Nuance, naysayers and 20 years of studying species invasions

1st meeting: Morro Bay, 1991

Pre-web lists
Pre-ppt
Pre- ‘invasion biology’

California Invasive Plant Council

Cal-IPC

Protecting California's wildlands through science, education, and policy

- **Google Scholar:**
  - **Invasive species-1,000,000 hits;**
  - **Invasive plants-254,000 hits;**
  - **Invasive plants in California-54,000 hits**

Yet more research is needed !

Don't Sweat the Invasion:

Why foreign plants and animals may not be that bad.

By Rebecca Tuhus-Dubrow|Posted, Wednesday, Nov. 4, 2009, at 1:30 PM ET

Are Invasives Bad? Not Always, Say Brown Researchers

May 17, 2010 | Contact: Richard Lewis

Naysayers

Don’t judge species on their origins

Conservationists should assess organisms on environmental impact rather than on whether they are natives, argue **Mark Davis** and 18 other ecologists.

Nature, June 9.2011

What can we do better ?

- Academics
- Managers
- Communicators
- Policy makers

I. Increase precision in our language

- Terminology is imprecise, inconsistent, combines objective and subjective concepts.
- Avoid casual use of important terms

What is an “*invasive*” species ?

3 Definitions in common usage

1. Any naturalized non-native species

- Species called ‘invasive’ just because they are non-native and reproducing in new land = origin based definition
- No specification for impact

California: 1800 plant species
(almost 1/3 of plant species in State)

1926-2011 85 GROWING NATIVE www.sbbg.org Santa Barbara Botanic the GARDEN

Ironwood

Quarterly Publication of the Santa Barbara Botanic Garden

Volume 19, Number 4 Fall 2011

The Never-Ending Battle Between Native and Invasive Plants

Our mild Mediterranean climate attracts many people to the Santa Barbara area, but has also contributed to the invasion by non-native plants. About 450 species of plants not native to California, but adapted to the climate, have become established in our region. Most of these non-native plants have been introduced from the Mediterranean area of Europe, either intentionally as decorative plants or unintentionally in imported materials. They now compete with our 1,500 species of native plants for water, soil nutrients, growing space, and pollinators and are a major threat to Santa Barbara County's biodiversity. These non-native plants alter the ecosystems they invade and can have long-term effects on soil erosion,

2. *Invasive* definition by IUCN and Executive Order 13112 (Clinton, 1999)

- "Invasive species" means an alien species whose introduction *does or is likely to cause economic or environmental harm or harm to human health*.

- Origin + harm

DANGER

- Calling an introduced species ‘invasive’ implies we know it is harmful
- We often do not know impact
- ‘Harm’ is a subjective interpretation of impact

- “1” + “2” = Xenophobia criticism

- Accusation all non-native species are ‘bad’ just because they are not native.

3. A species that *spreads rapidly* in a new region

Mostly used by ecologists

Diversity and Distributions (2000) **6**, 93–107

BIODIVERSITY RESEARCH

Naturalization and invasion of alien plants: concepts and definitions

DAVID M. RICHARDSON[1], PETR PYŠEK[2], MARCEL REJMÁNEK[3], MICHAEL G. BARBOUR[4], F. DANE PANETTA[5] and CAROL J. WEST[6] [1]*Institute for Plant Conservation, Botany Department, University of Cape Town, Rondebosch 7701, South Africa. E-mail: rich@botzoo.uct.ac.za,* [2]*Institute of Botany, Academy of Sciences of the Czech Republic, Cz-252 43 Průhonice, Czech Republic. E-mail: pysek@ibot.cas.cz,* [3]*Section of Evolution and Ecology, University of California, Davis, CA 95616, USA. E-mail: mrejmanek@ucdavis.edu,* [4]*Department of Environmental Horticulture, University of California, Davis, CA 95616, USA, E-mail: mgbarbour@ucdavis.edu,* [5]*Alan Fletcher Research Station, Department of Natural Resources, PO Box 36, Sherwood, Queensland 4075, Australia, E-mail: dane.panetta@dnr.qld.gov.au,* [6]*Southland Conservancy, Department of Conservation, PO Box 743, Invercargill, New Zealand, E-mail: cwest@doc.govt.nz*

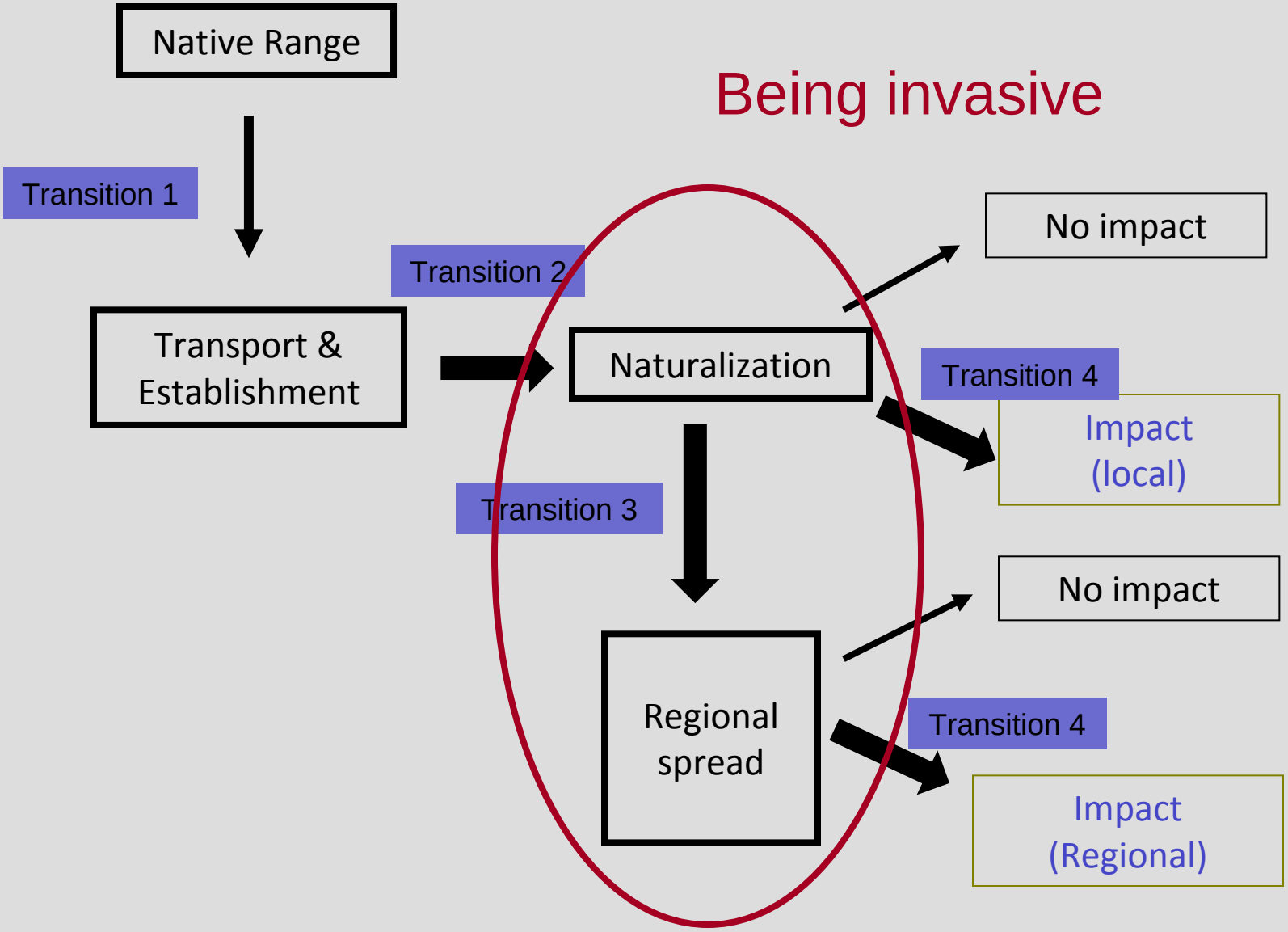
Table I Recommended terminology in plant invasion ecology

Alien plants[1]	Plant taxa in a given area whose presence there is due to intentional or accidental introduction as a result of exotic plants, non-native plants; nonindigenous plants).
Casual alien plants	*Alien* plants that may flourish and even reproduce occasionally in an area, but which do not form self-replacin on repeated introductions for their persistence (includes taxa labelled in the literature as 'waifs', 'transients', 'c 'persisting after cultivation', and corresponds to De Candolle's (1855, p. 643) usage of the term 'adventive'[2]).
Naturalized plants	*Alien plants* that reproduce consistently (cf. *casual alien plants*) and sustain populations over many life cycles wit humans (or in spite of human intervention); they often recruit offspring freely, usually close to adult plants, a natural, seminatural or human-made ecosystems.
Invasive plants[3]	*Naturalized plants* that produce reproductive offspring, often in very large numbers, at considerable distances f (approximate scales: > 100 m; < 50 years for taxa spreading by seeds and other propagules[4]; > 6 m/3 years for ta rhizomes, stolons, or creeping stems), and thus have the potential to spread over a considerable area.
Weeds	Plants (not necessarily *alien*) that grow in sites where they are not wanted and which usually have detectable e effects (synonyms: plant pests, harmful species; problem plants). 'Environmental weeds' are *alien plant* taxa tha usually adversely affecting native biodiversity and/or ecosystem functioning (Humphries *et al.*, 1991; Randall,
Transformers[5]	A subset of *invasive plants* which change the character, condition, form or nature of ecosystems over a substan of that ecosystem.

Notes:

Invasive plants: "naturalized plants that produce reproductive offspring…often in large numbers, at considerable distance from parent plants….have potential to spread over a considerable area"

Development of Impact



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Biol Invasions (2007) 9:309–315
DOI 10.1007/s10530-006-9034-4

ORIGINAL PAPER

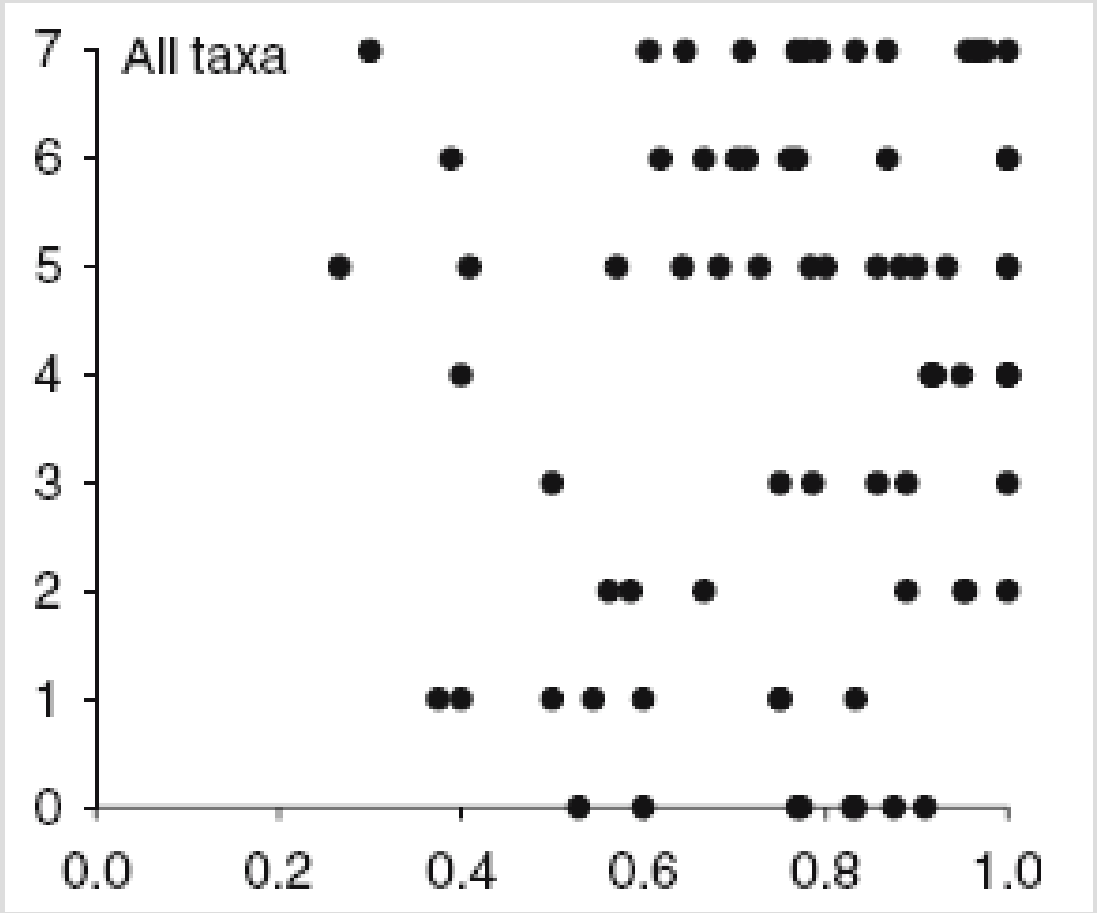
The invasiveness of an introduced species does not predict its impact

Anthony Ricciardi · Jill Cohen

Invasiveness = rate of establishment and spread

Impact = depression of native species

'*invasiveness*' does not correlate with *impact*



"*invasive*" : biogeographic and demographic processes

- NO implication for impact (or harm)

- BUT requires measures of 'invasiveness'
- Not used by public or policy makers

Lists from around the world of *invasive* species…

- Naturalized alien species (definition 1)
- Environmental weeds (definition 2)
- Invasive & harmful plants of wildlands (definition 2 & 3)
- Harmful alien plants (following IUCN) (definition 2)
- Invasive plants of country x (*invasive*= undefined, 1 or 2 or 3)

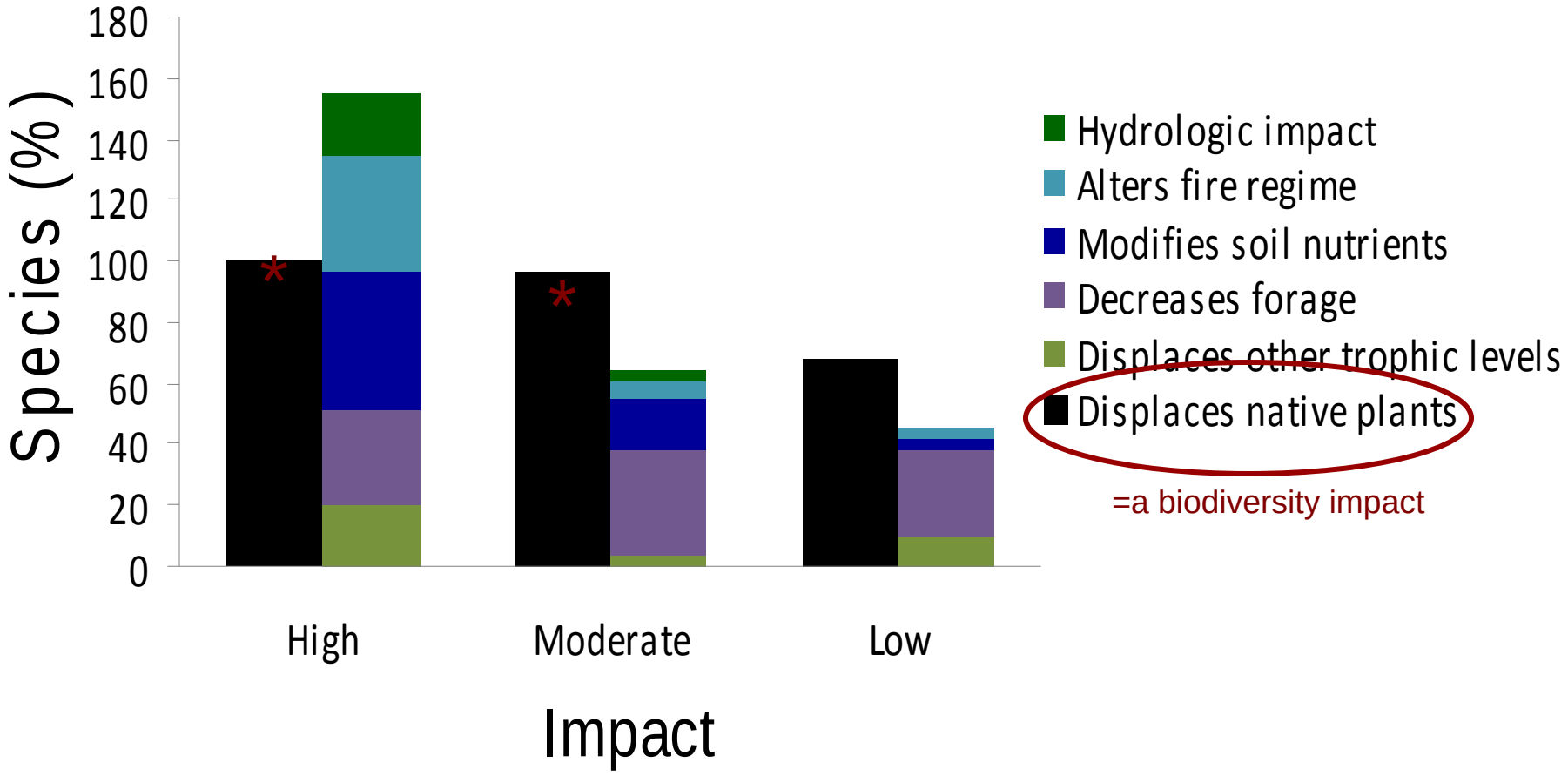
I. “Invasive” definition:

- Define terms carefully at outset of every communication
- Work harder to avoid definition “1”
- Know what you are comparing

II. Deepen our understanding of impact

- Particularly impacts on biodiversity

Impacts of Cal-IPC list species



Molinari and D'Antonio in prep.

From Cal-IPC web site:

- **Myth:** These species increase biological diversity.

- **Fact:** Many invasive species form monocultures (dense stands of one plant) that push out native species and reduce food and shelter needed by native wildlife, including endangered species.

Implication = decrease in biodiversity

(richness or abundance natives)

Do invaders ‘push out’ natives ?

- Directly via competition
- Indirectly through system alteration

DATA ?

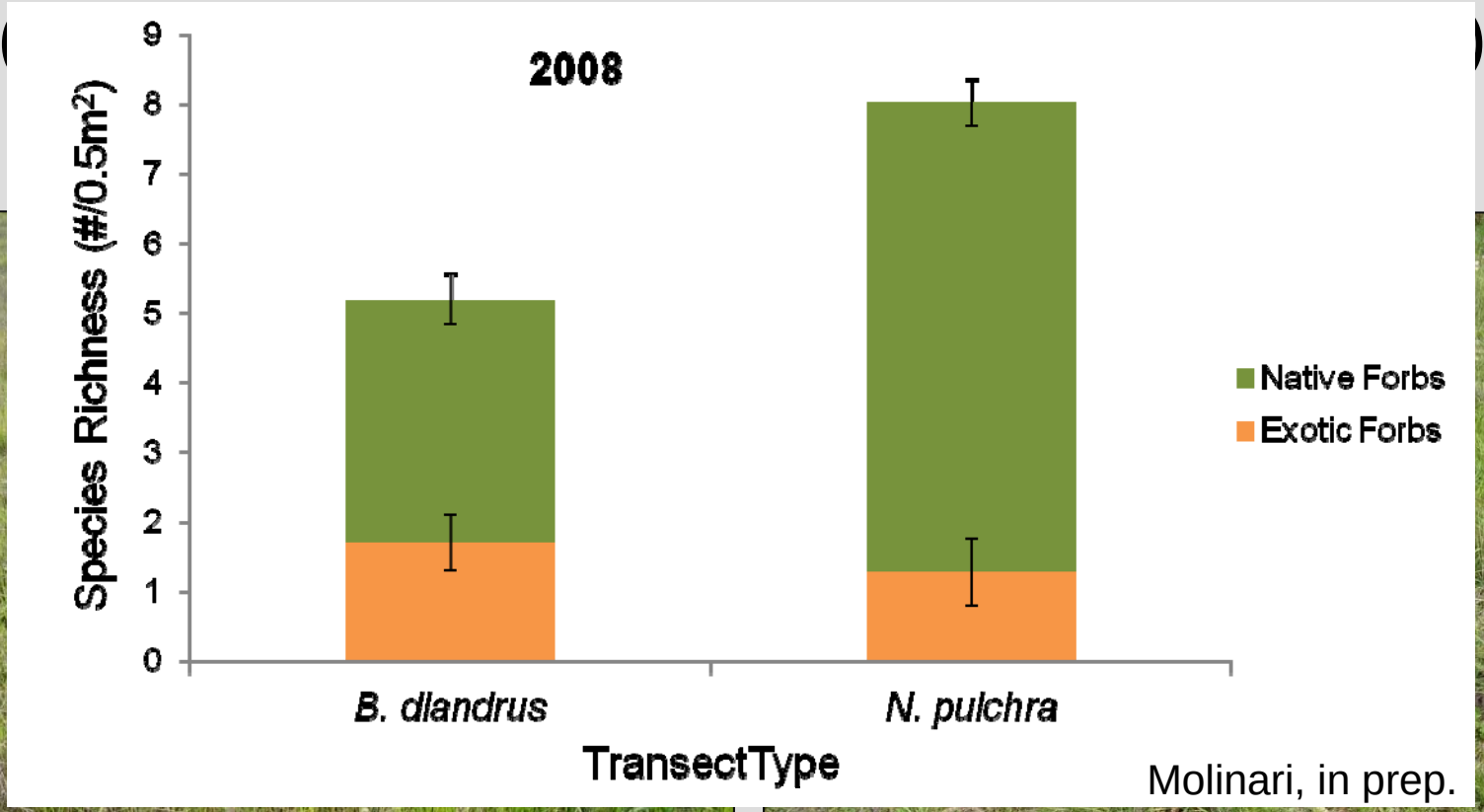
- For Cal-IPC high priority species, How many have data showing they “push out native species”

40 % reference data showing some sort of impact on growth or occurrence of a native species

Most commonly cited evidence = observation ….“form monospecific stands”

Correlational data

Bromus diandrus *Nassella pulchra*



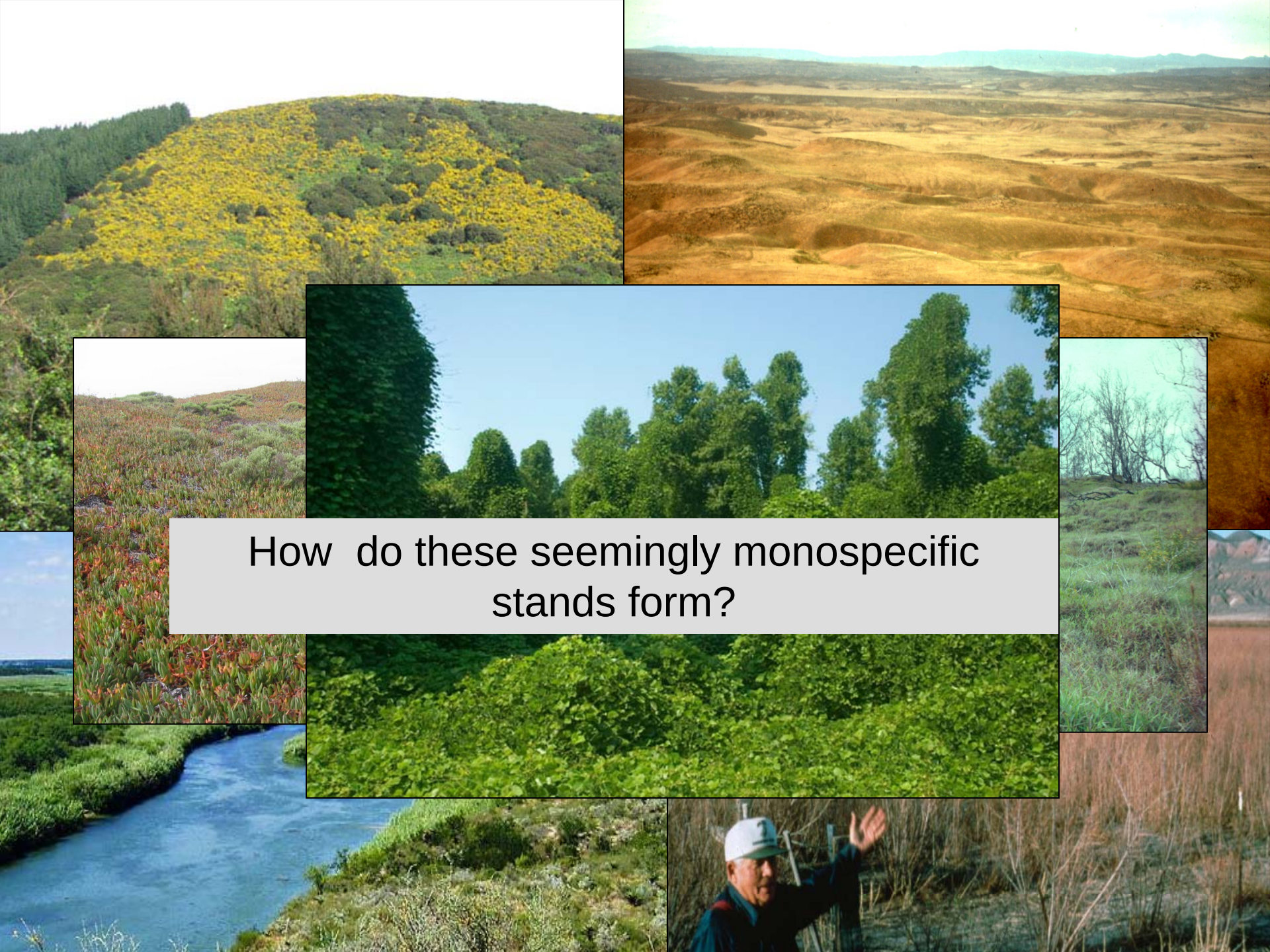
Molinari, in prep.

Correlational data common

Bromus diandrus
(non-native grass)

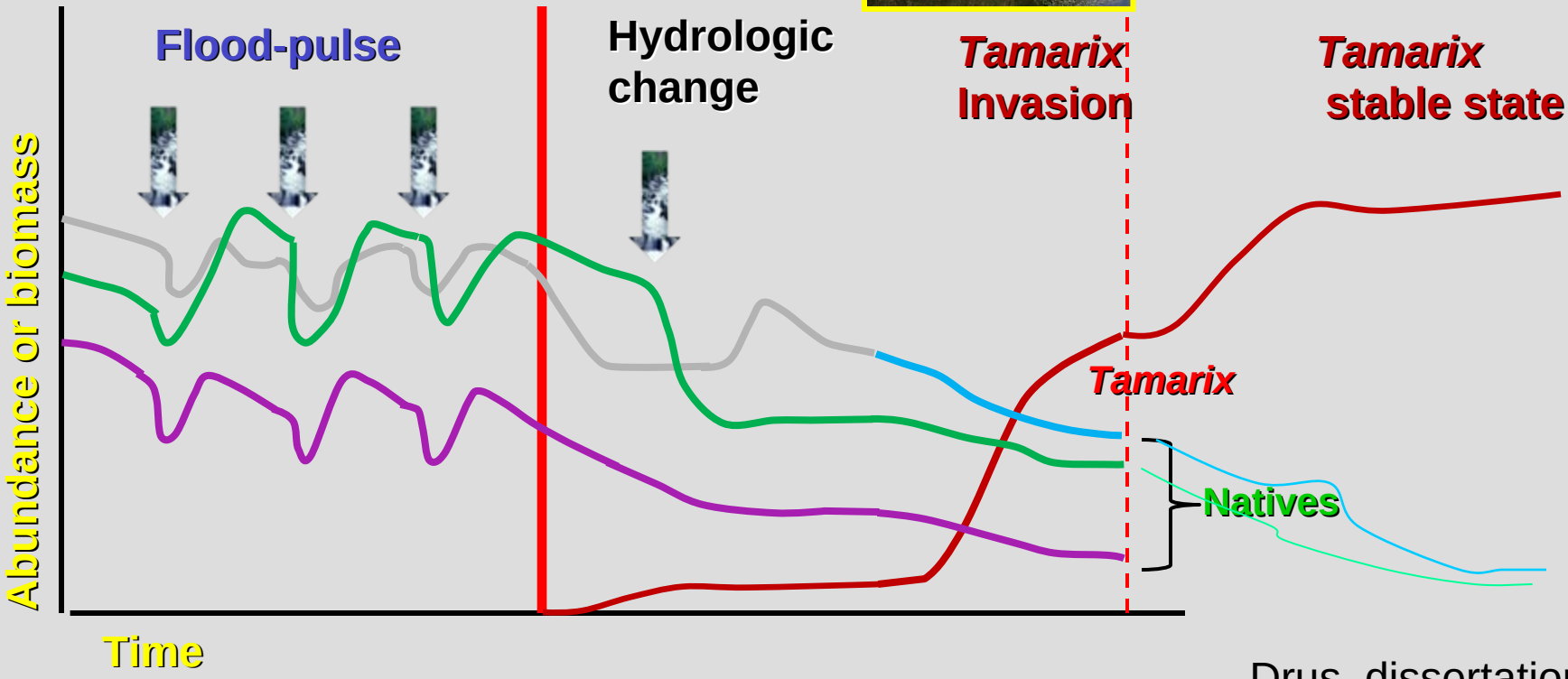
Nassella pulchra
(native grass)

- Competitive displacement
- Faster post-disturbance recovery
- Different soil or microenvironment conditions



How do these seemingly monospecific stands form?

Invader responds to altered system parameters or disturbances that natives can't handle



Drus, dissertation

Invaders alter ecosystem processes once they get foot in door. Reduces natives?

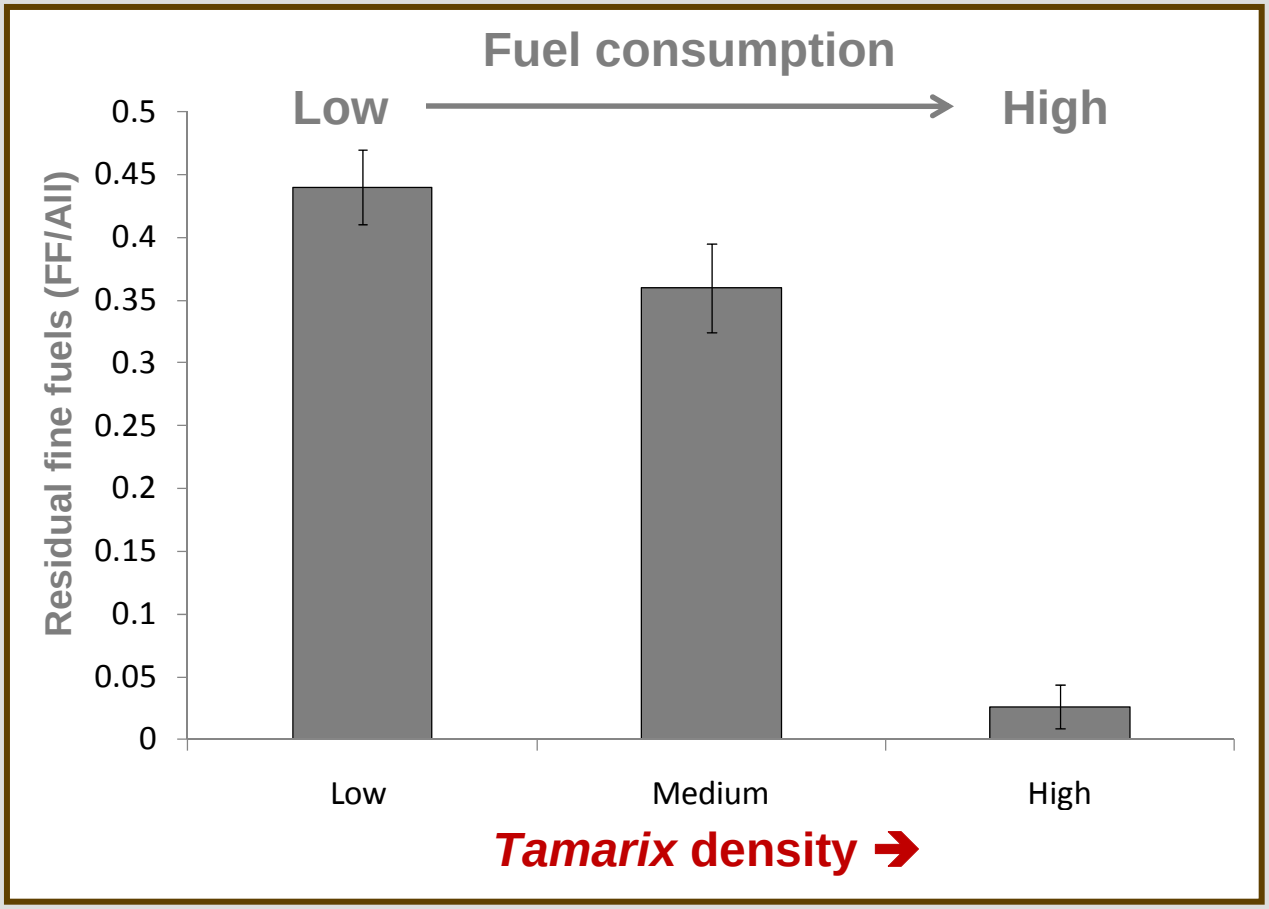
- Dozens of studies showing invasive plant alter environmental parameters
- Does that lead to reduced native cover or richness? Maybe!

Fire promoters

N fixers
Other soil alterations

Litter accumulators

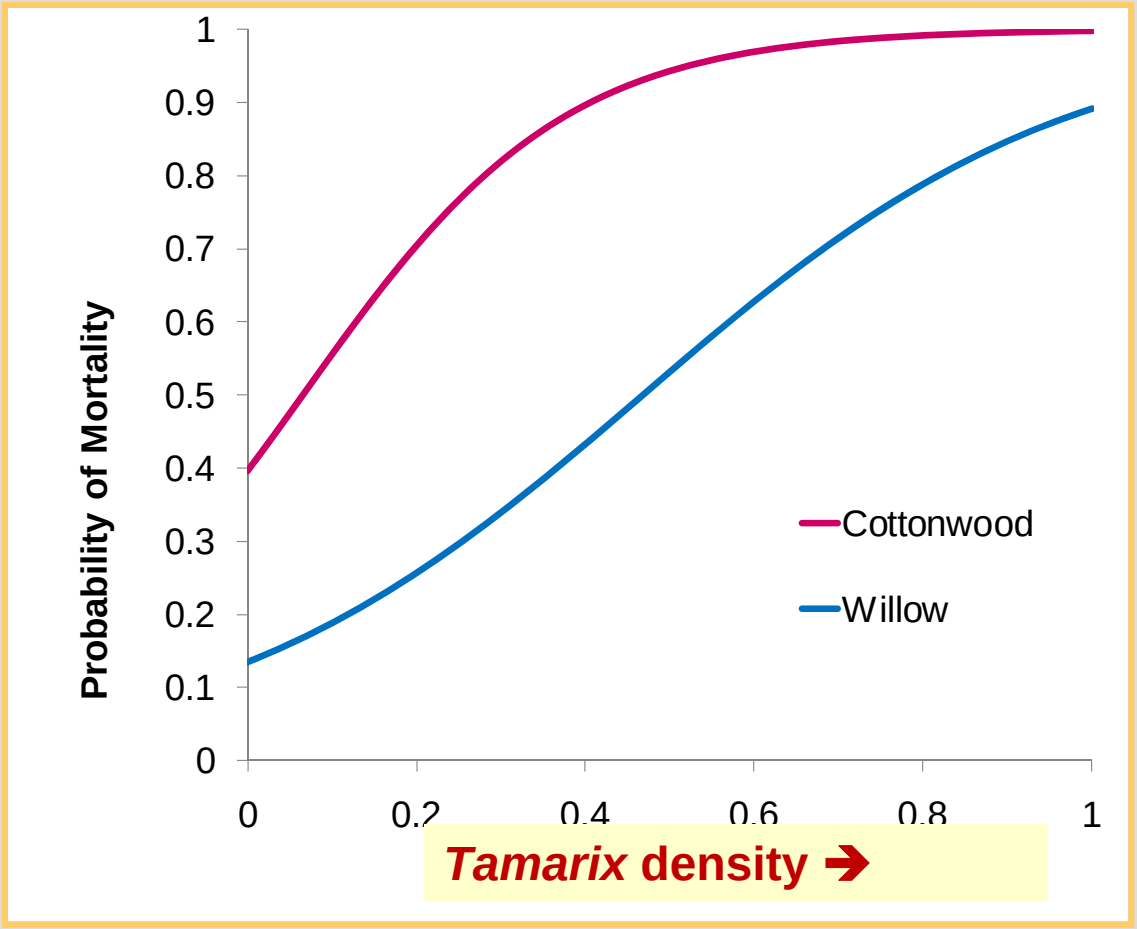
Tamarix promotes higher fire intensity



(ANOVA ≤ 0.05)

G. Drus, in prep.

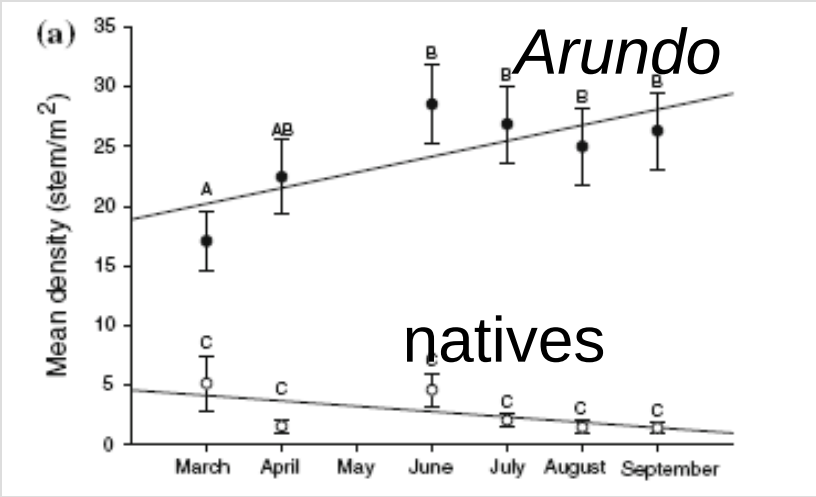
Native species mortality increases in these hotter fires



(Logistic Regression: Cottonwood; p <0.001, Willow; p <0.001,)

G. Drus, in prep.

Fire promoted by exotic grasses can reduce natives



Coffmann et al. 2010

Biotic Globalization: Does Competition from Introduced Species Threaten Biodiversity?

MARK A. DAVIS

Bioscience 2003

Opinion TRENDS in Ecology and Evolution Vol.19 No.9 September 2004

Are invasive species a major cause of extinctions?

Jessica Gurevitch and Dianna K. Padilla

Department of Ecology and Evolution, Stony Brook University, Stony Brook, NY 11794-5245, USA

Opinion TRENDS in Ecology and Evolution Vol.19 No.9 September 2004

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96 % of T and E species suffer multiple threats

4 % suffer only from alien plants

Alien plants *contribute to declines* in combination with other causes

•**http://www.natureserve.org**

Do invaders ‘push out natives’?

- Controversial…
- Through direct competition? Evidence limited.
- Through taking advantage of altered conditions: Likely
- Through altered ecosystem properties: Maybe (esp. for fire).
- Need sharper research focus in this area.
- Definition of biodiversity? Impacts on this ?
- Better communicate details of how changes in biodiversity come about and role of non-native species *relative to other factors*

III. Embrace the nuances: Impact is not a yes/no phenomenon

Varies with circumstance

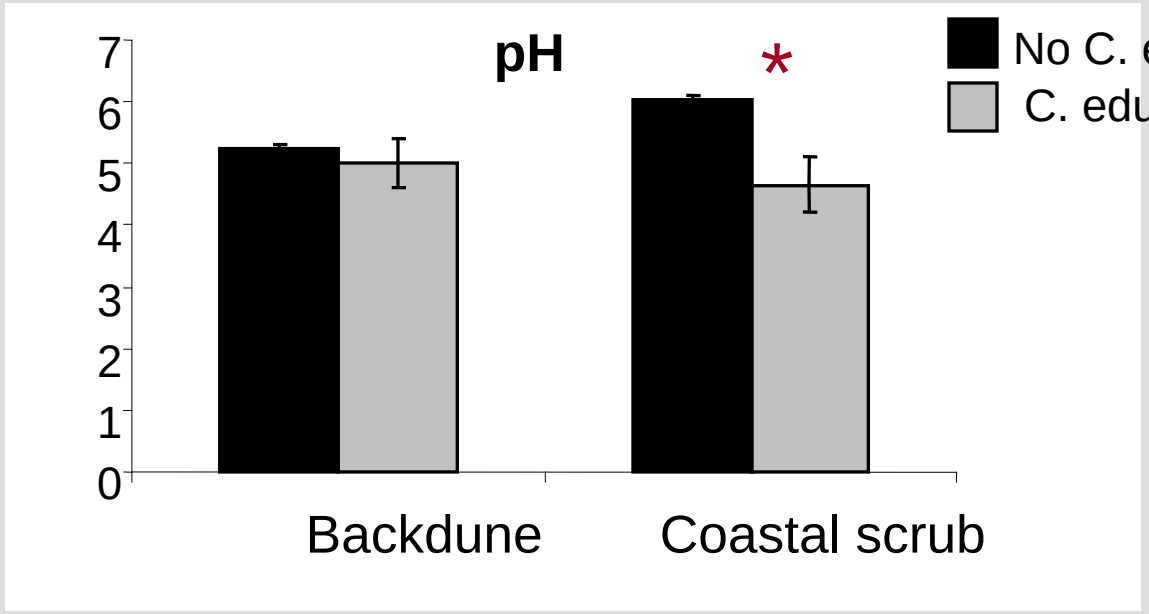
Varies with abundance of invader

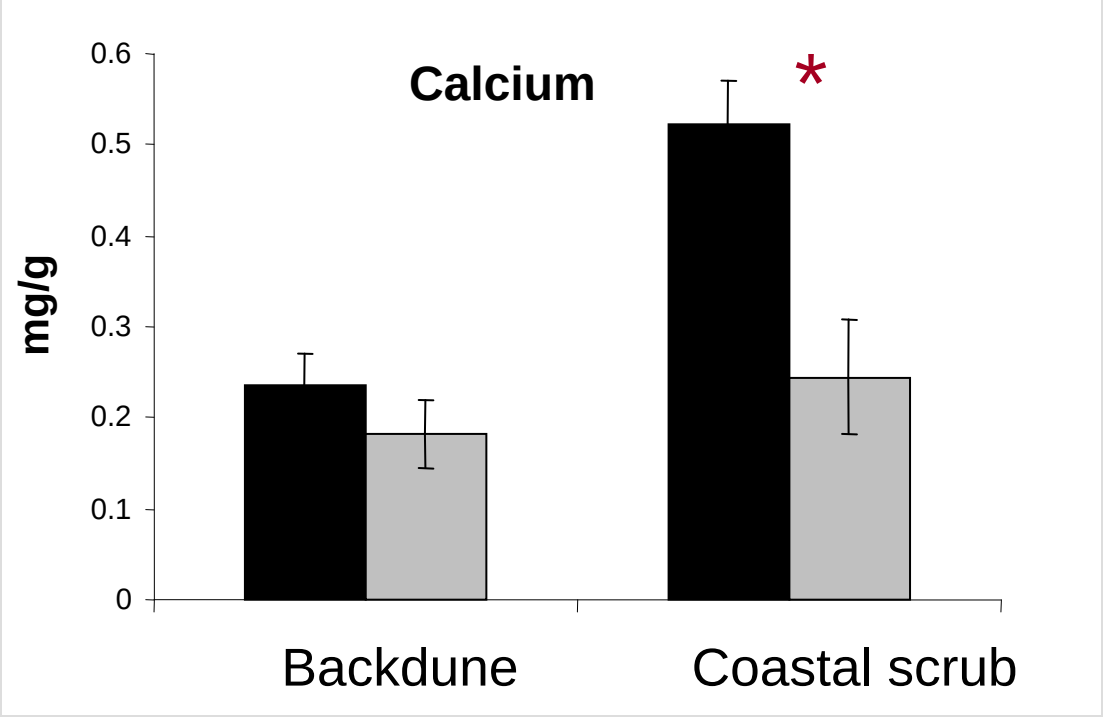
Varies with scale

Carpobrotus edulis:

Coastal dune/backdune

Coastal scrub


pH
*
No C. edulis
C. edulis present
7
6
5
4
3
2
1
0
Backdune
Coastal scrub

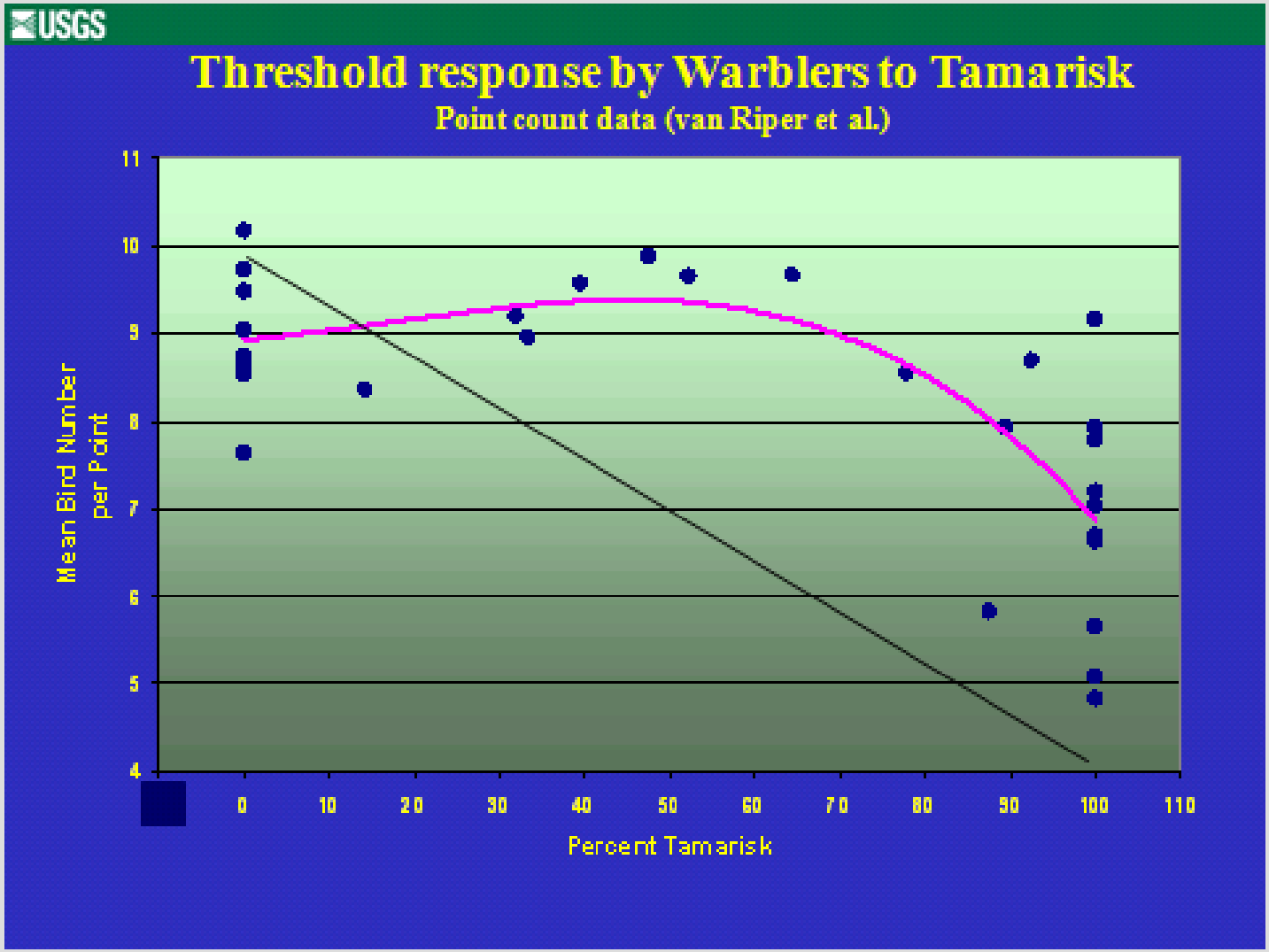

Calcium
*
mg/g
0.6
0.5
0.4
0.3
0.2
0.1
0
Backdune
Coastal scrub

Carpobrotus edulis:

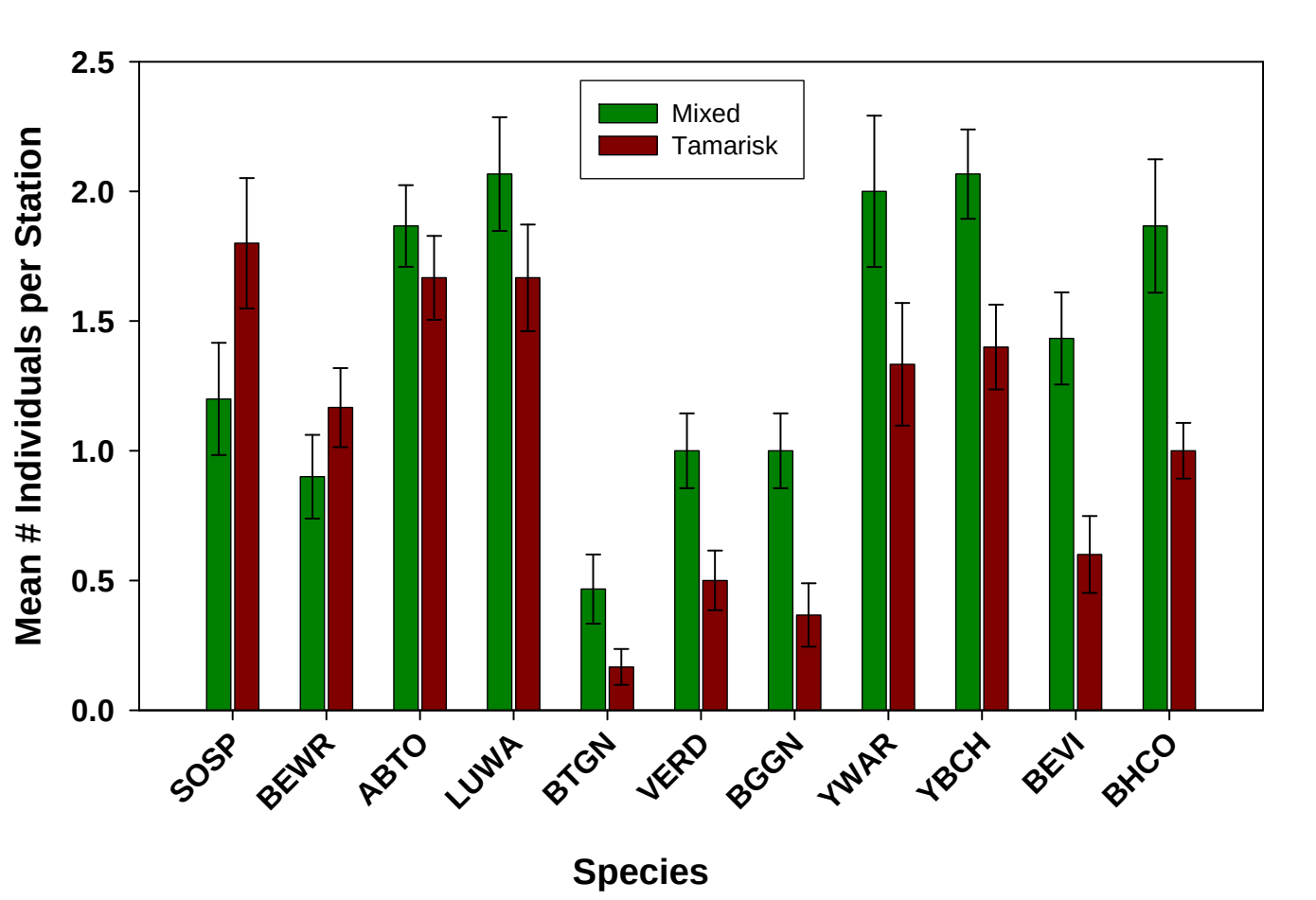
Invades faster in dune

But has lower impact even at 100% cover

Impact varies with abundance of invader (not a yes/no thing)



Native birds do well with some *Tamarix* but not complete *Tamarix*



Kuehn & Dudley, unpublished

Merits of mixed systems, may go unappreciated

Give greater attention to scale…

Ecologists have since discovered that tamarisks use water at a rate comparable to that of their native counterparts[8]. And the plants are now the preferred nesting habitat of the endangered southwestern willow flycatcher *Empidonax traillii extimus*.

Davis et al., Nature 2011

Implication: *Tamarix* has no impact on water availability

Tamarix ramossisima

Salix

Populus

Water loss per unit leaf area very similar

Sala et al. 1996

Daily water use is function of leaf area

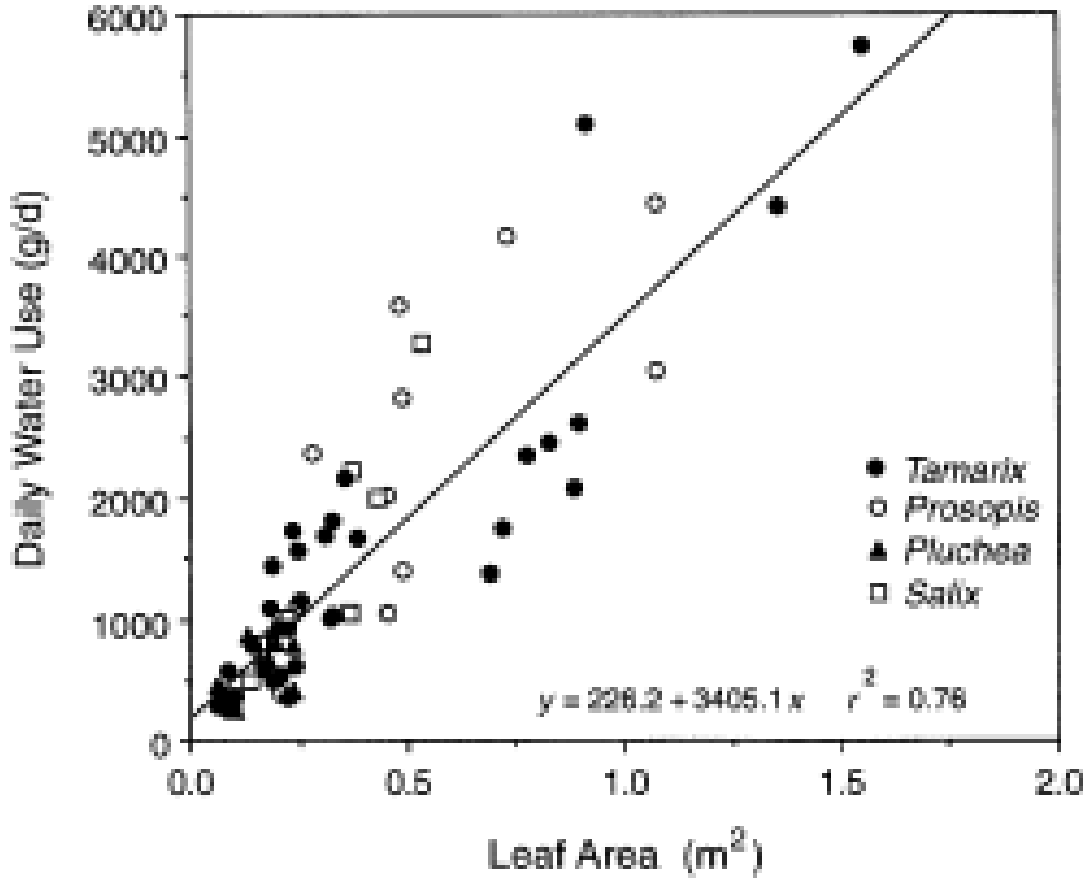


FIG. 1. Relationship between leaf area and total daily water use of *Tamarix*, *Pluchea*, *Prosopis*, and *Salix* stems sampled during the summer of 1993 at the upper site (Half Way Wash). The linear function shown describes the relationship for all four species combined.

Tamarix can become very dense

BASIN SCALE impacts on water loss depend on
-density of *Tamarix*
- what species would replace it

Difficult to estimate Tam. water use in Large & heterogeneous landscape

Measurements and reporting at appropriate scale are key…

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Davis et al., Nature 2011

Overall Conclusions:

- 20 years--research has been rich
- Integration of research and management has been rich
- But we can do even better !
  - More clear terminology
  - Sharper research focus related to impacts
  - Develop better understanding of biodiversity impacts
  - Embrace and communicate nuance

Cal-IPC Web site

- Approximately 1,800 non-native plants also grow in the wild in the state. A small number of these, approximately 200, are the ones that this Inventory considers invasive. *Improved understanding of their impacts will help those working to protect California's treasured biodiversity*.