The Novel Ecosystem Debate Reframed for Land Managers: An ecologist’s perspective

An interactive physical system with abiotic and biotic parts
A view of Spruce Gulch from the northeast, looking southwest. The knapweed is found at the upper portions of the drainage. Photo by David Knochel, taken Aug. 17, 2010.
Factors affecting ecosystems

"Pristine" communities have been influenced by a number of anthropogenic factors for multiple decades.
Restoration Options

Historical community

Classical restoration goal

Current community

Do nothing
(implicit: stays the same)

Deliberately altered to ‘something else’.

a.

b.

c.
The local/regional textbook example:

1990s: Control of diffuse knapweed (\textit{Centaurea diffusa}):
Classical restoration model

Sustainable management solution

Invasive weeds

Historically Present
vegetation

TIME →

AMOUNT
Demise of knapweed on eastern Boulder grassland:

Knapweed flowering stems

- Y-axis: stems per sq. meter
- X-axis: Years (1997-2008)

Graph shows a decline in knapweed flowering stems from 2001 onwards.
But the demise of knapweed was exploited by other introduced species... Why?

Relative Cover: Natives vs Introduced

Percent of Vegetation

Pre-2002 | 2002-

Native | Introduced

0 | 10 | 20 | 30 | 40 | 50 | 60 | 70

Median values for "Native" and "Introduced" with error bars representing the 75% confidence interval.
We got rid of what we don’t want...why won’t the system go back to it’s historical configuration?

Possibilities (not exhaustive):
Passive restoration efforts produce new systems because:

a) Longer growing season (favors ‘winter species’)
b) Wetter winters but no overall increase in precipitation
c) Higher CO$_2$ and atmospheric nitrogen deposition makes some plants better competitors.
d) Altered (suppressed) fire regimes favor different species
e) Fragmentation effects on microhabitats & source-sink relationships
f) Recently introduced species better matched to changes.
The current reality:

Invasive weeds

Native plants (historically present)

New vegetation components

Sustainable management solution
Historical community

Current community

New species, climate, N deposition, etc

Classical restoration goal

Do nothing

(Recovery Extremely unlikely)

Deliberately altered ecosystem

Getting rid of what you don’t want under the ‘new rules’ only facilitates additional changes…
Novel tropical forests: Nature’s response to global change

Ariel E. Lugo

“Novel forests include native tree and animal species as well as significant numbers of introduced and naturalized species. **These introduced species dominate forest stands,** and their dominance is not incompatible with the regeneration of native species.”
Lugo’s findings are a potential paradigm buster:

The introduced (now dominant) species may be neutral or even positive with respect to the presence of the historically present species.

Novel forests will function similarly to current native forests in their delivery of vital ecological services to people.

Historical communities are unlikely to replace novel communities ...because the environmental conditions continue to change and the historic conditions that favored traditional native species are not likely to prevail.
Dr. Lugo’s findings are only one outcome.... But, his finding may be widespread...

But, there will be other outcomes where ‘doing nothing’ is probably less desirable.
Example.... Boulder Open Space “natural areas”

Vegetation monitored since 1997.....

look at results from ‘undisturbed’ sites lacking prairie dog colonies..... (plot data from about 8000 acres)
Doing nothing is resulting in directional changes in community composition...
Directional changes:

Expanded growing season without additional rainfall means suppression of species caught in the middle?
Prairie dogs in Boulder:
Pawnee Grassland Prairie Dog community: Classic keystone species role: attracting other, desired species to area.
Boulder prairie dog colony, September
Boulder County Prairie dog colony, March: Prairie dogs consume dominant, introduced forb.
Dust from prairie dog town endangers traffic
Prairie dogs on longer growing season now ‘farming’ introduced plant species? Consequences of farming result in bare soil in late winter/early spring.
Prairie dogs interact with new climate & plant species to destabilize landscapes: “keystone species” status?
Previous community

New species, climate, N deposition, etc

(Recovery Extremely unlikely)

Classical restoration goal

Current community

Deliberately altered ecosystem

Do nothing: system still can transform
Human activities have also altered ‘extreme events’:

* Changes in fire frequencies and intensities (deliberate fire suppression activities + climate change)

* Changes in storm frequencies and intensities.
Colorado Springs, June 2012: Colorado joins Southern California in demonstrating that structures generate ‘canopy fires’.

The four most expensive fires in Colorado history have all occurred since 2010 (Boulder, Ft. Collins, Colorado Springs) Fire has moved to where people live, and people have moved into a high fire frequency zone.
Fire causes system to become a meadow for extended period. Second disturbance prior to tree seed production, can create long-term meadow habitats.

Modified from Paine et al. 1998
Ecosystem State

Classical forest succession

Fire causes system to become a meadow for extended period

Since the entire region will be largely in regrowth mode, seed source for a regrowth forest becomes much less common...

Also, seedling survivorship inhibited by hotter, drier climate!

Paine et al. 1998
The Rockies will be composed of a much larger percentage of ‘mountain meadows’ and savannas than occurred in last century (landscape generated by 0-3 fires since 1988)
Boulder Precipitation in September, 1899-2013
(highest previous monthly record for ANY month was 9.59 inches)
Historical (relictual?) community

Current novel community

New species, climate, N deposition, etc

(Recovery Extremely unlikely)

Deliberately altered ecosystem
(forward-looking conservation and restoration)

Do nothing

X
Niche difference
Fitness

Abiotic and biotic ‘filters’

Climate filter
Site Resource filter
Disturbance filter

Biotic filters (already present)
- symbionts
- pathogens
- herbivores
- competitors
- service providers

Introduced Plant characteristics

Introduction → Establishment → Outcome
(rare, common, dominant)

Abiotic site characteristics
Biotic site characteristics
Invader traits

Potential rapid evolution
Plant feedbacks

Niche difference
Fitness

- Abiotic site characteristics
- Biotic site characteristics
- Invader traits
Thanks!
Factors affecting ecosystems

Even “Pristine” communities have been influenced by a number of anthropogenic factors for multiple decades.
The last step remains the ‘prediction’, One affected by plague as well as by climate.
With the loss of topsoil and continued new environmental drivers...return to the historical composition of this prairie is highly unlikely.
Transformative events (wholesale conversion of one community type to another)

Under what circumstances are proactive efforts on invasive species the equivalent of rearranging the deck chairs of the Titanic?
Getting rid of what you don’t want under the ‘new rules’ only facilitates additional changes…while doing nothing allows for uncontrolled change caused by directional ‘drivers’ like fire suppression and atmospheric chemistry!
Niche difference

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