INVASIVE SPECIES (text pp. 279-299) – We may add case studies during last day or two of class.

I. Terms

exotic, *non-indigenous*, *alien*, *non-native* = species historically absent from an area
native, *indigenous* = those that have been present in an area for some time
invasive = species that grow in profusion and produce a significant change in terms of community composition or ecological processes
- these may be *native* **or** *exotic*
Tens rule = generally only 5 to 20% of species transition from stages of introduced to established to invasive
invasibility = degree to which an area is susceptible to invasion

II. Some hypotheses as to why invasive spp are successful in wetlands

A. High reproductive capacity
-often a particularly high capacity for vegetative spread
e.g., *E. crassipes* pop doubles in 13 days, *Salvinia* spp from 3.5 to 17 d
B. Environmental stability/uniformity provided by water
- high number of cosmopolitan spp
C. Broad ecological tolerances of many wetland plants
- some are resistant to fire, flooding, drought (*Melaleuca*, *Tamarix*)
D. Escape from natural herbivores in their native habitats
E. Have different "niche compatibilities" than native assemblages

III. Human dispersal of invasive spp

A. Unintentional transport
- ship ballast, e.g.
B. Escape from cultivation for crops, horticulture, erosion control
- seeds included in rice and plants grown for edible foliage (*Nasturtium*)
- grasses for erosion control (*Arundo, Panicum repens*)
- *Schinus terebinthifolius* (Brazilian pepper)
C. Aquarium spp
- *Elodea, Myriophyllum, Hydrilla*, etc
D. *Melaleuca* was brought into S. FL to help drain wetlands for agriculture
E. Educational collections
- *Azolla, Salvinia*

IV. Factors that increase the invasibility of an area

A. Islands
- up to 20% of mainland species, but 20 to 50% on islands
- New Zealand has received 42 wetland plants but exported only one (no canopy-forming native spp in NZ)
- Hawaii and Florida in the US

IV. Factors that increase the invasibility of an area

B. Land-use change
- deforested watersheds, construction sites, drained wetlands

C. Damming and impoundment
- changes hydroperiod and water depth

D. Fragmentation of natural habitats
- from agriculture and urban development

E. Freshwater inflows to salt marshes
- from agr, urban runoff, and cutoff of tidal inputs

V. Effects of invaders on the natural assemblage

A. Altered community structure (Fig 8.1, e.g.)
- *Melaleuca* invaded ecotonal areas between Cypress sloughs and uplands
- *Schinus terebinthifolius* shades out understory
- *Colocasia esculena* grows densely in riparian areas
- *Alternanthera philoxeroides* forms surface canopies b/c of hollow stems

B. Serious detrimental effects on seed banks

C. Effects on aquatic animals

D. Altered ecosystem functions
- Reduced water column prim prod (canopy formers: *Typha, Salvinia, Eichhornia*)
- Changes in hydrology (*Melaleuca, Tamarix*)
- Altered fire regime (*Arundo, Melaleuca*)

E. Effects on human use of ecosystems
- clogging of waterways & water intakes/outlets
- increased sediment loads
- fisheries reductions

VI. Control

A. Habitat alteration
1. Shading water surface
2. Shading sediment surface
   - both of these are limited in effect and area that can be treated
3. Dredging sediments
   - not very effective
4. Altering hydrology (Table 8.1)
   - depends strongly on timing of drawdown

B. Mechanical controls (Table 8.2)
- also of limited effectiveness

VI. Control

C. Chemical controls
1. Only 10 to 12 herbicides listed for use on wetland plants
2. Table 8.4 lists advantages/disadvantages & 8.3 susceptibility of selected spp
3. Salt also can be used to control intolerant invaders of brackish marshes

D. Biological controls
1. Two broad types
   a. selective agents
   b. polyphagous organisms
2. Difficulties
   a. potential creation of new problems
   b. difficult to establish control agent in new habitat
   c. 75-80% of attempts have not worked
3. Insects
   a. usually specialist insects (beetles/weevils)
   b. ex: alligator weed beetle, *Melaleuca* weevil, *Myriophyllum*, *Lythrum*
   c. some success on *Eichhornia* (3 insect spp) and *Lythrum salicaria* (6 insect spp)
4. Fish
   a. all polyphagous
   b. tilapia, carp
   c. can be successful in general removal, but stocking rate is critical
5. Pathogens, Other
   a. limited success and effort with pathogens
   b. other generalist vertebrate animals, again, little success

Environmental characteristics altered by some of the 31 most invasive plant species in Florida (Gordon 1998).

Habitat characteristics	No. of species (percent)
Erosion rate, sedimentation rate, stream channel morphology	2 to 7 (6 to 22%)
Water cycling, water table depth, surface-flow patterns	2 to 7 (6 to 22%)
Soil nutrient availability, water chemistry	10 to 12 (32 to 39%)
Addition of plant growth form, alteration of vertical structure	4 to 18 (13 to 58%)
Physical or chemical barrier to native species recruitment	13 to 23 (42 to 74%)
Reduced light avail, altered nutrient and/or water avail	10 to 22 (32 to 71%)

The tens rule, Williamson and Fitter 1996 (Ecology 77: 1661-1666)

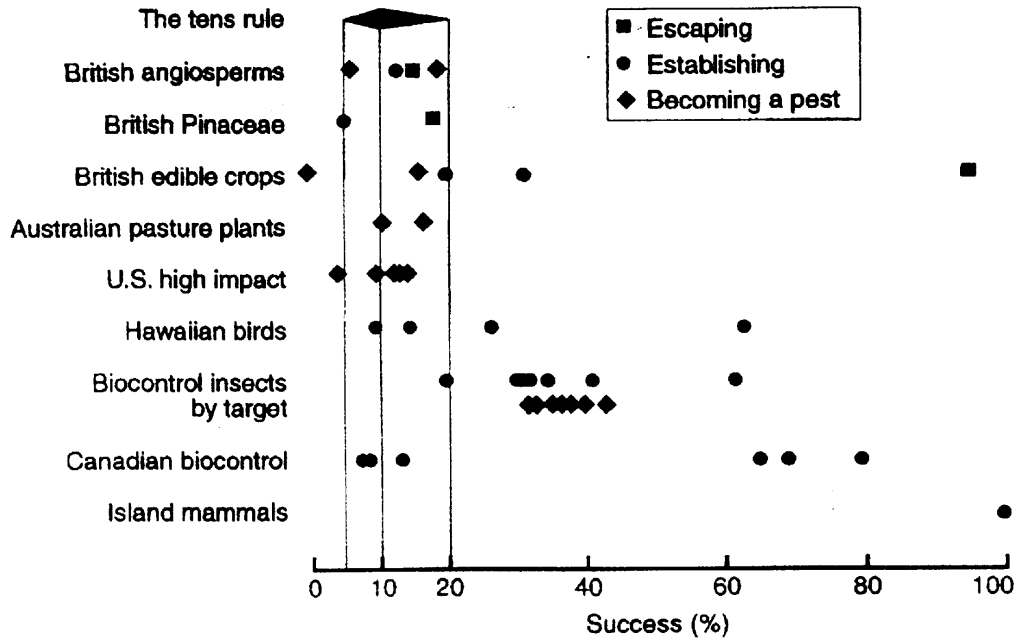

FIG. 1. The tens rule, showing ratios of the three invasion transition stages. The suggested range for the tens rule is shown by the black diamond at the top. For British angiosperms (from Williamson 1993) the two points for becoming a pest are for severe pests (left) and all pests. British Pinaceae data are from Williamson and Fitter (1996). For British edible crops see Table 2. Australian pasture plants are weedy species in Lonsdale (1994): legumes 10%, grasses 17%. United States "high impact" invaders are, left to right, fishes, plant pathogens, insects, mollusks, and terrestrial vertebrates (from OTA 1993: Fig. 2-2). Hawaiian birds are, left to right, all species in native forest, all species in native forest and open grassland, Columbiformes in all habitats, Passeriformes in all habitats (Table 3). Biocontrol insects by target are from Table 4, with the pest symbol used for those effecting control (see *Statistical rules: Exception three . . .*). Canadian biocontrol data are from Beirne (1975) (see *Statistical rules: Exception three . . .*). Island mammals are from Ireland and Newfoundland combined (see *Statistical rules: Exception four . . .*). For expanded definitions of symbols, see Table 1.