



**Novel Ecosystems:
Hope or Hype?
- New Thinking -**

**Association of State Wetland Managers
November 19, 2015**

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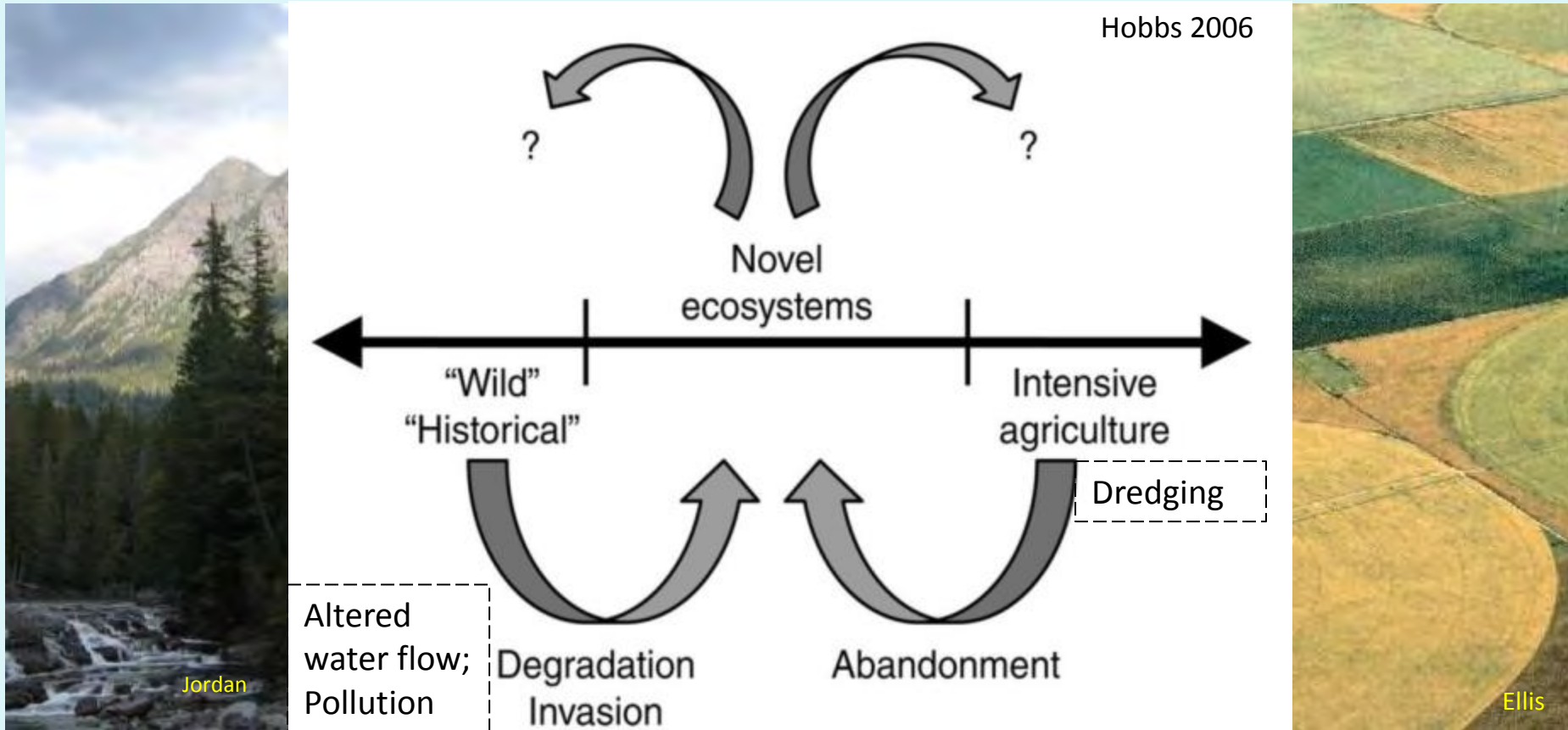
What are novel (no analog/emerging) ecosystems?

- ❖ New species combinations (introduced/alien).
- ❖ Result from deliberate/inadvertent human actions.
- ❖ Need no human management to persist (and typically are not managed).
- ❖ Includes all ecosystems at all scales: terrestrial, fresh water, estuarine, and marine.

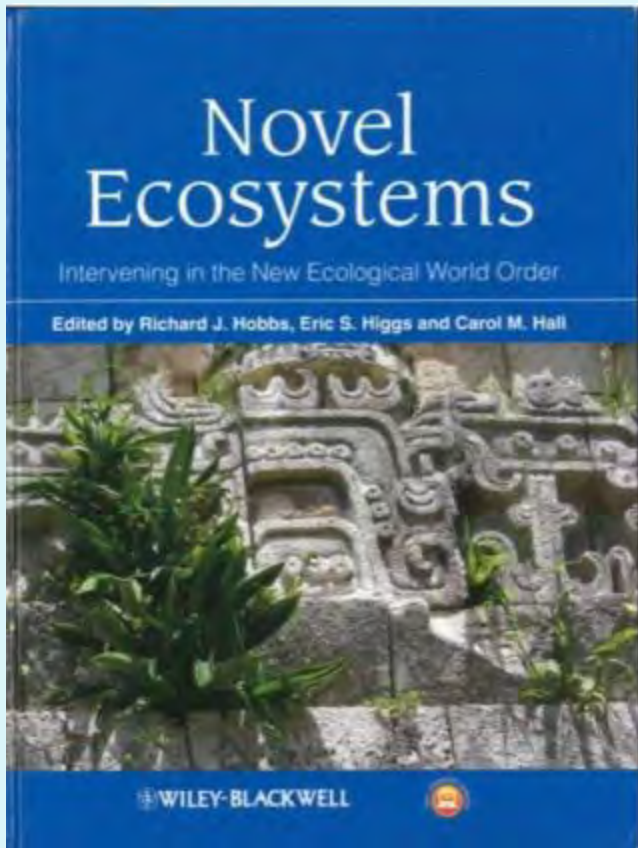
None of the species in this image are native

Novel ecosystem are created by changes in:

- (1) Species: invasion/extinction/degradation
- (2) Terrestrial, aquatic & wetland ecosystems (by human agency)
- (3) Global processes: climate, oceanic and atmospheric chemistry



New thinking about novel ecosystems



Hobbs, Higgs and Hall. 2013.
Novel Ecosystems: Intervening
in the New Ecological World
Order. Wiley-Blackwell ISBN



Richard Hobbs

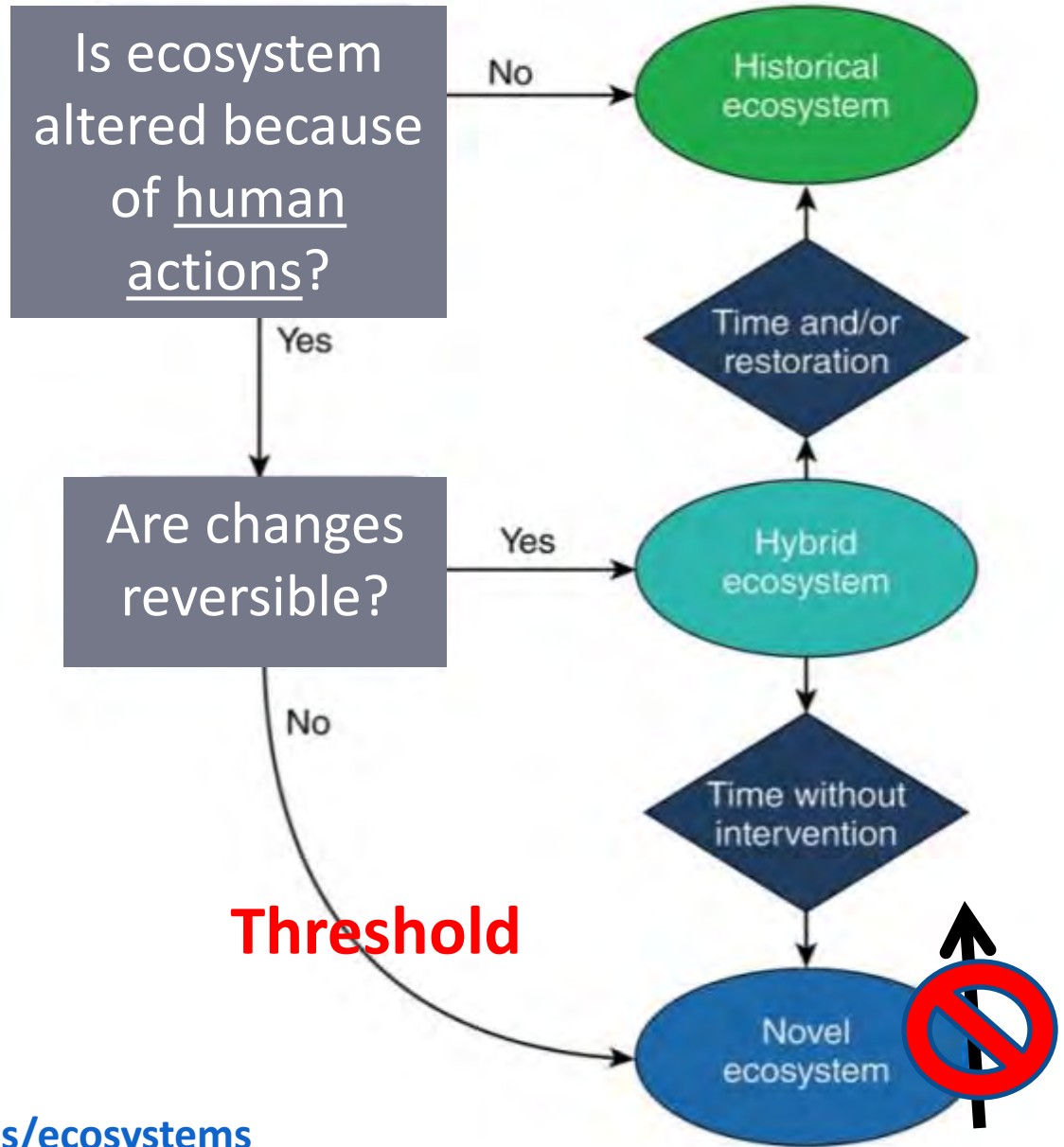
New:

- 1. Different** from historic ecosystems.
- 2. Includes social components** (e.g. values, regulations, funding, land ownership, technical knowledge).
- 3. Thresholds** (ecological, environmental & social) distinguish novel from hybrid ecosystems.

<http://www.wiley.com/go/hobbs/ecosystems>

Access to tools and resources

How to identify a novel ecosystem



Harris, Mascaro, Murphy and Nelson: Chapter 6 in Hobbs et al. 2013. Novel Ecosystems: Intervening in the New Ecological World Order. Wiley-Blackwell ISBN

<http://www.wiley.com/go/hobbs/ecosystems>

Ecosystem alterations and degradation:

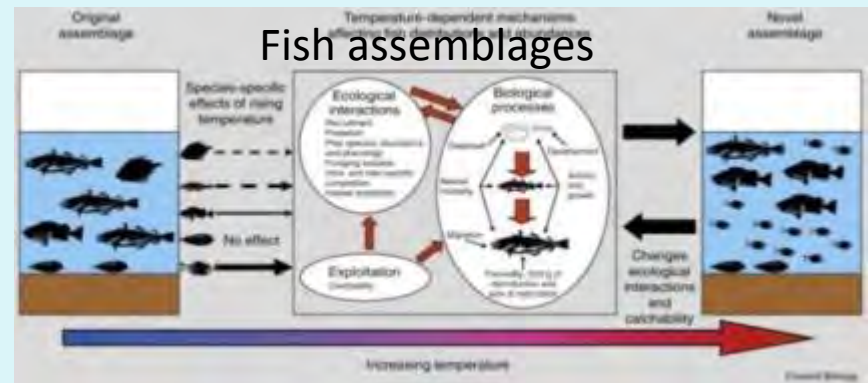
- Abandoned agricultural/cleared lands
- Pollution / excess nitrogen fertilization
- Overharvesting (e.g. clearcuts, overfishing)
- Dispersal barriers (fragmentation)
- Invasive species introductions / lost natives
- Forest pests & pathogens [Invasive species]*
- **Predator removal /excessive deer browse***

Global change:

- Climate change
- Ocean acidification

*Poorly recognized
but important
creators of novel
ecosystems

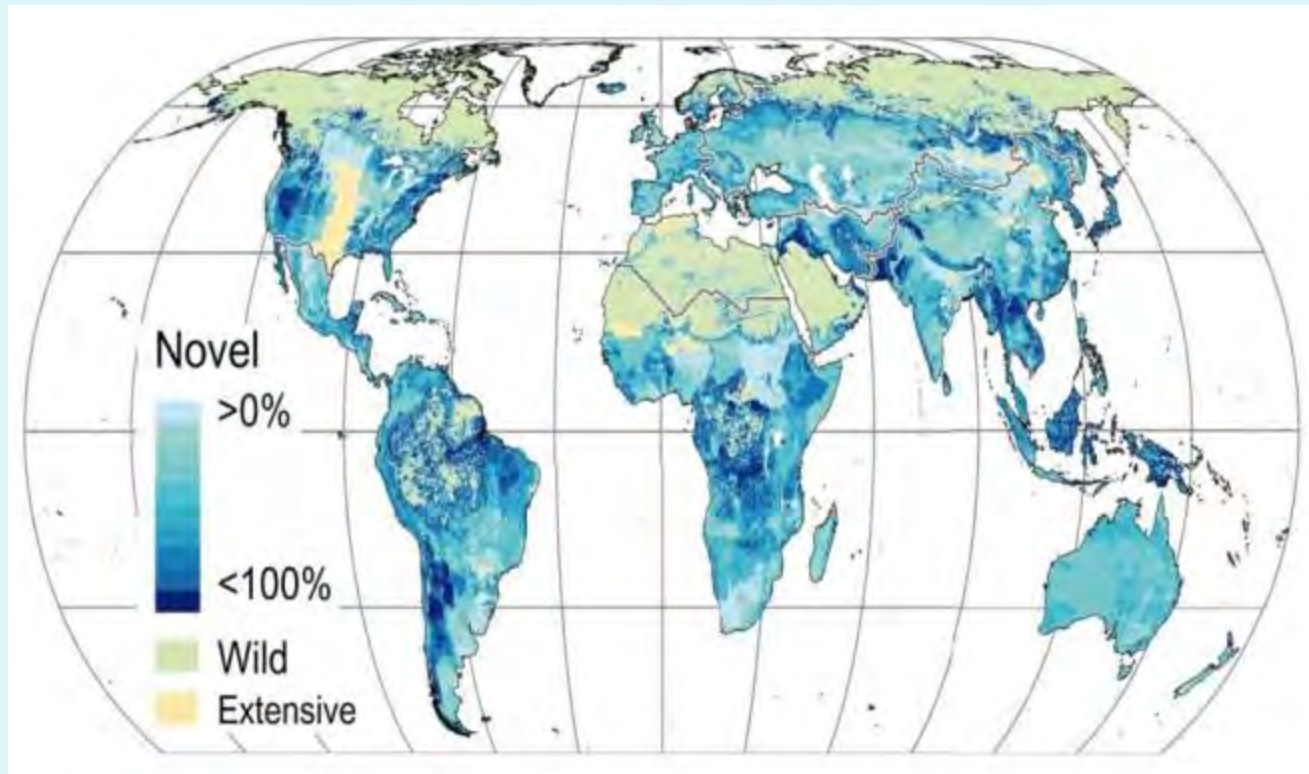
Examples of novel ecosystems



Ellis' definition of novel ecosystems:

Unused lands embedded within settlements, croplands, rangelands and seminatural anthromes:

- They cover ~37% of the ice-free terrestrial globe.
- “Used” + “Seminatural” >75%



Ellis et al. 2010. Anthropogenic transformation of the biomes, 1700 to 2000. *Global Ecology & Biogeography*. Univ. MD, Anthropogenic Landscape Ecology

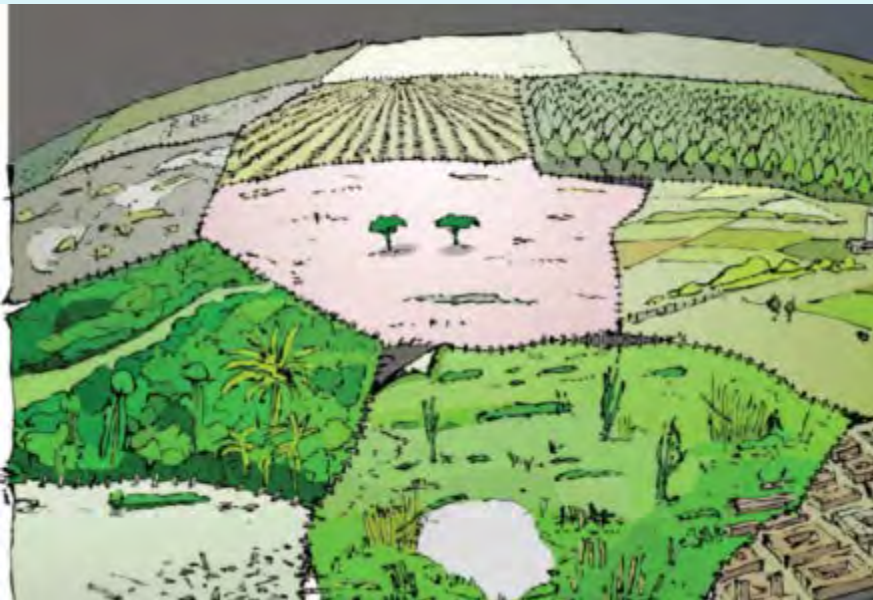
Age of the Anthropocene

The **Anthropocene** is a proposed geologic chronological term for an epoch that begins when human activities have had a significant global impact on the Earth's ecosystems.

Viewing the biosphere as “natural ecosystems with humans disturbing them” is outdated. Anthropogenic biomes tell a completely different story, one of “human systems, with natural ecosystems embedded within them” (Ellis and Ramankutty 2008).

Global transportation system
www.globala.org

As though working through the five stages of grief, more and more ecologists are reluctantly accepting that we live in a **human-dominated world**. And some are discovering that patchwork ecosystems might even **rival their pristine counterparts**.



Marris, E. 2009. Ragamuffin Earth. *Nature News Feature* Vol 460, p. 450-453



Marris. 2010. The New Normal. *Conservation Magazine* 11(2):12-17

Identical articles

Novel Ecosystems: hope or hype?

Scrubby, untended, feral, worthless weed patches?

- OR -

Valuable **functional** habitats?

Rival “pristine” counterparts?

Producers of **ecosystem services** for people?

Ecosystem Processes/Functions

Processes: flow of energy and materials.

Functions: Interactions of species & processes

- Primary production
(photosynthesis)/Carbon storage
- Nutrient & carbon cycling / maintain soil fertility
- Decomposition / maintains cycling
- Water uptake by plants / regulates water regimes

Ecosystem services

Ecosystem processes and functions that **benefit people**

Provisioning

- Food production
- Pollination
- Clean water and air
- Maintain soil fertility
- Timber

Supporting

- Primary productivity
- Soil formation
- Nutrient cycling

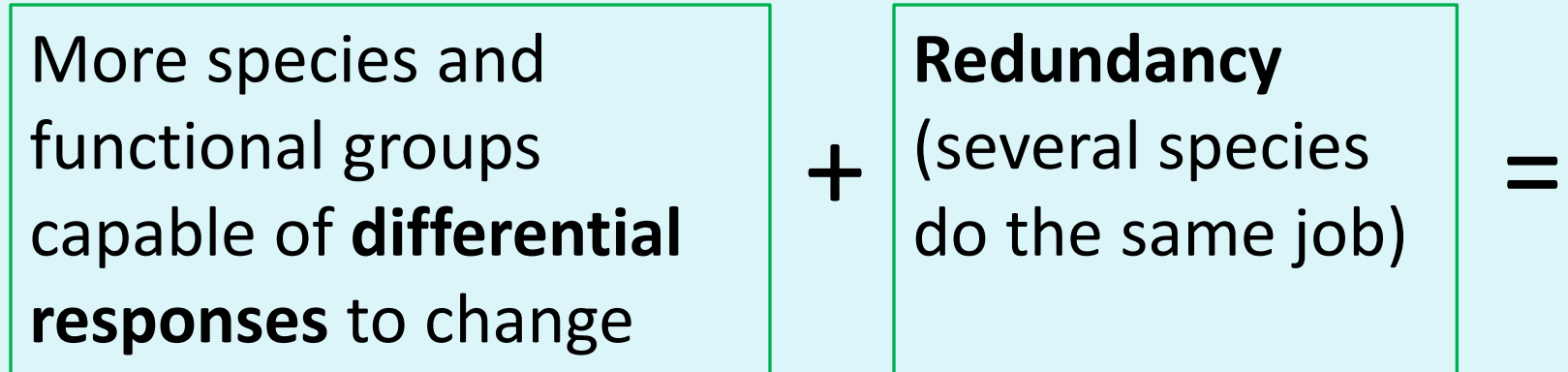
Regulatory

- Contribute to climate stability
- Flood control
- Disease control

Cultural

- Support human health (physical and mental)
- Recreation
- Esthetics

Ecosystem functions and services depend on high (native) biodiversity



Oscillations are damped = Greater ecosystem resilience and adaptability to disturbance
i.e. “the insurance effect.”

But – Field tests at scale of food webs and ecosystems are few.

Effects of invasive plant species on:

- Biodiversity
- Ecosystem processes & services
- Food webs



Implications for the functioning
of novel ecosystems?

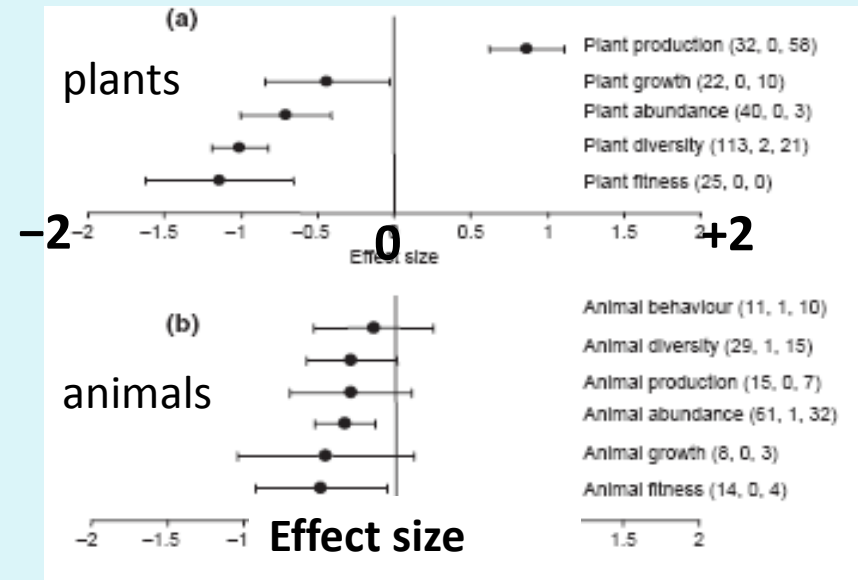
Effects of invasive alien plants on native SPECIES and COMMUNITIES (meta-analysis)

DECREASES

- **ABUNDANCE** (number) of native plant and animal species.
- **DIVERSITY** of native plant and animal species.
- **PRODUCTION** of native plant and animal species.
- **ANIMAL GROWTH/FITNESS.**
- **ANIMAL BEHAVIOR.**
- **DECOMPOSITION**
- **pH:** Soil becomes more acidic.

INCREASES

- **TOTAL PLANT PRODUCTION** of invaded COMMUNITY (sometimes with a strong invader).



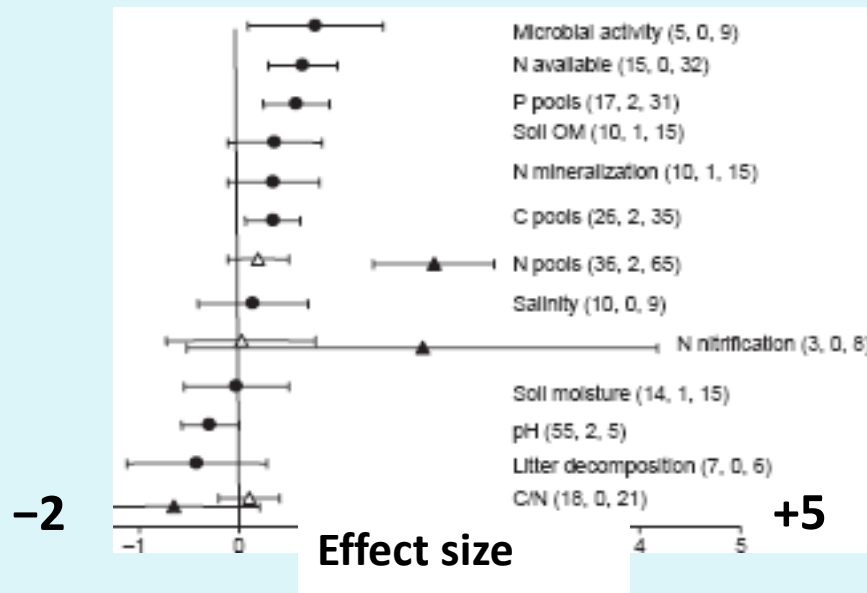
Effects of invasive alien plant species on ECOSYSTEM FUNCTION (meta-analyses)

DECREASES

INCREASES

- **DECOMPOSITION**
- **LIGHT AVAILABILITY** (tall invaders)
- **pH**: Soil becomes more acidic

- **NITROGEN & PHOSPHORUS** cycling
- **MICROBIAL** activity.
- **CARBON** pools in soil.



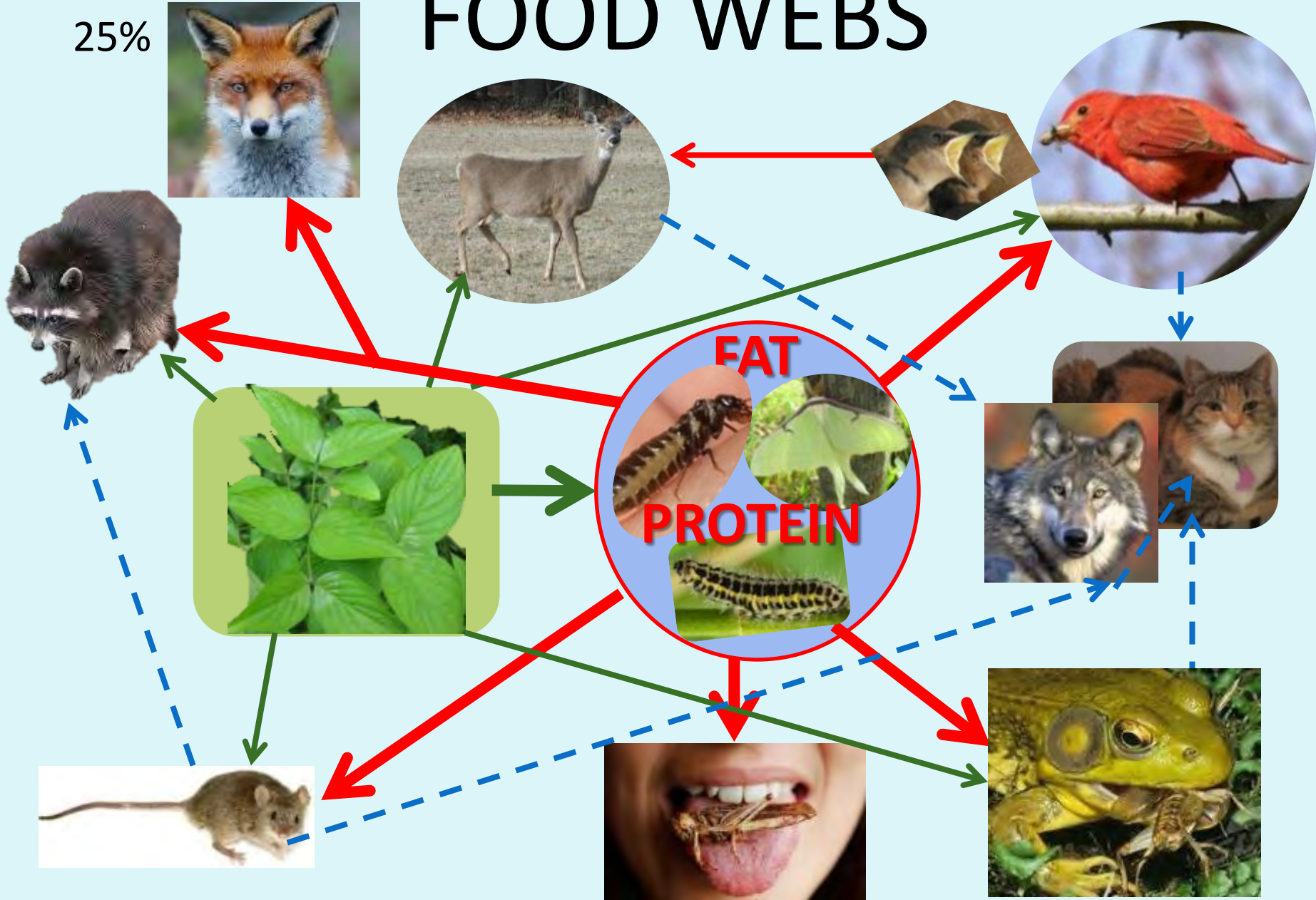
Vila et al. 2011. Ecological impacts.... meta-analysis. Ecology Letters
Cardinale et al. 2006. The functional role of primary producer diversity... Am.J.Bot 98

A close-up photograph of a yellow and black spider on its web. The spider has a yellow abdomen with black spots and black legs with yellow bands. It is positioned in the center of the frame, facing away from the viewer. The web is made of fine, white threads and is set against a background of green foliage. The text "How do nonnative plants affect insects and food Webs?" is overlaid in yellow at the bottom of the image.

How do nonnative plants
affect insects and food Webs?

FOOD WEBS

25%



Real Paleo Diet

Many insect species – even generalists – are able to eat relatively few plant species



COMMON SECONDARY METABOLIC COMPOUNDS FOUND IN THE LEAVES OF PLANTS

| Chemical Class | Plant Sources |
|--------------------|--|
| <i>Glycosides</i> | |
| cyanide glycosides | almonds, cassava, lima beans |
| iridoid glycosides | <i>Plantago</i> , <i>Lagochilus</i> , <i>Incarvillea</i> |
| cardenolides | milkweeds, <i>Isoplexis</i> , <i>Digitalis</i> |
| glucosinolates | broccoli, cauliflower, rapeseed |
| <i>Phenols</i> | |
| coumarins | Tonka bean, lavender, licorice |
| tannins | oaks, beech, hickory |
| lignins | grasses |
| <i>Terpenes</i> | |
| cucurbitacins | cucurbits, candytuft |
| limonoids | neem, <i>Carapa</i> |
| saponins | yucca, daisies, horse chestnut |
| <i>Alkaloids</i> | |
| benzylisoquinoline | poppy, <i>Colchicum</i> |
| pyrrolizidine | composites, legumes |
| quinolizidine | <i>Lupinus</i> , <i>Nicotiana</i> , <i>Conium</i> |
| nicotine | tobacco, eggplant, tomato |

Douglas Tallamy. 2007. Bringing Nature Home. Timber Press

Moth & butterfly species – even generalists – are able to eat relatively few plant species



Liquidambar styraciflua
(sweetgum)



J.S. Peterson

USDA-NRCS

Luna moth caterpillar

Luna moth
Jordan

Asclepias syriaca



Russell. Smithsonian



Monarch butterflies needs native milkweeds

Forest vegetation “...is not a banquet waiting for the guests to arrive — but a Devil’s buffet of poisoned plates from which the herbivores snatch the least deadly morsels.” David Haskell 2012. *The Forest Unseen*.

Alien ornamentals support 29 times less biodiversity than native ornamentals

Similar results are expected for other insect groups

| Genus | Common Name | Native Lep spp |
|----------------------------|---|----------------|
| NATIVE: Top 5 | | |
| <i>Quercus</i> | oak | 518 |
| <i>Prunus</i> | beach plum, cherry, chokecherry, peach, | 429 |
| <i>Salix</i> | willow | 440 |
| <i>Betula</i> | birch | 400 |
| <i>Populus</i> | aspen, cottonwood, poplar | 358 |
| NON-NATIVE (Top 5) | | |
| <i>Pyrus</i> | pear (native species mixed in?) | 119 |
| <i>Physocarpus</i> | ninebark | 40 |
| <i>Syringa</i> | lilac | 35 |
| <i>Cydonia</i> | quince | 21 |
| <i>Ligustrum</i> | privet | 19 |
| NON-NATIVE (common) | | |
| <i>Elaeagnus</i> | autumn olive, Russian olive, thorny olive | 8 |
| <i>Morus</i> | mulberry | 6 |
| <i>Ailanthus</i> | ailanthus, tree of heaven | 4 |
| <i>Ginkgo</i> | maidenhair | 4 |
| <i>Lagerstroemia</i> | crapemyrtle | 3 |

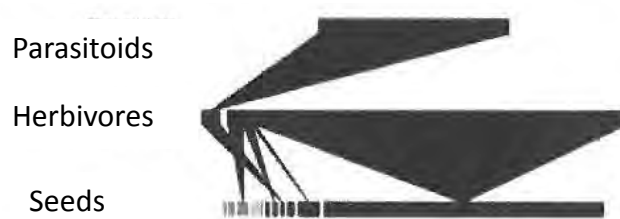


<http://www.bringingnaturehome.net/>

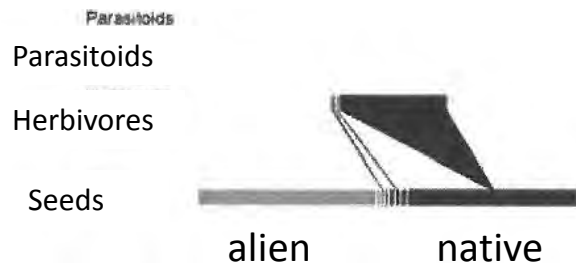
Tallamy & Shropshire. 2009. Conservation Biology 23(4): 941-947

Replacement of native plants with non-native ornamentals results in significant bottom-up reductions of energy available for seed predation food webs.

(a) Native plot 4.7% alien seeds



(b) Partially invaded plot 50% alien seeds



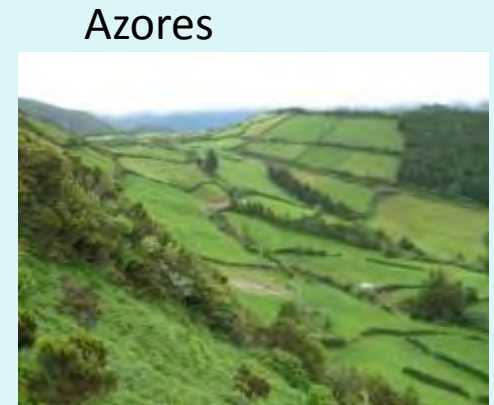
(c) Highly invaded plot 99% alien seeds



SEED EATING INSECT FOOD WEBS from plots with different levels of alien plant invasion.

- Each vertical bar = one species of plant.
- Area of triangles = relative number of insect species attacking lower level.

67% of insect biomass in seed-predation food webs will be lost if native forest is replaced by alien vegetation.



Replacement of native plants with non-native ornamentals results in significant bottom-up reductions of energy available for seed predation food webs.

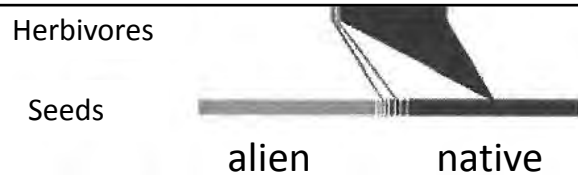
(a) Native plot 4.7% alien seeds



SEED EATING INSECT FOOD WEBS
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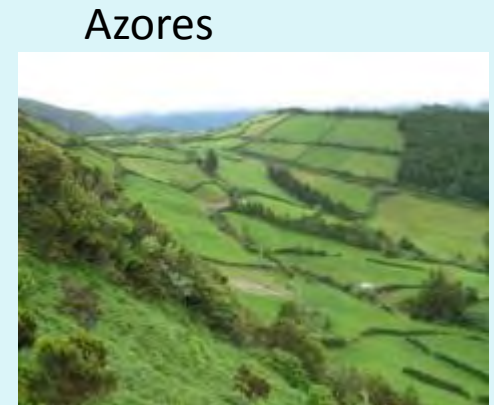
Impact of nonnative plants on higher trophic levels is one of the least-studied areas of invasion biology (Heleno et al. 2008).



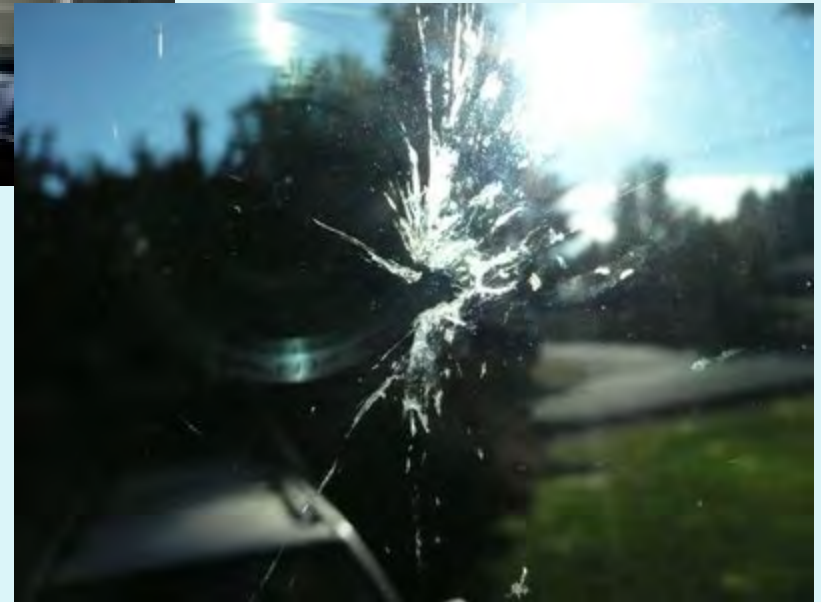
(c) Highly invaded plot 99% alien seeds



replaced by alien vegetation.



Bug splat indicator



When we build novel ecosystems – a hodgepodge of plants from around the world that have no evolutionary history with our local insects – **we risk losing 90% of our insect herbivores!** (Tallamy 2013).
[Youtube.com/user/Nyinvasives/videos](https://www.youtube.com/user/Nyinvasives/videos)

Will evolution be the solution?

Number of herbivore species supported

| Non-native plant species | Homeland | Novel | Years since introduction |
|--------------------------------|----------|-------|--------------------------|
| <i>Phragmites australis</i> | 170 | 5 | >300 |
| <i>Eucalyptus stelloleta</i> | 48 | 1 | 100 |
| <i>Opuntia ficus-indica</i> | 16 | 0 | 250 |
| <i>Clematis vitalba</i> | 40 | 1 | 100 |
| <i>Melaleuca quinquenervia</i> | 406 | 8 | 120 |

Data from Tallamy 2007. Bringing Nature Home. Timber Press.



Age of the Anthropocene

The **Anthropocene** is a proposed geologic chronological term for an epoch that begins when human activities have had a significant global impact on the Earth's ecosystems.



CONTROVERSY

About the Anthropocene
and about novel ecosystems

Traditional conservationist attacks on the “Anthropocene movement”



Michael Soule, Ph.D. “Grandfather of Conservation Biology.” *A founder of the Society for Conservation Biology and The Wildlands Project*

2013. The “New Conservation.” *Conservation Biology*, Volume 27, No. 5, 895–897

GOAL of the “New Conservationists” to replace the biodiversity based traditional model of traditional conservation with campaigns emphasizing human economic progress.

PHILOSOPHY: Nature has little value except as a human resource... Nature protection for its own sake is dysfunctional.

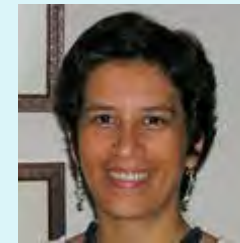
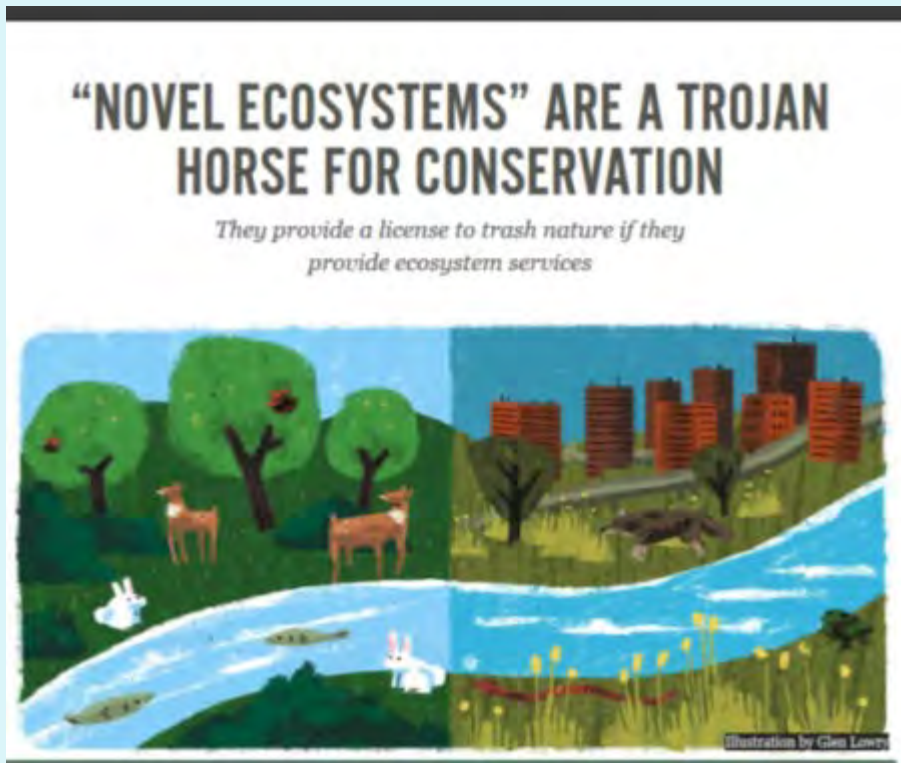
MISSION OF CONSERVATION ought to be primarily humanitarian ... [and] should seek to enhance those natural systems that benefit the widest number of people, especially the poor”



...conservation cannot promise a return to pristine, prehuman landscapes...What conservation could promise instead is a new vision of a planet in which nature -- forests, wetlands, diverse species, and other ancient ecosystems -- exists amid a wide variety of modern, human landscapes [NOVEL ECOSYSTEMS].
...None of this is to argue for eliminating nature reserves or no longer investing in their stewardship.

Breakthrough Journal Winter 2012

<http://thebreakthrough.org/index.php/journal/past-issues/issue-2/conservation-in-the-anthropocene>



D. Simberloff

C. Murcia

J. Aronson

OPINION PIECE: “They [novel ecosystems] provide a license to trash nature if they provide ecosystem services.”

The argument that attempting to restore an ecosystem is futile — despite the fact that it is demonstrably often wrong — and that novel ecosystems can serve our purposes better can only lead policy-makers to be more willing to allow environmentally damaging projects.

<http://ensia.com/voices/novel-ecosystems-are-a-trojan-horse-for-conservation/>

CONSERVATION IS COMPLICATED, AND ALL APPROACHES NEED TO BE ON THE TABLE

Dispatches from the front line suggest an important role for a novel ecosystem approach to conservation



“The magnitude of human-driven degradation of ecosystems is so huge that pragmatic approaches such as the novel ecosystems framework simply must be given careful consideration.”



David
Richardson

RESPONSE: I find their [Simberloff, Murcia, Aronson] outright condemnation of the idea shortsighted.

<http://ensia.com/voices/conservation-is-complicated-and-all-approaches-need-to-be-on-the-table/>

“Richard Hobbs and co-authors (including me) have argued that adopting aspects of the “novel ecosystems” approach need not be a slippery slope in our commitment to conservation and restoration.”

Trash nature or restore?



Kristen Hulvey

“...where there is evidence that we have moved out of reach of the past, novel ecosystems management offers possibilities for thoughtfully choosing alternative management goals and priorities” (Hulvey et al. 2013).

Incorporating novel ecosystems into management frameworks.
Chapter 18 in: Hobbs et al. 2013. Novel Ecosystems: Intervening in the New Ecological World Order. Wiley-Blackwell ISBN

- How do we know when to restore or use a novel ecosystem approach?
- How do we choose alternative management goals and priorities?

Serene Conservationist's Prayer

- [Higher Power] grant me the serenity to accept the novelty I cannot change.
- The funding to restore the ecosystems that I can.
- And a flow diagram to know the difference.

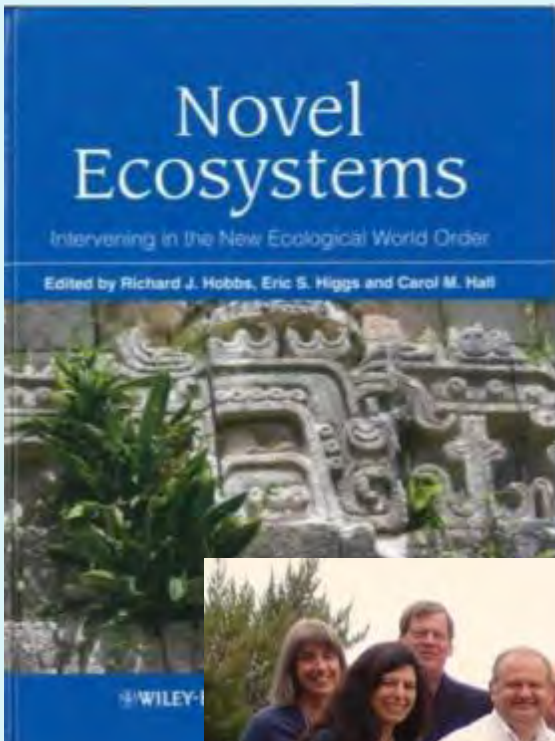
*With apologies to American theologian
Reinhold Niebuhr (1892–1971).*

Major decisions to be made on interventions in historical, hybrid and novel ecosystems.



Figure 18.1 from Hulvey et al. 2013. Incorporating novel ecosystems into management frameworks. Chapter 18 in: Hobbs RJ, ES Higgs and CM Hall. Eds. 2013. Novel Ecosystems: Intervening in the New Ecological World Order. Wiley-Blackwell ISBN

Serene Conservervationist's "Bible"



Hobbs, Higgs and Hall. 2013.
2011 Pender Island Workshop:
Many points of view & opinions.

<http://www.wiley.com/go/hobbs/ecosystems>

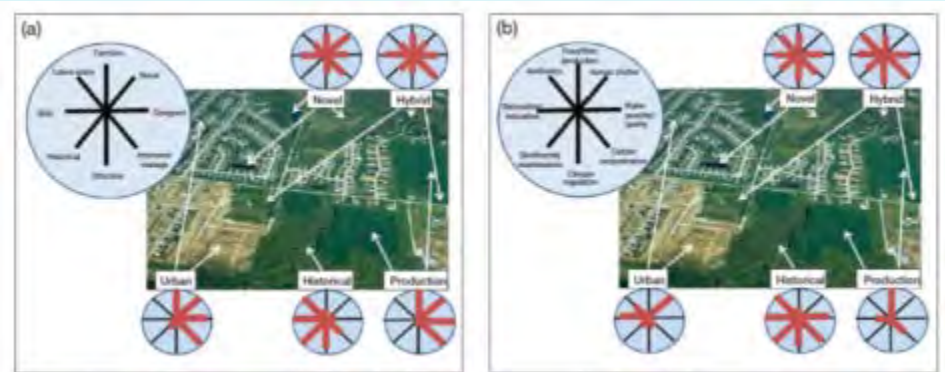


CliffsNotes version

Hobbs et. Al 2014. *Frontiers in Ecology and the Environment*.
2014; 12(10): 557–564

REVIEWS REVIEWS REVIEWS

Managing the whole landscape: historical, hybrid, and novel ecosystems



Landscape elements

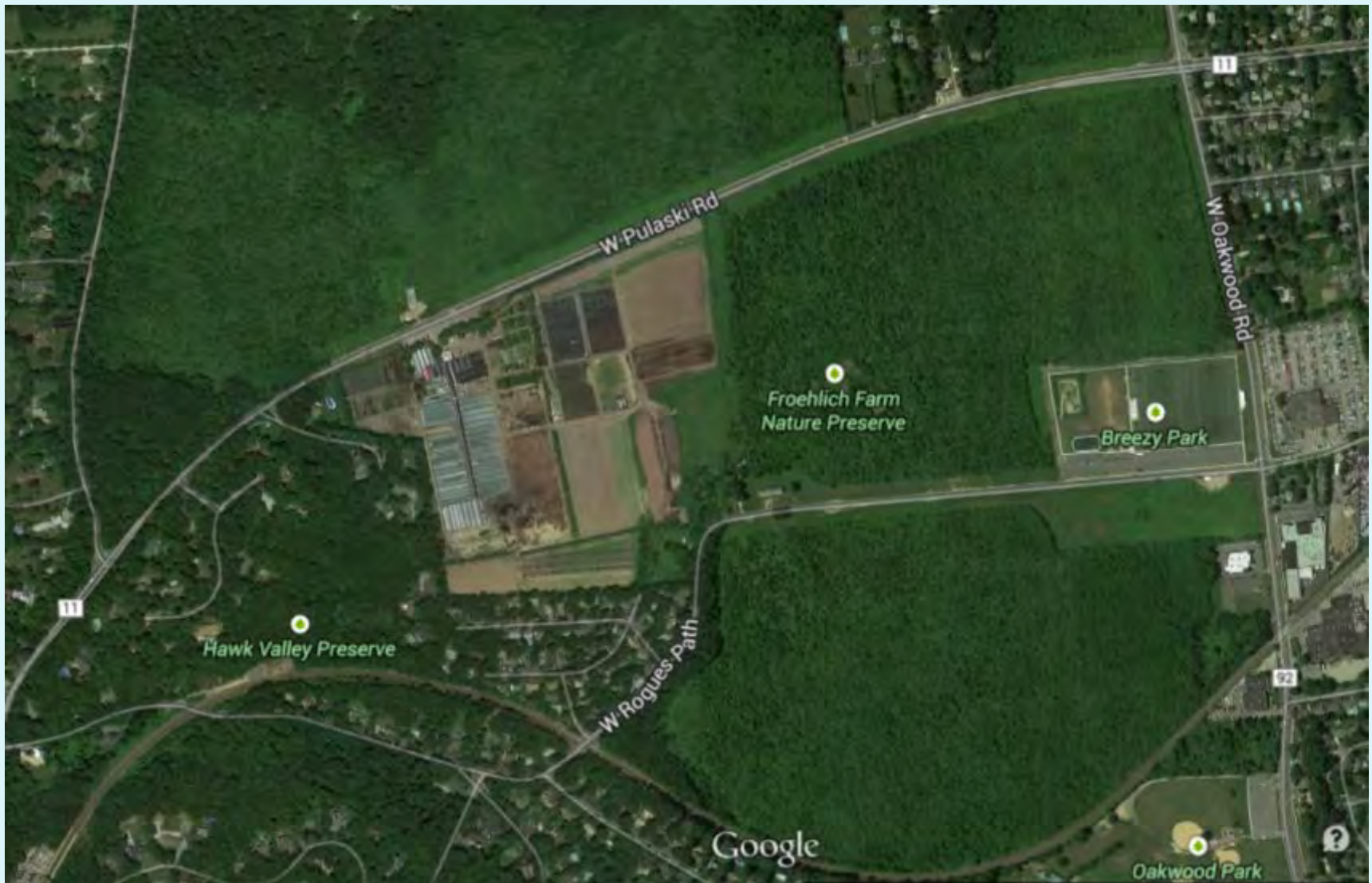
Ecosystem services

Ecological Society of America
<http://www.esajournals.org/>

Figure 2. Flowchart showing a developing framework to guide major decisions regarding interventions in historical, hybrid, and novel ecosystems. This framework has received only preliminary testing (Hobbs et al. 2013; Trueman et al. 2014); and an important next step is adequate testing with further real-world examples (eg to characterize reversibility or to effectively implement multiple goals). Modified from Hulvey et al. (2015).

GOAL: Manage for ecosystem services for people

Froelich Farms County Park, Huntington Station, NY



GOAL: Manage for ecosystem services for people
Froelich Farms County Park, Huntington Station, NY



GOAL: Manage for ecosystem services for people Froelich Farms County Park, Huntington Station, NY

Autumn olive

Multiflora rose

Callery pear

Mugwort

Japanese honeysuckle

Asian crabapples

Oriental bittersweet

Porcelain berry



“Restoration” to a pre-settlement forest – or any native ecosystem? – is realistically impossible.

GOAL: Manage for ecosystem services for people Froelich Farms County Park, Huntington Station, NY



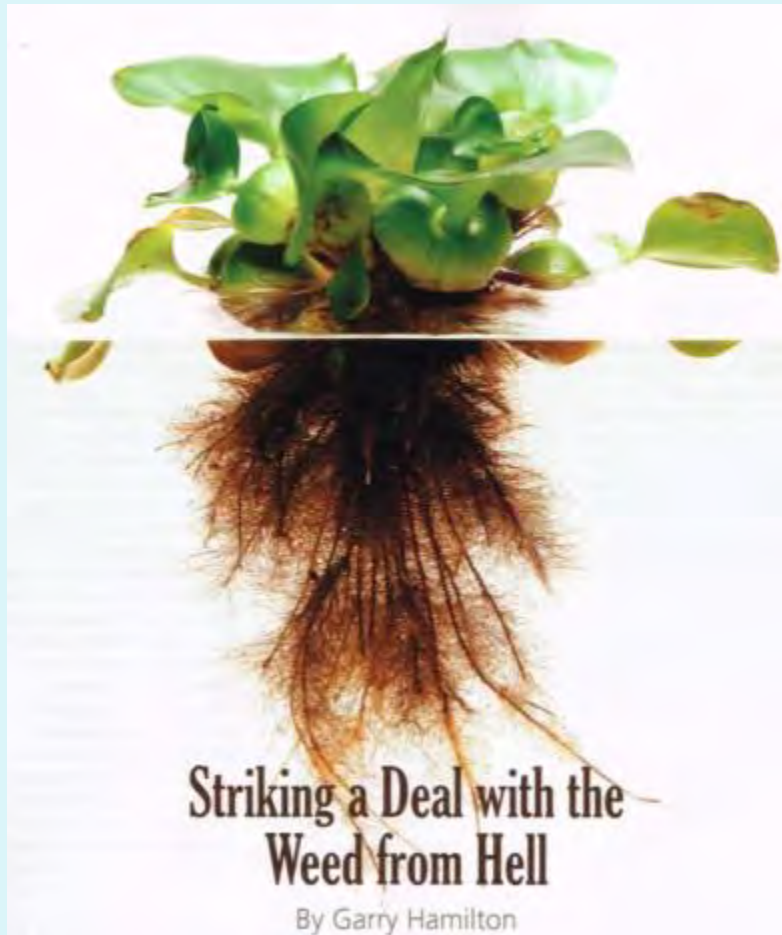
GOAL: Manage for ecosystem services for people
Froelich Farms County Park, Huntington Station, NY



Goal: Manage for novel species and/or ecosystem services (including rare species)

Florida's Crystal River National Wildlife Refuge

Hamilton. G. 2014. Conservation Magazine 15(1):48–51.



1. 1950s Water hyacinth spread a nuisance for boaters.
2. Chemical control used.
3. Hydrilla invaded.
4. 1960s Sulfuric acid dumped.
5. 1970s Copper based herbicides; copper in sediments and dead manatees.
6. Mechanical harvesting and herbicides.
7. 1990s Slimy algal blooms, murky water, lost eelgrass that once nourished manatees.
8. Pressure on underground aquifers increased salinity and reduced flushing?
9. Algal toxins in some dead manatees.
10. 2012

Goal: Manage for novel species and/or ecosystem services (including rare species)

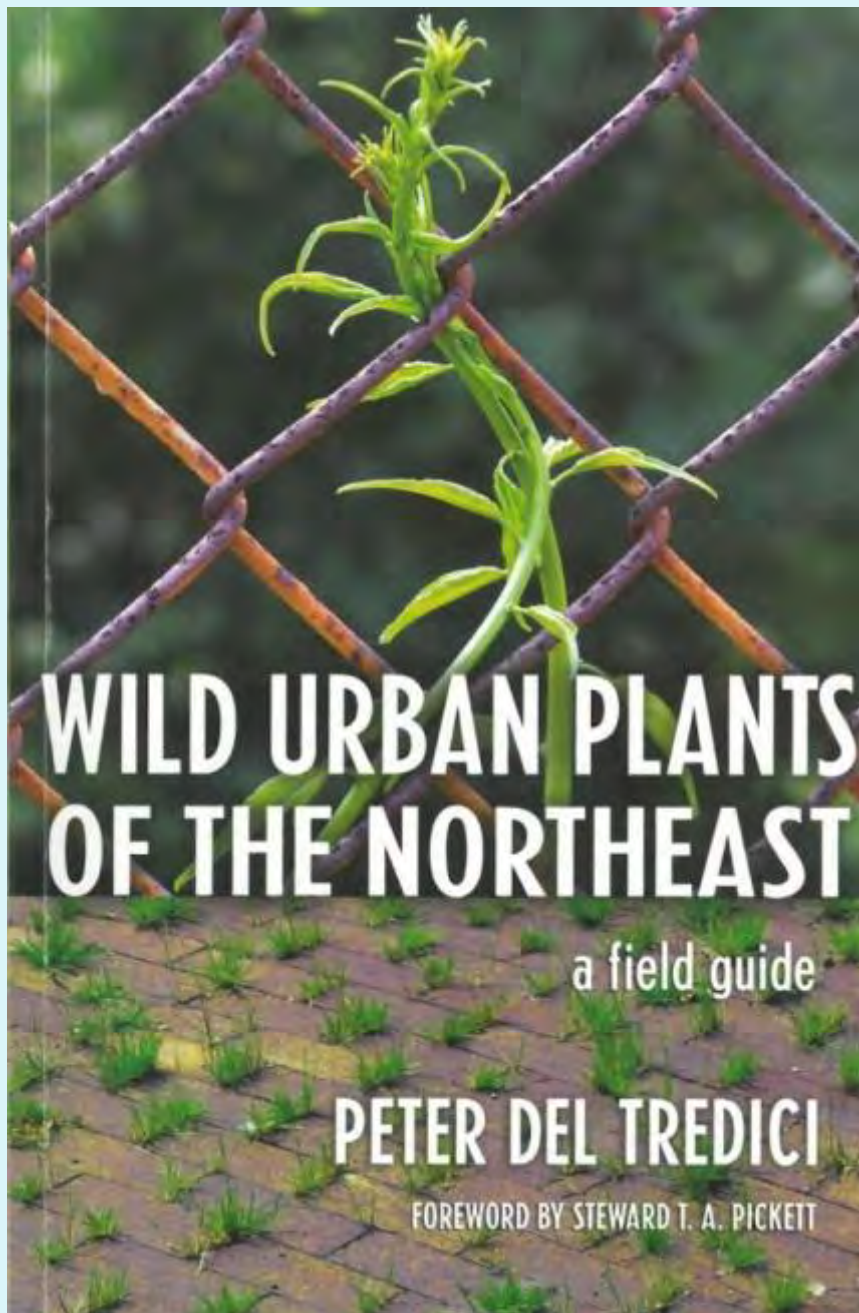
Florida's Crystal River National Wildlife Refuge

Hamilton. G. 2014. Conservation Magazine 15(1):48-51.



2012

Experimental
stocking of:
water hyacinth,
frog's bit
water lettuce.



Peter Del Tredici

Senior research scientist

Arnold Arboretum

Harvard University

Understand and love
spontaneous wild urban
plants: they are pre-adapted
to urban conditions.

Accept change/novelty

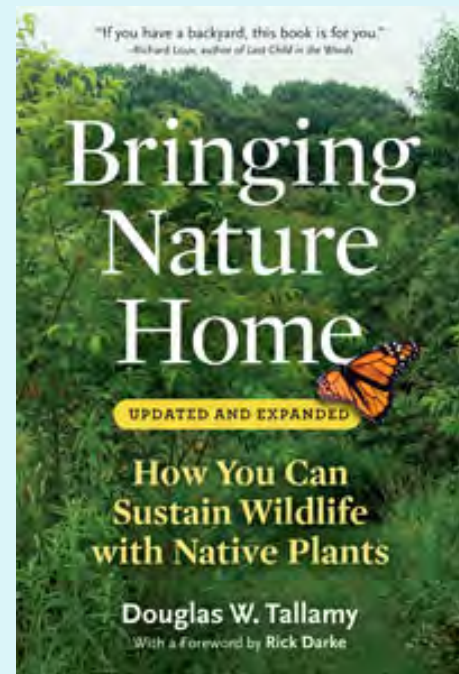


Douglas Tallamy' thoughts about novel ecosystems

Professor & Chair of Entomology and
Wildlife Ecology, University of Delaware.

Personal communication April 5, 2013

**Use native plants
and fight
Degradation**



- Food webs in greatly altered novel ecosystems are highly simplified and degraded with low species diversity, leading to global functional homogenization.
- Many native plant genotypes can survive in cities.
- Try them first and make urban environments less harsh.

Manage the landscape matrix

We can expect to lose 95% of the species that once lived here unless we learn how to share our living, working, and agricultural spaces with biodiversity.

Tallamy

Carmans
River

Google earth



Asia

Europe

Rockies

Pacific Northwest

Asia

Asia

Africa

Asia

About half of all invasive plants were introduced from horticulture as ornamentals

Europe

Asia

Photo Courtesy of Doug Tallamy

Manage the matrix at all scales

BACKYARD HABITATS

- Shrink lawns.
- Encourage use of more native plants in backyards & restorations.
- Leave leaf litter in place for insect habitat.

LANDSCAPES

- **Reduce degradation** (e.g. excess nutrients (septic, fertilizers); dams; pollution; erosion; disturbance; excessive deer browse; etc.).
- Natural areas in developments.
- Green infrastructure.
- **Allow sale of only non-invasive plant species and cultivars.**



Hope in the age of man?

“Yes we live in the anthropocene – but that does not mean we inhabit an ecological hell... We have a duty as a species to protect and manage [the earth]with love and intelligence. It is beautiful still...”

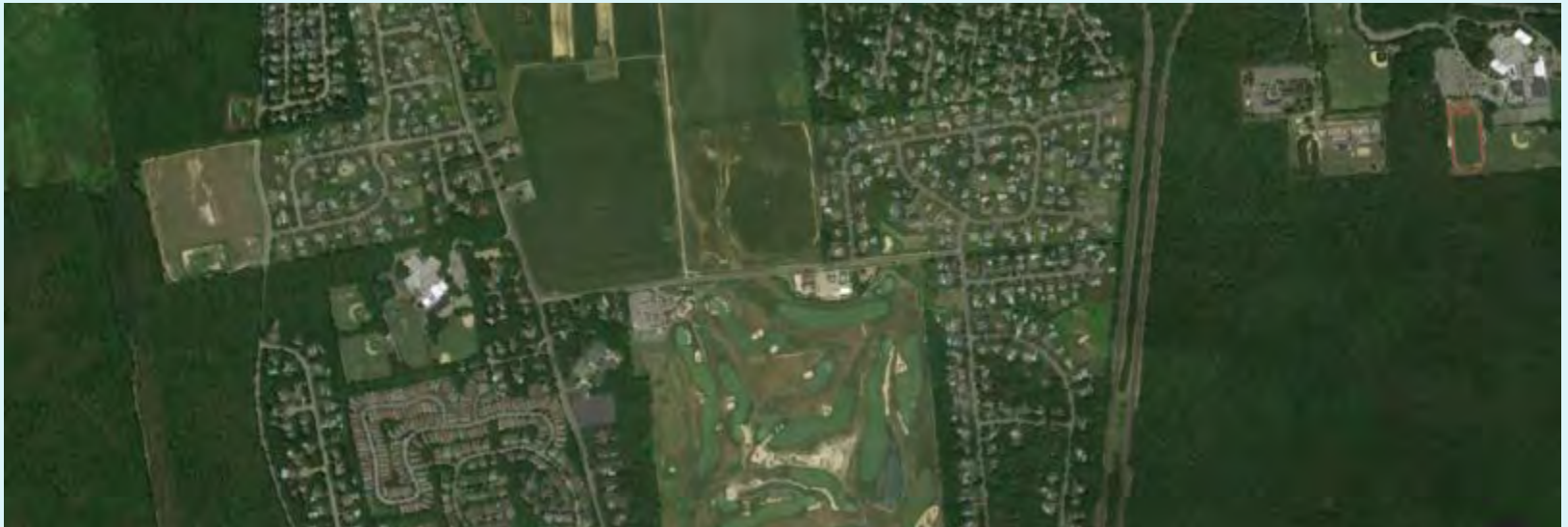


Marris, Kareiva, Mascaro and Ellis. Hope in the age of man. Op-Ed New York Times, December 7, 2011

Responses April 10-11, 2012: <http://dotearth.blogs.nytimes.com>

Novel Ecosystems: Bottom Line

Novel/hybrid ecosystems do have value and we need them – but be aware of their deficiencies, especially simplified food webs and lost biodiversity.





Protect and restore the
“natural/historic”

Accept/manage the “novel”

For nature and for people.

–The End–

mj.eco.phd@gmail.com