SER- Design-to-Dirt Workshops

Ecological Principles of Weed Management

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Presentation Outline

- Introduction—a restoration ecology perspective on weed ecology
- What constitutes a weed? Definition
- What is an "ideal" weed?
- Annual vs. perennial strategies
- Seed dispersal vs. vegetative dispersal
- Weeds have a competative advantage

Weed Ecology -A Restoration Perspective

Why are weeds a problem on restoration sites?

- They increase the costs of site preparation
- They increase the costs of maintenance
- They decrease growth rates in plantings
- They result in higher planting mortality

Increase the Cost of Protection

- Weeds harbor other pests and therefore increase the opportunity for the pests to persist in the environment. e.g. volunteer wheat on the margins of fields host wheat streak virus.
- Insects can then play host to viruses e.g. aster yellow virus is carried by a leafhopper from lettuce to broadleaf plantain

Increase the Cost of Planting and Maintenance

- If there were no weeds there would be no weeding maintenance costs.
- Weeds can interfere with water management on both agric and restoration sites since weeds consume the water meant for your plantings, cause water loss by seepage, evapo-transpiration, and reduce water flow in irrigation ditches.
- Aquatic weeds can reduce flow in small streams and lakes.

Weed Ecology

The study of adaptive mechanisms that enable weeds to do well under conditions of maximum soil disturbance

Weed Ecology

Understanding weed ecology will (hopefully) lead to more effective weed prevention because:

- **Weeds more susceptible to herbicides are replaced by resistant species.**
- **Monoculture species are problematic if using only one strategy (reed canarygrass).**
- **It is very expensive to maintain sites!**
- **Herbicides are often and usually detrimental to the overall environment.**

Weed Ecology

Weeds and Climate

The important factors that determine a weed's ecological interactions are:

- **Light**
- **Temperature**
- **Water and humidity**
- **Wind**

Weed Ecology

Edaphic (soil) Factors

Determine what weeds survive and compete

- Water
- Aeration (O2 availability)
- pH
- Fertility
- Temperature

What Constitutes a Weed-Definition

"Colonizers", "weeds", "invaders", "aliens", "invasives"

- "Plants which are a nuisance" (Harper 1960)
- "Non-native, invasive plant (Barbour 1999)
- A plant growing where it is not desired (WSSA)
- "Any plant that is objectionable or interferes with the activities and welfare of humans" (Weed Science Society of America)

All definitions are more classifications than a grouping of plants with common biological characteristics

What Constitutes a Weed-Definition

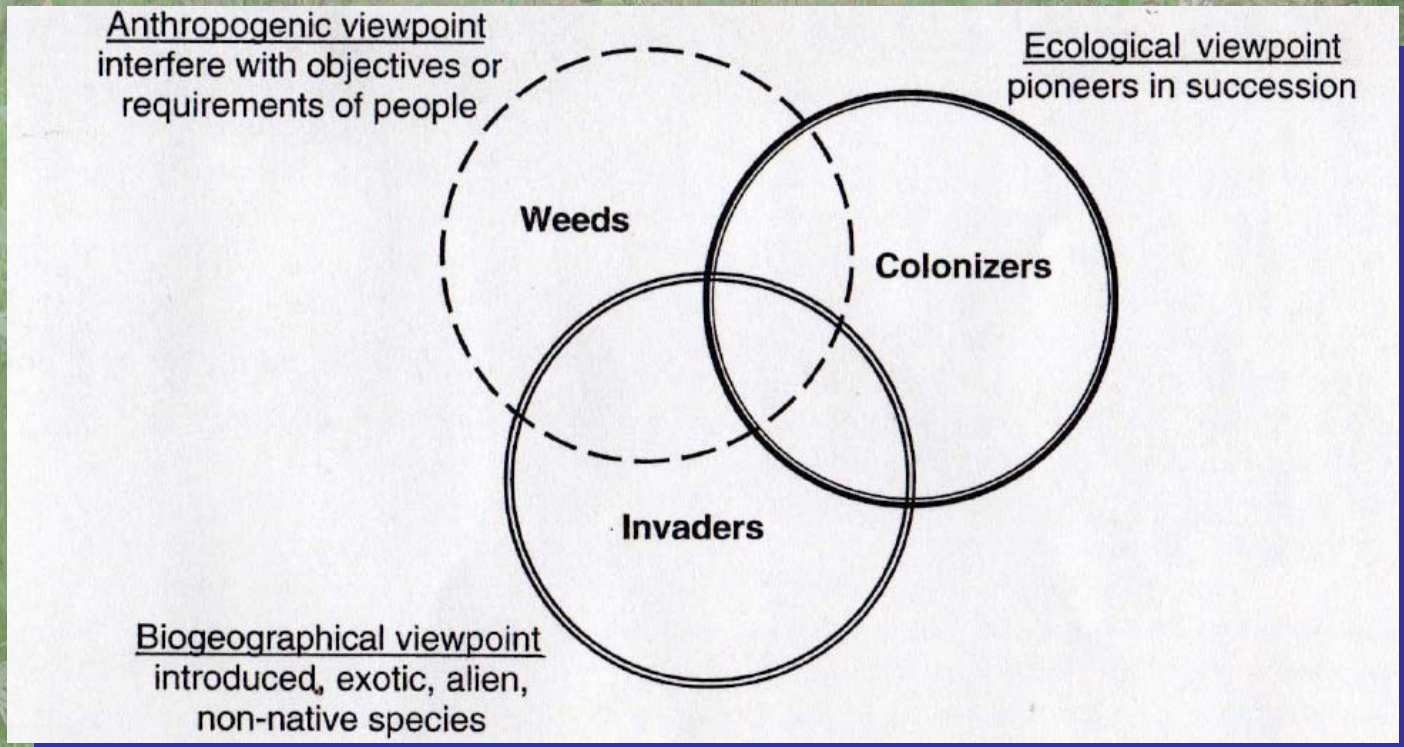
Is the definition based on abundance?

Does weed cover have to reach a threshold before it is considered a weed?

A suggested definition is:

"a native or introduced species that has a perceived negative ecological or economic effect on agricultural or natural systems"

What Constitutes a Weed-Definition



Families of PNW Worst Weeds

- Poaceae
- Cyperaceae
- Asteraceae
- Polygonaceae
- Solanaceae
- Lythraceae
- Brassicaceae
- Leguminosae
- Convolvulaceae
- Rosaceae
- Caryophyllaceae

Types of Weeds

Categorize weeds based on the habitats they invade:

- Agricultural systems, croplands
- Waste sites
- Grasslands, rangeland
- Aquatic systems
- Forestry systems
- native systems

Annuals* vs. Perennials

- Completes life cycle in < 1 year
- Produces lots of small seed
- Grows quickly, spends little energy on roots

* Biennials live > 1 year but not more than 2 years. Include: bull thistle

- Completes life cycle over many years
- Sometimes doesn't produce seed at all
- Spends energy on biomass and roots
- Simple - spread by seed only
- Creeping-reproduce by seed and vegetatively via rhizomes, stolons, tubers, aerial bulblets, bulbs

"Ideal" Weeds (Baker 1974)

- Germinates in a wide range of environmental conditions.
- Long-lived seeds that are internally controlled so germination is not continual
- Weed seed remain dormant in the soil for long periods.
- Seed is often the same size and shape as crop seed so it is difficult to separate.
- Seeds produced continually throughout growth period, or some set seed twice per year
- Seeds are produced through a wide variety of environmental conditions

"Ideal" Weeds (Baker 1974) cont..

- High seed output when conditions are favorable
- Seeds are adapted to short and long distance dispersal
- If perennial, has a high rate or vegetative reproduction or can regenerate from fragments
- The vegetative parts fragment easily and plants will re-sprout from fragments
- Strong potential to compete with other species using special adaptations, rosette formation, climbing growth

"Ideal" Weeds (Baker 1974) cont..

- Plants are often deeply rooted and the roots are thick and hold reserves to get the plant through stress
- Rapid growth from vegetative stage through flowering stage, quick maturation
- Cross pollination by wind or generalist insects
- Self pollination is common

Weed Prerequisites

- Respond favorably to disturbance (although not all kinds)
- Location of plant, a weed may not always be weedy under all circumstances
- Ability to grow in habitats disturbed by human (or natural) activity
- Able to out-compete other plants for resources

Weed Invasions- Dispersal Modes Seed Production

- Seed dormancy is the way seeds disperse with time.
- Mechanical dispersal involves bristles, spines, hooks that attach the seed to the dispersing agent for transport.
- Wind dispersal is Key. It involves very small, light seeds, structures that allow for being held aloft or rolling along.
- Water dispersal- float or survive submerged
- Human dispersed- usually as contaminant in seed, or tag along in planting pots.

Typha
seed
dispersal

Weed Invasions- Dispersal Modes

- Animal dispersed- attach to fur or feathers, or pass through in scat.
- Plowing under manure increases germination- 3% germination dropped by cattle, 13% when top dressed, 23% when plowed under.
- Mimicry by weed seed of crop seed.

Seed Dormancy

- Breaking weed seed dormancy is usually brought on by soil disturbance.
- Many species require light for germination- light becomes available with soil disturbance.
- Some seeds are “hardened” and require passage through the acid digestive system, physical damage (scarification), or microbial decomposition.
- Some burried seed needs more oxygen to germinate. Being closer to the surface and reducing soil compaction both increase germination.

Weed Invasions- Dispersal Modes
Vegetative Dispersal

- Vegetative dispersal can be vastly more efficient than sexual reproduction e.g. water hyacinth 300 seeds per pod, , 1 year to flowering vs. double size of clone in 10 to 15 days
- Vegetative means shoots can sprout if broken, bulbets can be released, roots can send both above and below ground runners
- Tilling the soil can increase the spread!

Why are Weeds More Competative?

- They are able to obtain more of the resources (light, water, space, nutrients) than non-weedy plants.
- The respond favorably to disturbance to edaphic and climatic conditions, while non-weedy plants are often impacted.
- They are often Allelopathic (able to interfere with the growth of non-weedy plants

An Example- the ecology of Phalaris

Experiments show why *Phalaris* is invasive:

- **Light** allows seedling establishment and vegetative spread
- **Clonal subsidy** allows rhizomes to penetrate dense shade
- **Nutrients** enhance vegetative spread
- **Nitrate** enhances its ability to suppress diversity
- **Sedimentation** eliminates topographic heterogeneity, and facilitates invasion

and what limits *Phalaris* establishment:

- **Species-rich canopies reduce invasibility**

Thanks to the Following Publication for Providing Graphics:

Booth, B, Murphy, S., Swanton, C. 2003. *Weed Ecology in Natural and Agricultural Systems.* CABI Publishing

Zimdahl, R. 1999. *Fundamentals of Weed Science.* Academic Press