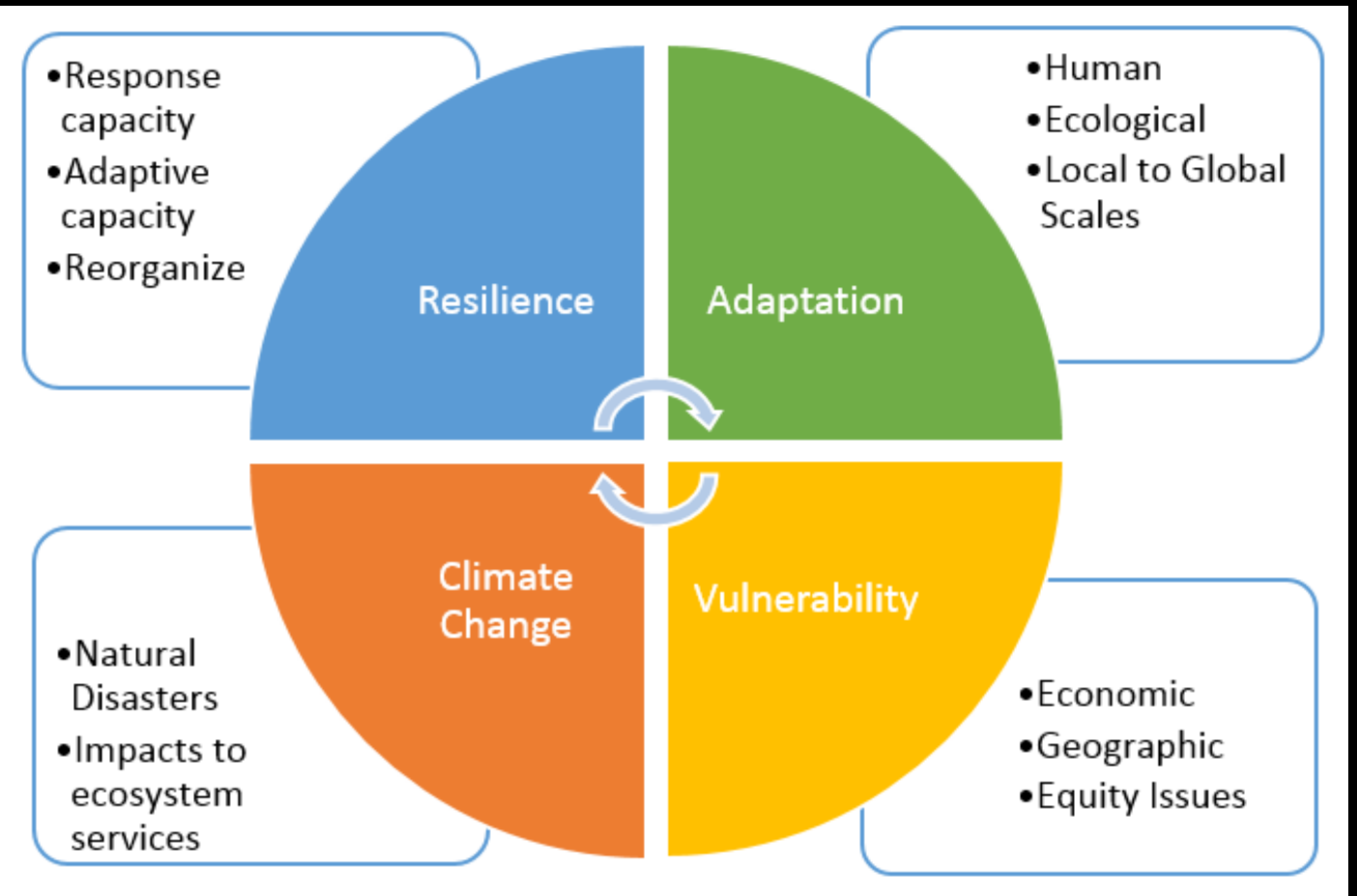


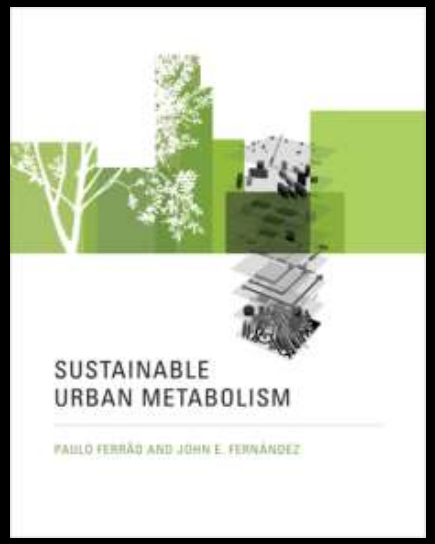


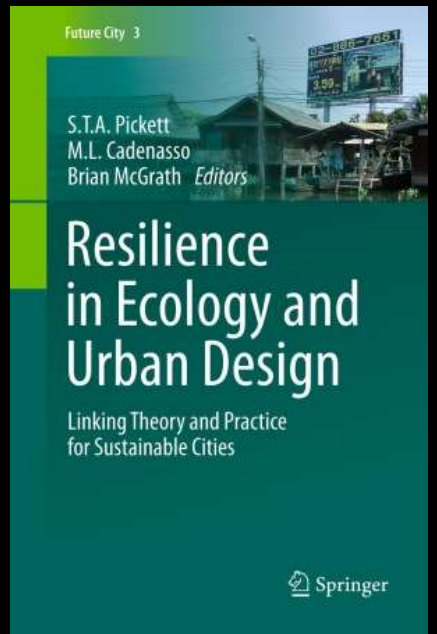
Resilience and Urban Metabolism – Homeostasis

The characterization of flows and the relationships between anthropogenic urban activities and natural processes and cycles defines the behavior of urban production and consumption.

Homeostasis - Self-regulating process by which biological systems tend to maintain stability while adjusting to conditions that are optimal for survival.





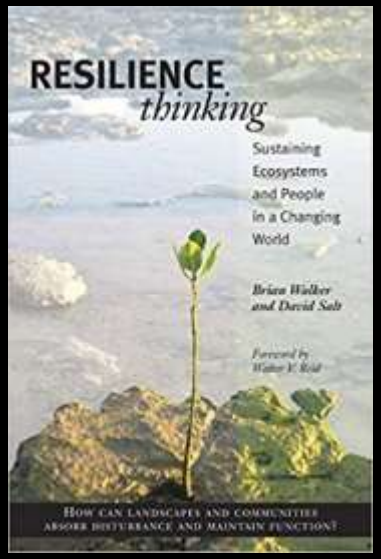


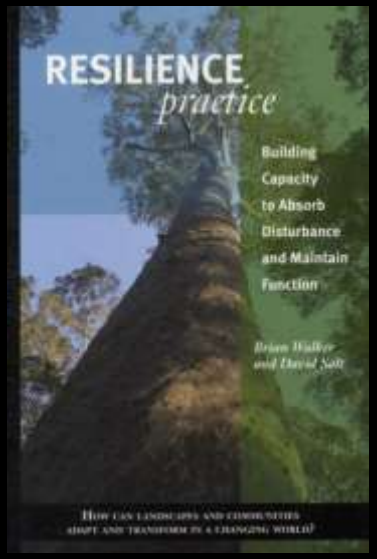
Resilience, the Ecological City, and Socio-Ecological Systems

We define resilience, formally, as the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure and feedbacks - and therefore the same identity.

The basic concepts are:

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





http://www.resalliance.org

Resilience Alliance

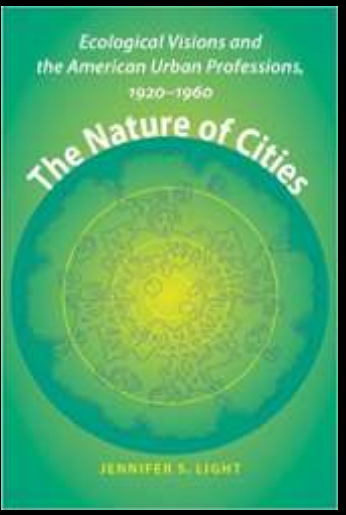
research on resilience in social-ecological systems - a basis for sustainability

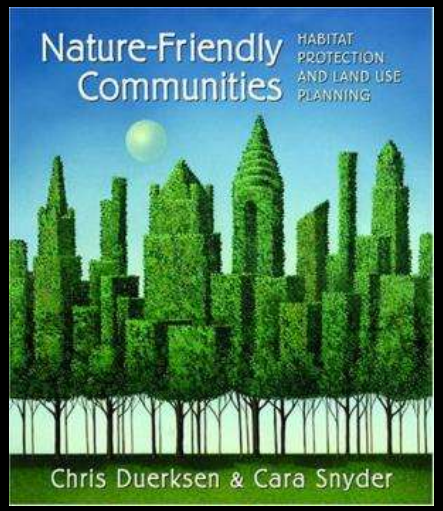
New Narrative of Urban Nature and the Ecological City?
Redemptive? Restorative? Other?
Urban Design, Management, and Science

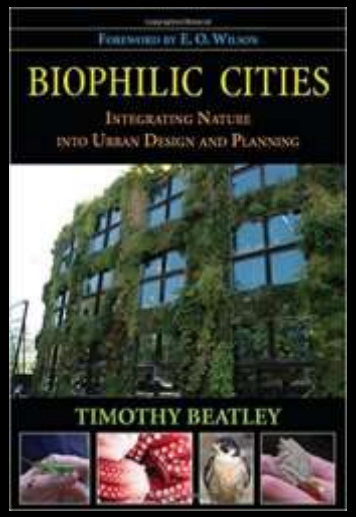
The Nature of Cities is a "boundary organization" interested in ideas at the frontiers of science, design, policy, and the arts — an idea hive that puts different approaches and points of view together, to discover what novel perspectives might emerge.

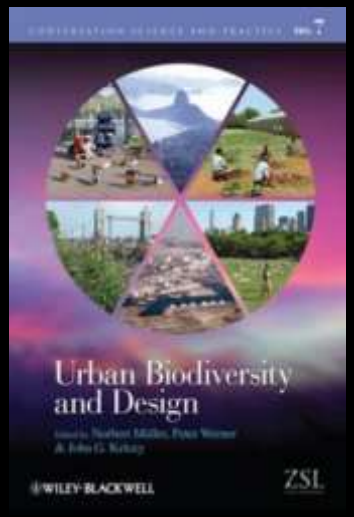
a virtual magazine and discussion site

https://www.thenatureofcities.com/







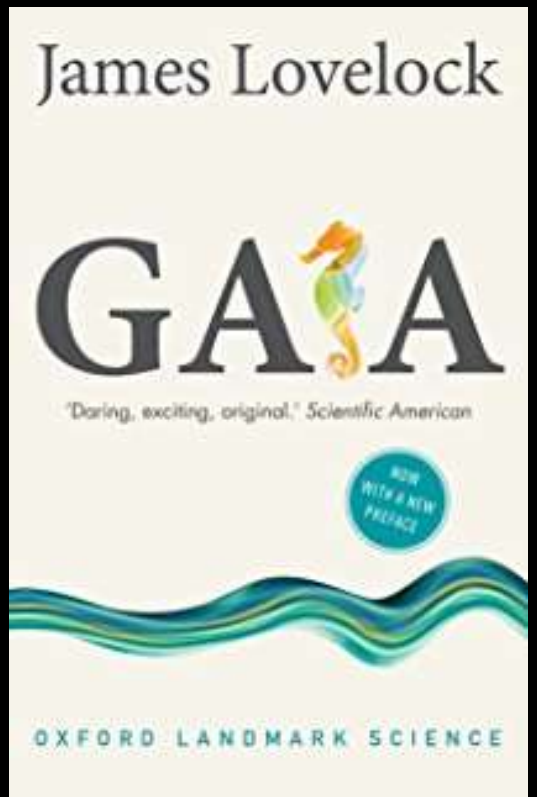


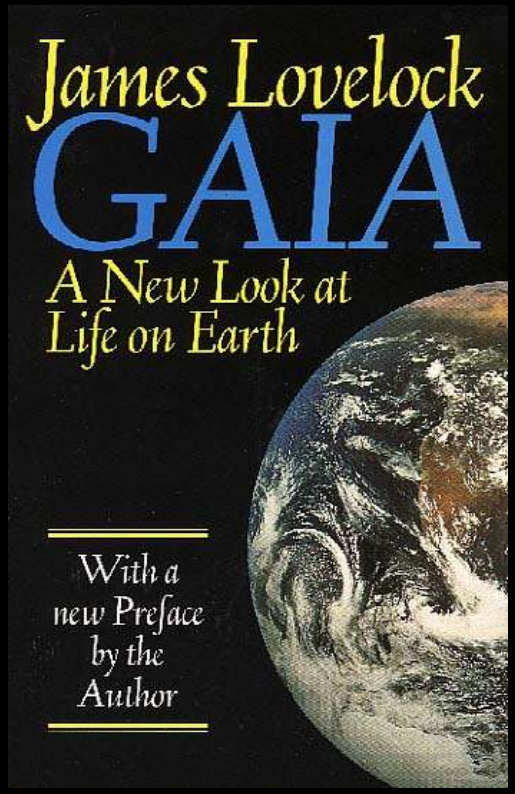
Sustainability and New Myths of Nature
Gaia – James Lovelock

Nature - What it is, does, means…how it works

James Lovelock's Gaia hypothesis – Homeostasis

– that the biosphere acts like a living organism, one that self-regulates to keep conditions just right for life





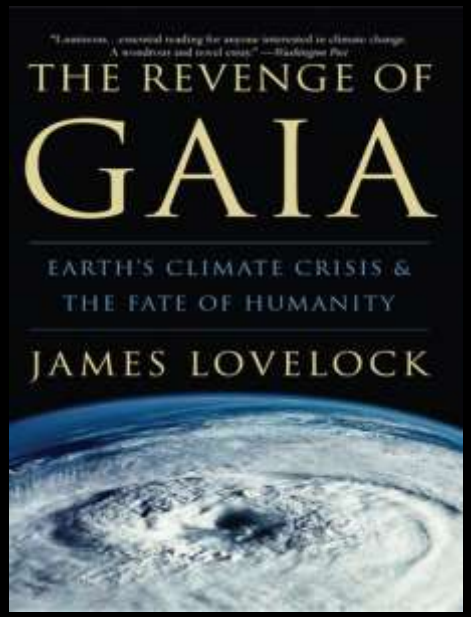
Sustainable Retreat

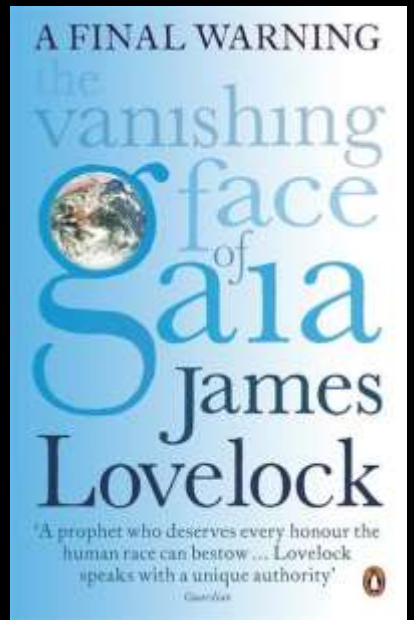
The Revenge of Gaia – James Lovelock

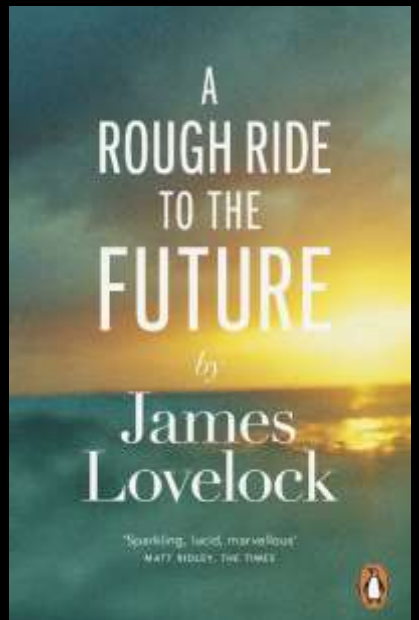
Lovelock thinks the time is past for sustainable development, and that we have come to a time when development is no longer sustainable. Therefore, we need to retreat.

"Retreat means it's time to start talking about changing where we live and how we get our food; about making plans for the migration of millions of people from low-lying regions like Bangladesh into Europe; about admitting that New Orleans is a goner and moving the people to cities better positioned for the future. Most of all, he says, it's about everybody 'absolutely doing their utmost to sustain civilization, so that it doesn't degenerate into Dark Ages, with warlords running things, which is a real danger. We could lose everything that way.'"

The concept of sustainable retreat emphasized a pattern of resource use that aims to meet human needs with lower levels and/or less environmentally harmful types of resources.







The Ecological City

- Nature and Culture
- Socioecological
- Sustainable?

Urban Nature

- What it is
- Where it is
- What it does
- What it means

Narratives of Urban Nature

- Redemptive
- Restorative
- Functional