Novel Ecosystems: Hope or Hype? - New Thinking -

Association of State Wetland Managers
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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


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

Is ecosystem altered because of human actions?

Are changes reversible?


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

Successional old field, Wicks Farm County Park Huntington, Long Island
Jordan

Japanese barberry Bear Mountain, NY
Wilson-Pines

Hards Lake Dam, Carmans River, LI
Google Earth

Fish assemblages

California grassland
Jordan

Peconic River
Jordan
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%

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Viewing the biosphere as “natural ecosystems with humans disturbing them” is outdated.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).
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**.
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

More species and functional groups capable of **differential responses** to change

+ **Redundancy** (several species do the same job)

= **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).

![Effect size graph for plants and animals](image-url)
Effects of invasive alien plant species on ECOSYSTEM FUNCTION (meta-analyses)

DECREASES

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

INCREASES

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

Cardinale et al. 2006. The functional role of primary producer diversity... Am.J.Bot 98
How do nonnative plants affect insects and food Webs?
Many insect species – even generalists – are able to eat relatively few plant species.


COMMON SECONDARY METABOLIC COMPOUNDS FOUND IN THE LEAVES OF PLANTS

<table>
<thead>
<tr>
<th>Chemical Class</th>
<th>Plant Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glycosides</td>
<td>almonds, cassava, lima beans, Plantago, Lagochilus, Incarvillea</td>
</tr>
<tr>
<td>cyanide glycosides</td>
<td></td>
</tr>
<tr>
<td>iridoid glycosides</td>
<td>milkweeds, Isoplexis, Digitalis</td>
</tr>
<tr>
<td>cardenolides</td>
<td>broccoli, cauliflower, rapeseed</td>
</tr>
<tr>
<td>glucosinolates</td>
<td></td>
</tr>
<tr>
<td>Phenols</td>
<td>Tonka bean, lavender, licorice, oaks, beech, hickory, grasses</td>
</tr>
<tr>
<td>coumarins</td>
<td></td>
</tr>
<tr>
<td>tannins</td>
<td></td>
</tr>
<tr>
<td>lignins</td>
<td></td>
</tr>
<tr>
<td>Terpenes</td>
<td>cucurbits, candytuft, neem, Carapa, yucca, daisies, horse chestnut</td>
</tr>
<tr>
<td>cucurbitacins</td>
<td></td>
</tr>
<tr>
<td>limonoids</td>
<td></td>
</tr>
<tr>
<td>saponins</td>
<td></td>
</tr>
<tr>
<td>Alkaloids</td>
<td>poppy, Colchicum, composites, legumes, Lupinus, Nicotiana, Conium, tobacco, eggplant, tomato</td>
</tr>
<tr>
<td>benzylisoquinoline</td>
<td></td>
</tr>
<tr>
<td>pyrrolizidine</td>
<td></td>
</tr>
<tr>
<td>quinolizidine</td>
<td></td>
</tr>
<tr>
<td>nicotine</td>
<td></td>
</tr>
</tbody>
</table>
Moth & butterfly species – even generalists – are able to eat relatively few plant species.

*Liquidambar styraciflua* (sweetgum)

Monarch butterflies needs native milkweeds

Asclepias syriaca

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

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

http://www.bringingnaturehome.net/
Replacement of native plants with non-native ornamentals results in significant bottom-up reductions of energy available for seed predation food webs.

**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.

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

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

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)
Will evolution be the solution?

<table>
<thead>
<tr>
<th>Non-native plant species</th>
<th>Homeland</th>
<th>Novel</th>
<th>Years since introduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phragmites australis</td>
<td>170</td>
<td>5</td>
<td>&gt;300</td>
</tr>
<tr>
<td>Eucalptus stelloletha</td>
<td>48</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Opuntia ficus-indica</td>
<td>16</td>
<td>0</td>
<td>250</td>
</tr>
<tr>
<td>Clematis vitalba</td>
<td>40</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Melaleuca quinquenervia</td>
<td>406</td>
<td>8</td>
<td>120</td>
</tr>
</tbody>
</table>

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”


**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.
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/
“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.”

“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.”

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

Trash nature or restore?

“...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).


• 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.

Serene Conservationist’s “Bible"


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

I highly recommend this book
Managing the whole landscape: historical, hybrid, and novel ecosystems

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, Truman et al. 2014), and an important next step is adequate testing with further real-world examples (e.g., as demonstrated in these case studies). Modified from Hudak et al. (2013).

Landscape elements

Ecosystem services

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

A potato field in 1951
GOAL: Manage for ecosystem services for people
Froelich Farms County Park, Huntington Station, NY

Autumn olive       Japanese honeysuckle
Multiflora rose    Asian crabapples
Callery pear       Oriental bittersweet
Mugwort            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

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

2012
Experimental stocking of:
water hyacinth,
frog’s bit
water lettuce.
Understand and love spontaneous wild urban plants: they are pre-adapted to urban conditions.

Accept change/novelty
Douglas Tallamy’s 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*
About half of all invasive plants were introduced from horticulture as ornamentals.
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.

www.konenlandscaping.com
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…”

Emma Marris: “Rambunctious Garden: Saving Nature in a Post-Wild World”


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–

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