Invasion Ecology
Definitions & Stages
Quiz Questions

1. What are the two ways that humans introduce non-native species? How does the pathway of introduction vary by taxonomic group?

2. Define the ‘lag’ phase of invasion. Name two factors that might contribute to a lag phase.

3. List and describe two examples of hypotheses about why a community might be vulnerable to invasion
Quiz Questions

4. List and describe two examples of invasive species impacts on native species populations or on ecosystem-level function

5. List and describe two strategies for the control of invasive species
Invasion Ecology’s History

Charles Elton

Published 1958
Definition of an invasive species

• Non-native
• Capable of surviving without direct help from people (established or naturalized)
• Spreading away from sites of initial establishment
• *Often with negative ecological and economic consequences*

Lockwood et al., 2007
The path to invasion is marked by many opportunities for failure

Blackburn et al., 2011
Stages of invasion

Lockwood et al., 2007
Stages of invasion

Lockwood et al., 2007
Pathways of Introduction
Why are non-native species introduced?

- Deliberately
  - Horticulture trade, pet trade
  - American Acclimatization Society
  - 60% of naturalized plants in the U.S. were deliberately introduced (Mack & Erneberg, 2002)
Why are non-native species introduced?

Immigration of humans and non-native species from Europe to N. America

Jeschke & Strayer, 2005
Why are non-native species introduced?

- Deliberately
- Accidentally
  - Seed contaminants
  - Ballast water discharge
  - Packing/shipping materials
  - APHIS & Border control inspect about 2% of shipping container for pests
Quantify Introduction Pathways

Team Task 1

• Sept 11, 16 & 18 (presentation)
Stages of invasion

Lockwood et al., 2007
Invasion Hypotheses

Vacant (or empty) niche hypothesis
Invasion Hypotheses

Vacant (or empty) niche hypothesis

vs.
Invasion Hypotheses

Vacant (or empty) niche hypothesis

Wilcove et al., 1998
Invasion Hypotheses

Enemy release hypothesis

Blumenthal et al., 2009
Invasion Hypotheses

Enemy release hypothesis

Species do better in the absence of native predators and competitors

Blumenthal et al., 2009
Invasion Hypotheses

Invasive species have unique traits
Compile Invasive Species Traits

Team Task 2
• Sept 30, Oct 2 & 7 (presentation)

Investigate other Invasion Hypotheses

Team Task 3
• Oct 16, 21 & 23 (presentation)
Stages of invasion

Transport
  | Death or captivity
  | Introduction
  | Fail
  | Establish
  | Spread
  | Remain
  | Local
  | Spread
  | Impact
  | Low
  | High

Invasion stages

Transport
Establishment
Spread
Impact

Lockwood et al., 2007
Invasion biogeography – predicting risk
Model Invasion Risk

Team Task 4

• Nov 6, 12 & 13 (presentation)
Impacts
Quantify Invasive Species Impacts

Team Task 5

• Nov 20, 25 & Dec 2 (presentation)
Species of the day:
Burmese python (*Python molurus bivittatus*)
Species of the day:
Burmese python (*Python molurus bivittatus*)
Burmese pythons eat everything

- Great blue heron
- Sheep
- Alligator (fail)
Python removal from the everglades
Roadkill counts 1990s

- Rodents
- Rabbits
- Opossum
- Raccoon
- Foxes
- Coyote
- Bobcat
- Panther
- Deer

Total number of roadkills
Roadkill pre- vs post- python

Roadkill per 100 km

ENP temporal variation
- 1996 – 1997 (6,599 km)
- 2003 – 2011 (56,971 km)
Group Discussion

• Go through your answers to the questions – see if you can make a longer list for the questions that ask for two examples

• If you get through all the questions, see if you can come up with another invasion hypothesis not listed by Mack et al.
Fig. 2. Many invaders occupy new ranges at an accelerating rate with pronounced "lag" and "log" phases of proliferation and spread. Terrestrial plant invasions most commonly illustrate this pattern (e.g., the spread of *Opuntia aurantiaca* in South Africa [Moran and Zimmerman 1991]).
TABLE 1. Escape from native parasites and predators often translates into a huge benefit in plant performance, including fitness.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Chrysanthemoides monilifera</th>
<th>Acacia longifolia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Australia</td>
<td>South Africa</td>
</tr>
<tr>
<td>Main flowering time</td>
<td>Apr–Aug</td>
<td>Jun–Sep</td>
</tr>
<tr>
<td>Flowers/m²</td>
<td>1010 ± 170†</td>
<td>840 ± 136</td>
</tr>
<tr>
<td>Fruit/flower</td>
<td>6.6 ± 0.3</td>
<td>4.5 ± 0.1</td>
</tr>
<tr>
<td>Green fruit/m²</td>
<td>6660‡</td>
<td>3755</td>
</tr>
<tr>
<td>Ripe seeds/m²</td>
<td>4450 ± 750</td>
<td>2160 ± 350</td>
</tr>
<tr>
<td>Soil seeds/m²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fragmented</td>
<td>6380 ± 605</td>
<td>2352 ± 20</td>
</tr>
<tr>
<td>Whole</td>
<td>2475 ± 560</td>
<td>2320 ± 17</td>
</tr>
<tr>
<td>Viable</td>
<td>2030 ± 460</td>
<td>46 ± 28</td>
</tr>
</tbody>
</table>

Notes: Chrysanthemoides monilifera and Acacia longifolia are native to South Africa and Australia, respectively. Plants of both species display much greater flower and seed production when grown in the other country, benefiting from the escape from native pests and little or no attack by native pests in their new ranges (Weiss and Milton 1984).

† Values are means ± SE.
‡ Calculated.
Fig. 3. Percentage levels of native and nonindigenous birds on Mauna Loa, Hawaii, infected with avian malaria, 1978–1979 and mean numbers of parasites per 10,000 RBCs. As a result of the native birds’ greater susceptibility, they were largely restricted to higher elevations. Numbers in brackets or parentheses are sample sizes (Van Riper et al. 1986). RBC = red blood cells.
**Fig. 4.** *Carpobrotus edulis*, a sprawling perennial plant, invades California coastal communities. It overtops native species, such as *Haplopappus ericoides*, and competes aggressively for soil water. Its removal coincides with a marked increase in canopy area of *H. ericoides*; values represent change as a percentage of initial canopy area. Error bars are +1 SE (D’Antonio and Mahall 1991).
FIG. 5. Invasion of Brazilian fire ants, *Solenopsis invicta*, into woodlands and grasslands in central Texas causes a radical change in the density and species composition of the native ant fauna, as reflected in pitfall trap records. Species richness and numbers of native ant workers decline sharply, while the invader's populations are several orders of magnitude greater than all ants in uninfested sites. Note the much larger scale on the bottom graph, showing numbers of all ants combined. All values were calculated with site pitfall trap totals summed across May, July, and October 1987 (Porter and Savignano 1990).