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# Chapter 12. Using Ecological Theory to Manage or Restore Ecosystems Affected by Invasive Species



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크기 + - | 스크랩☆ | 신고요 | 인쇄 | 0 0 보내기



나일틸라피아(사진)

경기 화성·평택 황구지천서  
주변 공장 많아 수온 높은 탓



## (단독.르포)아마존 물고기 ‘비파’ 괴산 달천서 잡혀

기사입력 : 2014년 07월 07일 12시 04분

(아시아뉴스통신=김성식 기자)



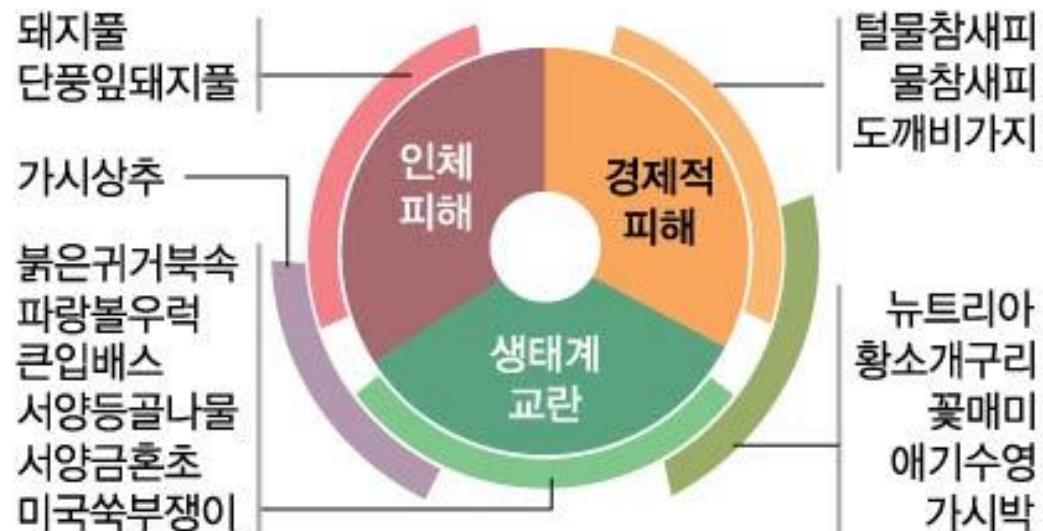
6일 충북 괴산 달천에서 잡힌 아마존 산 물고기 ‘비파’의 모습./아시아뉴스통신=김성식 기자

남한강 수계인 충북 괴산 ‘달천’에서 아마존 강이 원산지인 민물고기가 현지 어부에게 잡혔다

자연적으로는 일어날 수 없는 ‘해괴한 일’이 벌어진 것이다.



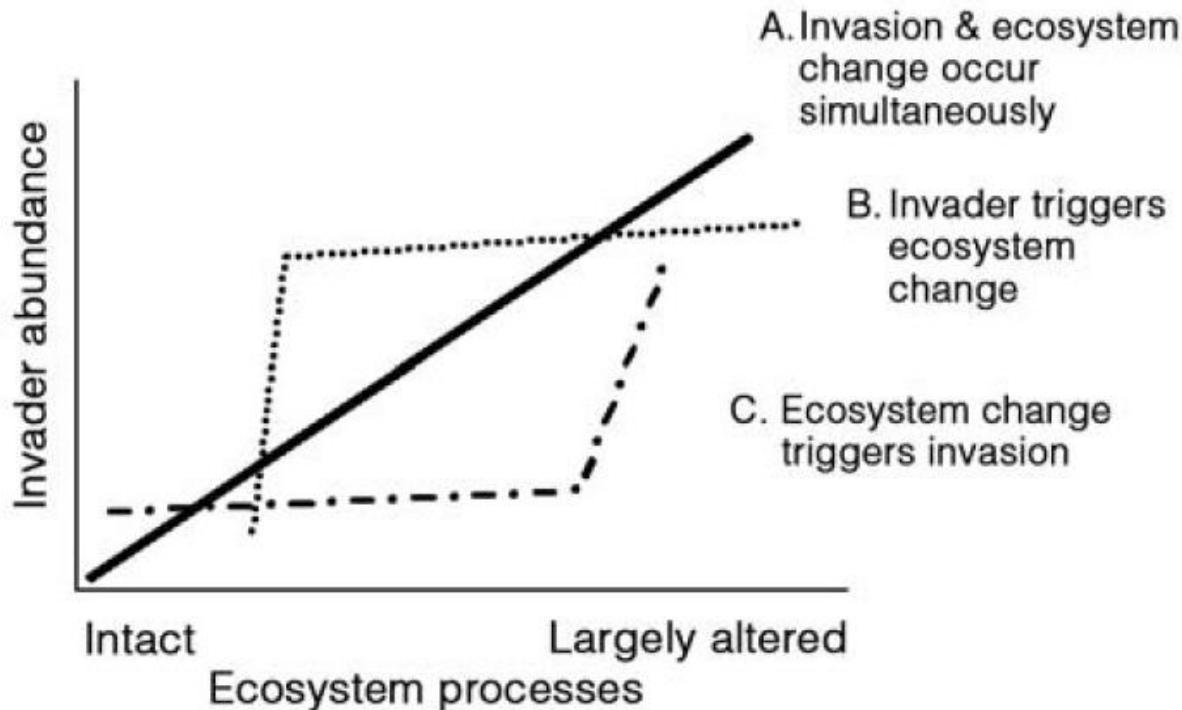
## 생태계교란 생물 피해 유형



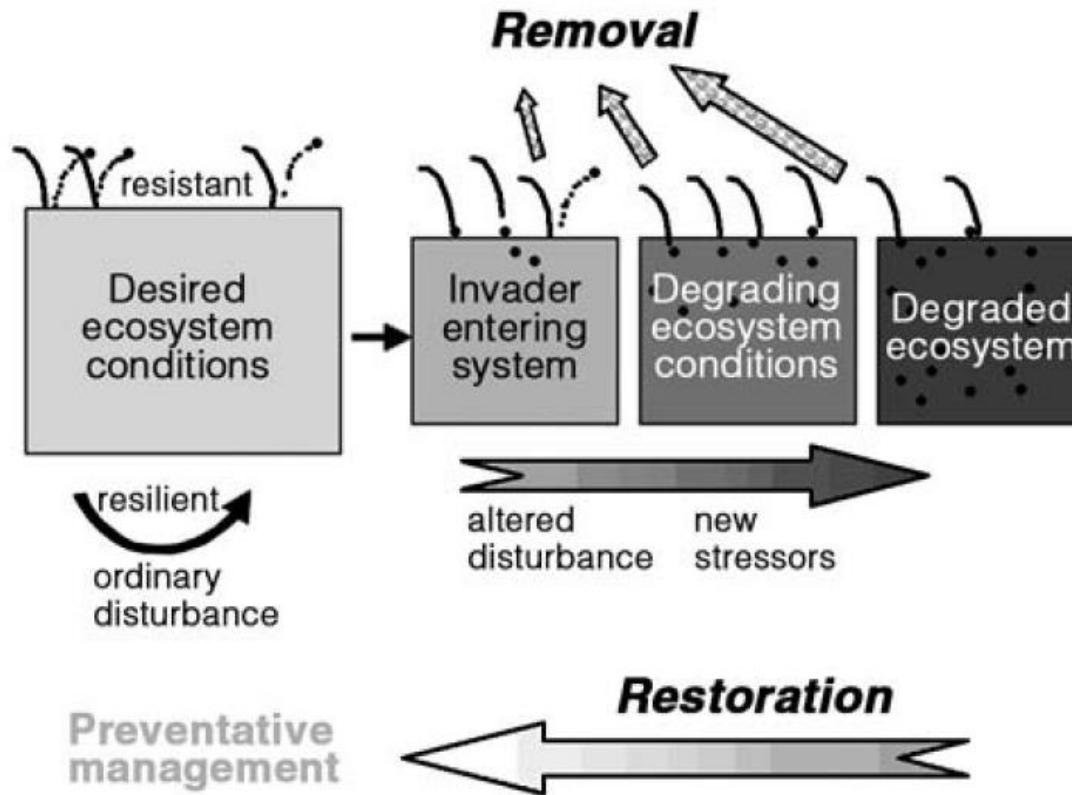
## 국내 도입 외래생물 추이



# Relationships b/w Invader Abundance & Ecosystem Change



# Conceptual Scheme for Restoration of Systems Affected by Invasive Plant Species



- ✓ Type of restoration action depends on the state of degradation of the ecosystem

# What Determines **Sustainable** Ecosystem?

## ✓ **Resilience:**

- Ability to return to pre-disturbance conditions following a disturbance

## ✓ **Resistance:**

- Ability to resist to change following arrival of propagules of potentially damaging species
  - Decreasing the likelihood of successful establishment & population growth of invaders

# Two Fundamental Approaches to Restoration of Invaded Ecosystems

## Preventive Management

- If the system is still providing valued ecosystem functions
- To reduce the likelihood of invasion

## Active Restoration

- If the system has already been invaded and is at risk of further degradation
- Removal of invasive species

→ Decision depends on the state of degradation of the system

# Two Basic Elements of Active Restoration

## ✓ **Top-Down Control:**

- Removing the damaging invader or
- Reducing its abundance and supply of propagules  
e.g.) manual removal, herbicides

## ✓ **Bottom-Up Control:**

- Restoration of properties or processes that contribute to sustainability
- Increasing the likelihood of competitive dominance for the desired species
  - Removal or amelioration of ecosystem stressors
  - Alteration or manipulation of environmental conditions (e.g. soil)

# Invasions

$$E = I \times S$$

**E** = the number of invaders in a site

**I** = the number of species introduced

**S** = the survival and reproduction of those arriving species

# Life-History Traits Predicting Arrival (I) – ‘Invasion Ability’

## ✓ **Dispersal mode/ability**

- “Early detection, rapid response” (EDRR programs)
- For plants, successful invaders:
  - Wind-dispersed seeds (high rates of propagule supply)
  - Larger numbers of propagules

# “Early Detection, Rapid Response” (EDRR) Campaign

The screenshot shows the NISC website with a green sidebar on the left containing a search bar, a 'go' button, and a 'Browse By Subject' menu with various categories. The main content area has a green header bar with navigation links. Below the header, the page title 'Early Detection and Rapid Response' is in red, followed by a detailed description of EDRR, a link to guidelines, and a list of three main categories: Early Detection, Rapid Assessment, and Rapid Response.

**The National Invasive Species Council**

Search NISC  **go**

HOME • ABOUT NISC • NEWSROOM • FAQ • National Invasive Species Information Center

You are here: Home / Early Detection and Rapid Response

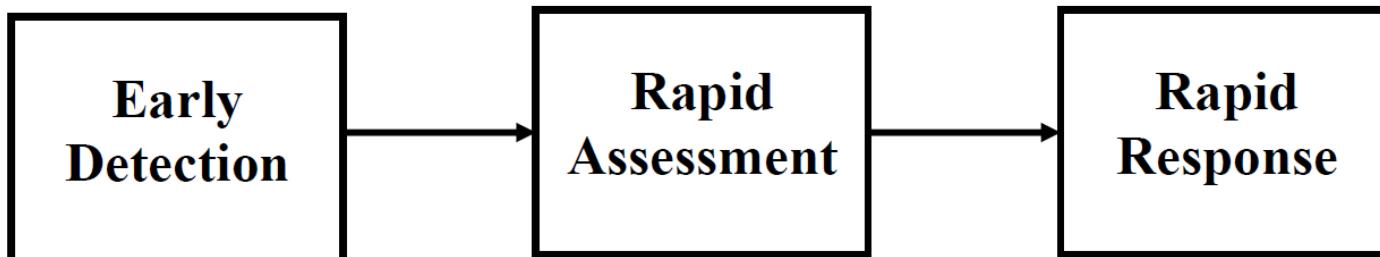
## Early Detection and Rapid Response

While prevention is the first line of defense, even the best prevention efforts will not stop all invasive species. Early detection and rapid response (EDRR) efforts increase the likelihood that invasions will be halted and eradicated. Once a species becomes widely established, the only action possible is the partial mitigation of negative impacts.

Based on the work of the ISAC/NISC EDRR Subcommittee, NISC has approved [Guidelines for Early Detection and Rapid Response](#). Many states and some regions of the U.S. have developed their own EDRR tools (see the [Aquatic Nuisance Task Force sites](#).)

EDDR actions are grouped into three (3) main categories:

- Early Detection
- Rapid Assessment
- Rapid Response



# Life-History Traits Predicting Reproductive Rate Once Established (S)

## ✓ Traits of Successful Invaders:

- Rapid growth to reproductive stage (= short juvenile stage)
- Short intervals b/w large seed crops
- Phenological plasticity

# Prioritizing Species for Removal

- ✓ Invasional Meltdown
  - The process by which the negative impacts induced on native ecosystems by one invading non-indigenous species are exacerbated by positive interactions with another exotic species
- ✓ Invaders that inhibit establishment of native species

# Many are Introduced, but Few Become Invasive

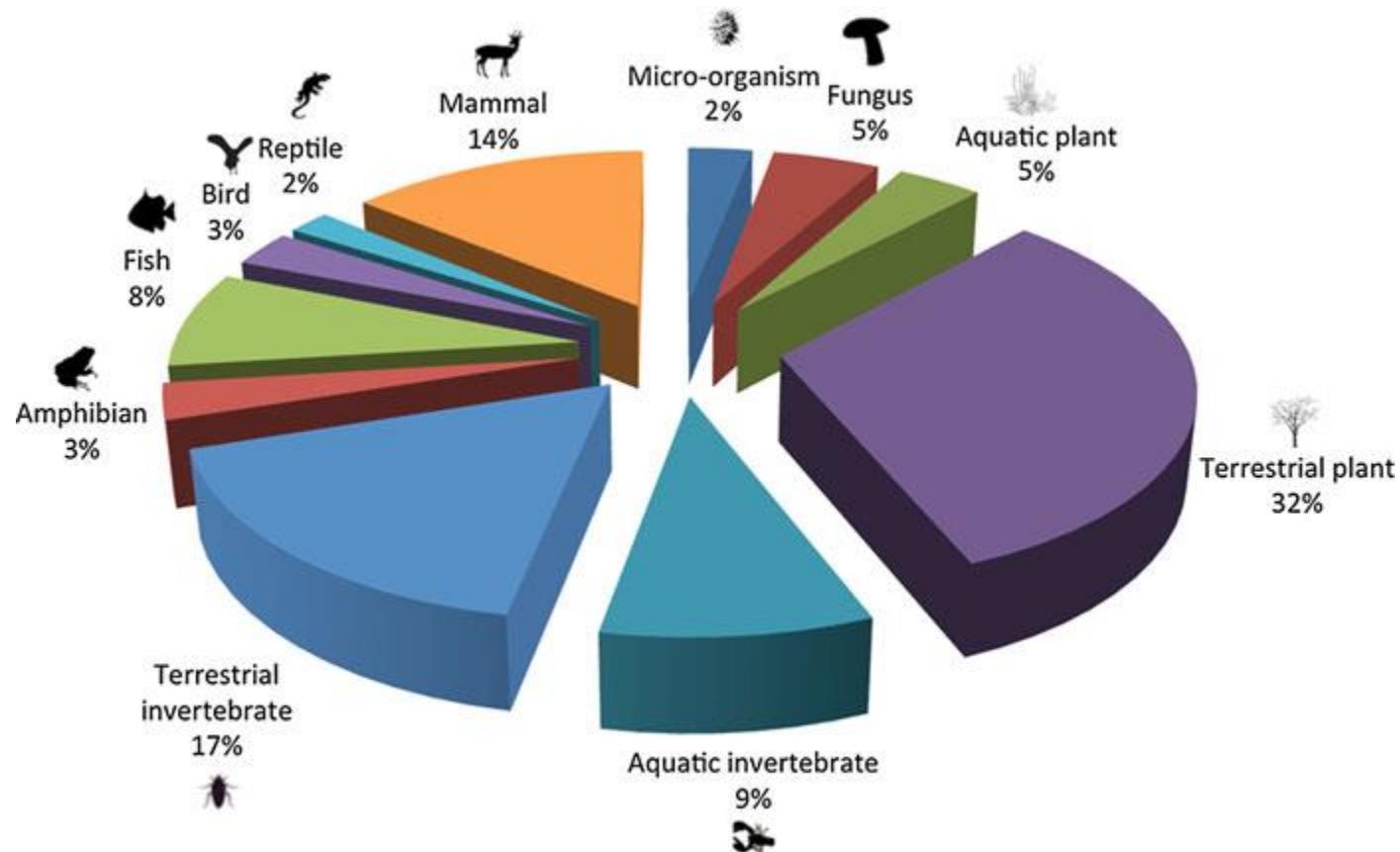
**100 OF THE WORLD'S  
WORST INVASIVE  
ALIEN SPECIES**

A SELECTION FROM THE GLOBAL  
INVASIVE SPECIES DATABASE

IUCN (2000)

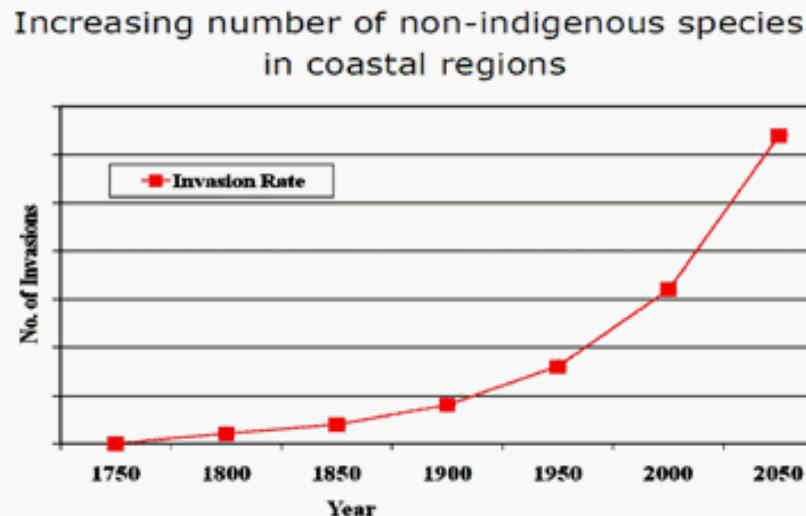


# Taxonomic Representation of 100 of the World's Worst Alien Invasive Species



# Many Aquatic Species are Introduced via Ballast Water

## NUMBER OF INVASIVE SPECIES ASSOCIATED WITH BALLAST WATER IS RISING



# Hypotheses about Why Invaders Succeed

- ✓ Invasive species have traits that favor establishment and spread (e.g. high fecundity, rapid growth)
- ✓ Invasive species are released from enemies (Enemy Release Hypothesis)
- ✓ Invasive species exploit “empty niches”
- ✓ Invasive species are favored by anthropogenic pressure on natives (disturbance)

# Disturbance Theory In Relation to Invasions

- ✓ Disturbance:
  - Promoting invasion (particularly if the regional pool of non-indigenous species is diverse)
  - Its type, size and frequency affecting an invasion probability
- ✓ Disturbance can be manipulated to prevent invasion
  - Frequent prescribed burning (but, poorly timed fires can promote)



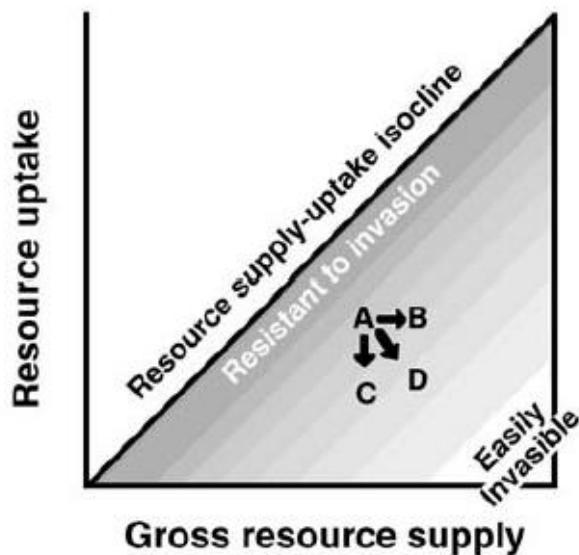
- ✓ Intermediate Disturbance Hypothesis [Connell 1978]

# Competition Theory In Relation to Community Resistance to Invasion

- ✓ Community resistance to invasion
  - Ability to limit establishments of an invading population
- ✓ Prediction of the competition theory
  - If residents are abundant, invasion likelihood decreases (except that the invader has access to unique resources; “empty niche”)
  - **Diverse communities utilize available resources more fully and therefore are less likely to be invaded (‘Diversity Resistance Hypothesis’)** [Levin & D’Antonio 1999]
  - ‘Enhance diversity within a restoration site (e.g. park)’

# Competition Theory In Relation to Community Resistance to Invasion

- ✓ **Community “invasibility” (Community susceptibility to invasion) – ‘fluctuating resources hypothesis’ [Davis *et al.* 2000]**
  - Invasibility (resistance) = the balance b/w community-level resource uptake and gross resource supply rates
  - Invasibility increases as resource availability (supply –uptake) increases



- Resource uptake ↓:  
Disturbance
- Resource supply ↑:  
High rainfall years in an arid system

# Restoration Difficulties of Invasive Species

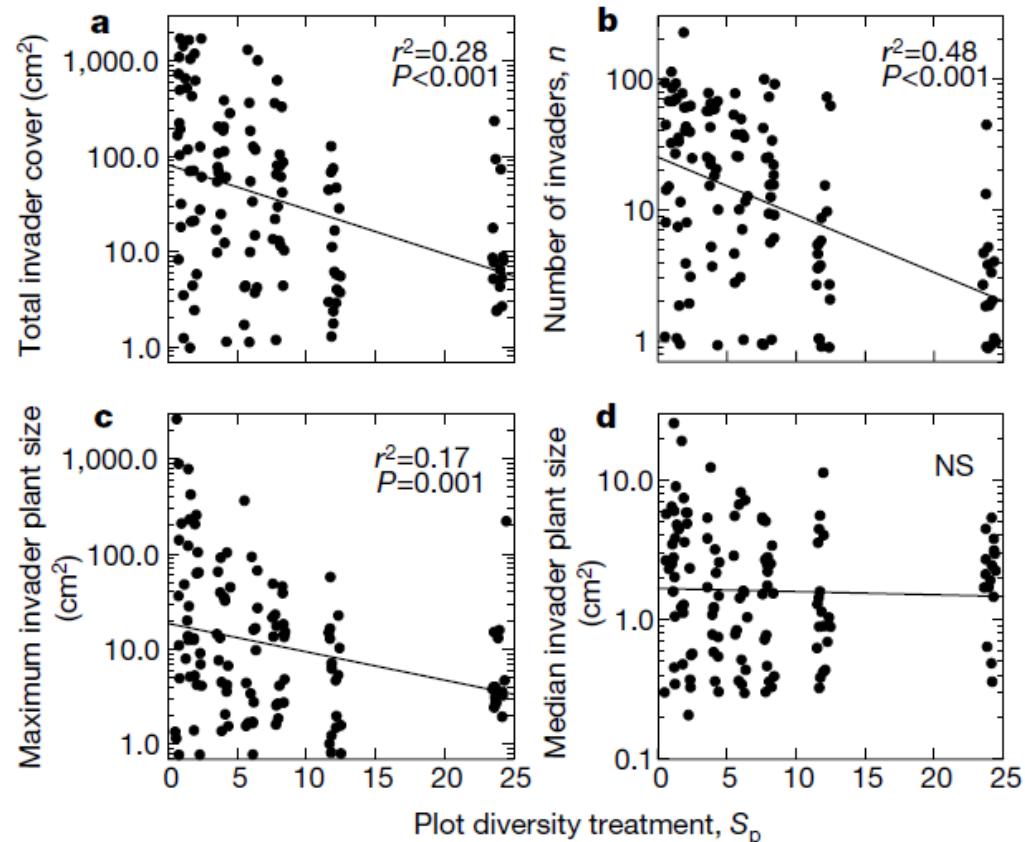
- ✓ Invasion paradox [Davis *et al.* 2000]
  - Removal of invaders → resource uptake ↓ → invasibility ↑
  - Fertilization practice: resource supply ↑ → invasibility ↑
  
- ✓ The most pernicious invaders
  - Invasive species that create positive feedbacks (from ecosystem changes) and enhance their own growth

# General Restoration Strategies of Invasive Species

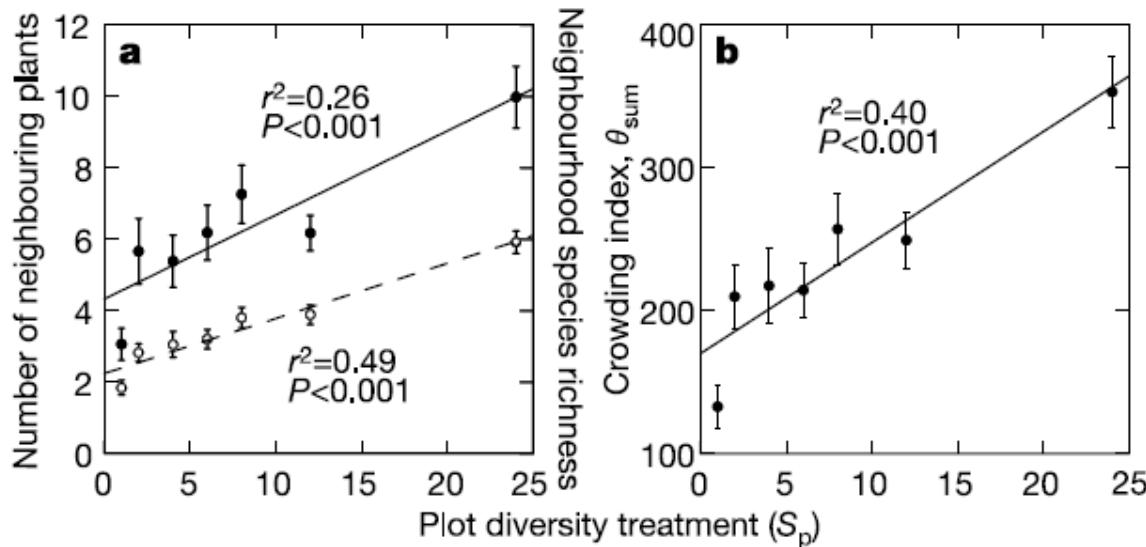
- ✓ Prevent the introduction of invasive species
  - Preventive Management
- ✓ Detect and respond rapidly to control populations of invasive species → Early Detection, Rapid Response (EDRR)
- ✓ Monitor restored sites frequently
- ✓ Promote public education on invasive species

# Biodiversity as a barrier to ecological invasion

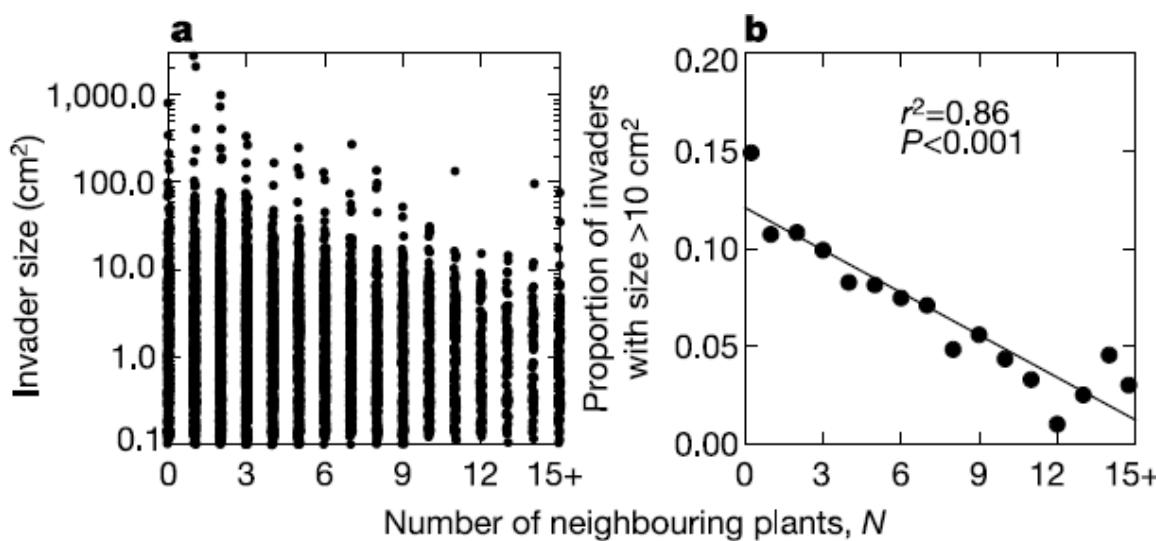
Theodore A. Kennedy\*, Shahid Naeem†, Katherine M. Howe†,  
Johannes M. H. Knops‡, David Tilman\* & Peter Reich§



→ Plot species richness had significant negative effect on the number and size of invaders



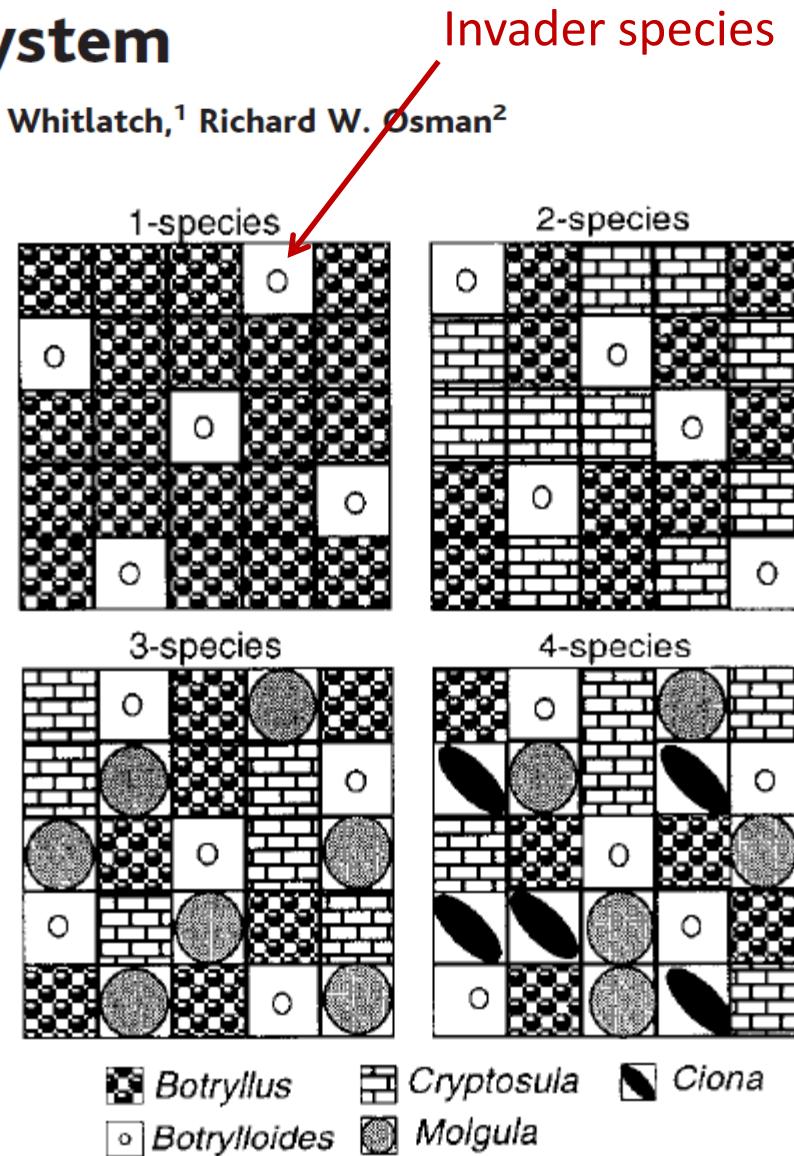
→ Diverse plots tend to have more neighboring plants

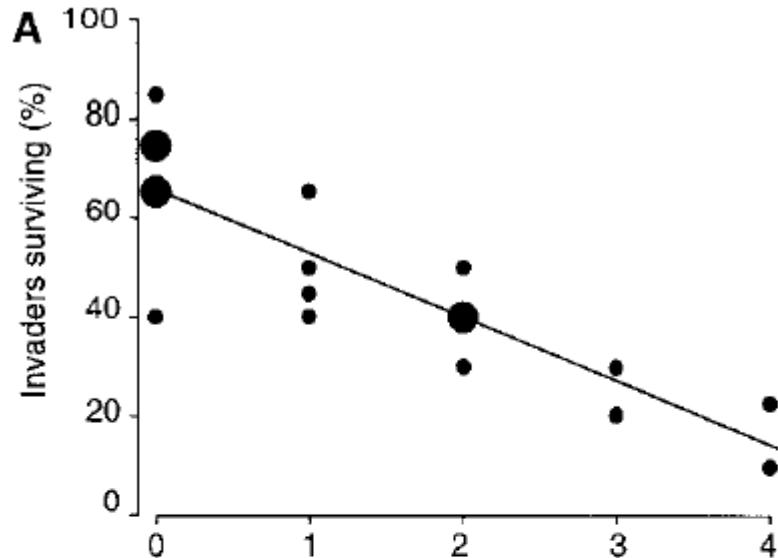


→ Invader size markedly decreases as the number of neighboring plants increases

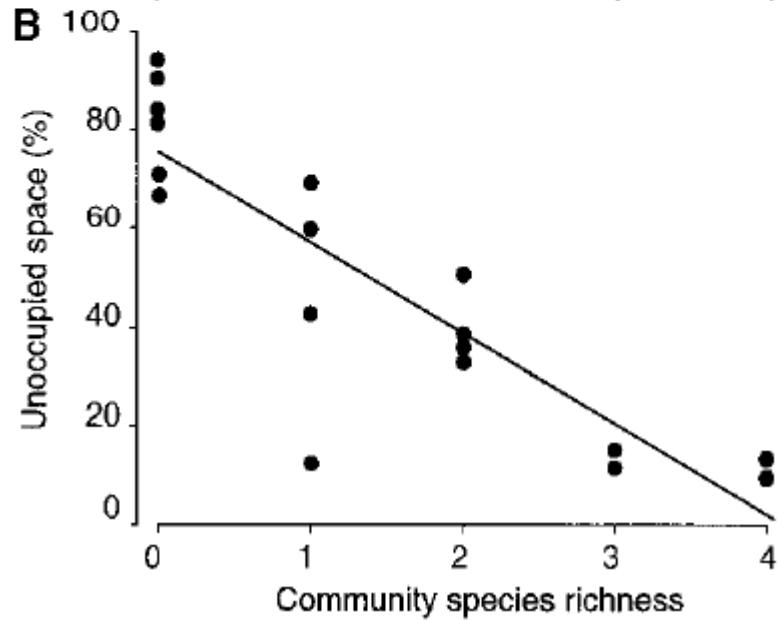
# Species Diversity and Invasion Resistance in a Marine Ecosystem

John J. Stachowicz,<sup>1\*</sup> Robert B. Whitlatch,<sup>1</sup> Richard W. Osman<sup>2</sup>





→ Decreased survival of invader recruits in communities with higher species richness



→ Less open space became available in communities with higher native species

# Take-Home Message

- ✓ For controlling invaders, a major emphasis needs to be placed on “**bottom-up**” approaches (e.g. **preventive management**), which will increase the resistance of the ecosystem to invaders and foster resilience following invasions
- ✓ How?  
Answer is always the same .....  
**“Maintain Species Rich Community at Target sites”**