Ecological Approaches for Weed Management
or
How Not to Reinvent the Wheel

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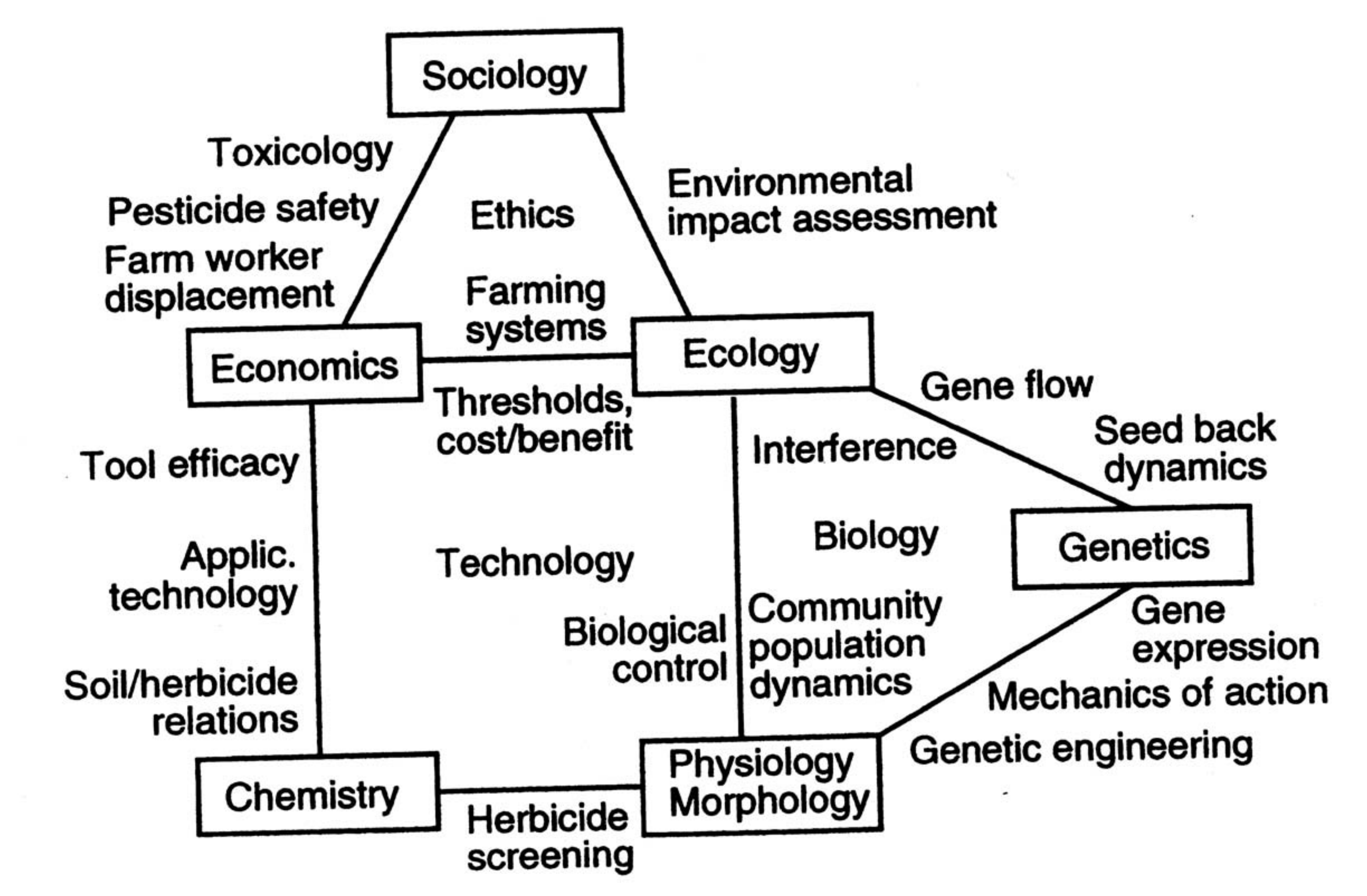
Outline

- Weed Science
  - Broadly defined
  - The Research-Extension continuum
  - Relevance to invasive plants
- Weed and Invasive Plant Management
  - Methods
  - Ecological principles
  - Integrated approaches
- Examples

What is Weed Science?

- Discipline defined by organisms studied
- Combines basic and applied sciences
- Includes continuum from research to extension of knowledge
- Traditionally focused on agricultural and managed lands
- 50+ year history as a a scientific discipline

Components of Weed Science



(Radosevich and Ghersa. 1992. Weed Technol. 6: 788-795)

Research-Extension Continuum

- Land grant universities
  - Basic research
    - Agricultural Experiment Station researchers
  - Applied research
    - Cooperative Extension Specialists
  - Extension/outreach
    - Cooperative Extension Advisors

Weeds and Invasive Plants

- Weed
  - A plant growing where it is not desired
  - A plant that is objectionable or interferes with the activities or welfare of humans
- Invasive Plant
  - Exotic plant that occurs and spreads outside of its native range
  - Plant that negatively impacts wildlands
- Weed Science applies to both agricultural and wildland ecosystems

Management of Weeds (and Invasive Plants)

- Minimize weed presence to achieve desired land use goal
- Grow or foster desired vegetation
- Suppress or remove weeds without injuring crop or desirable species

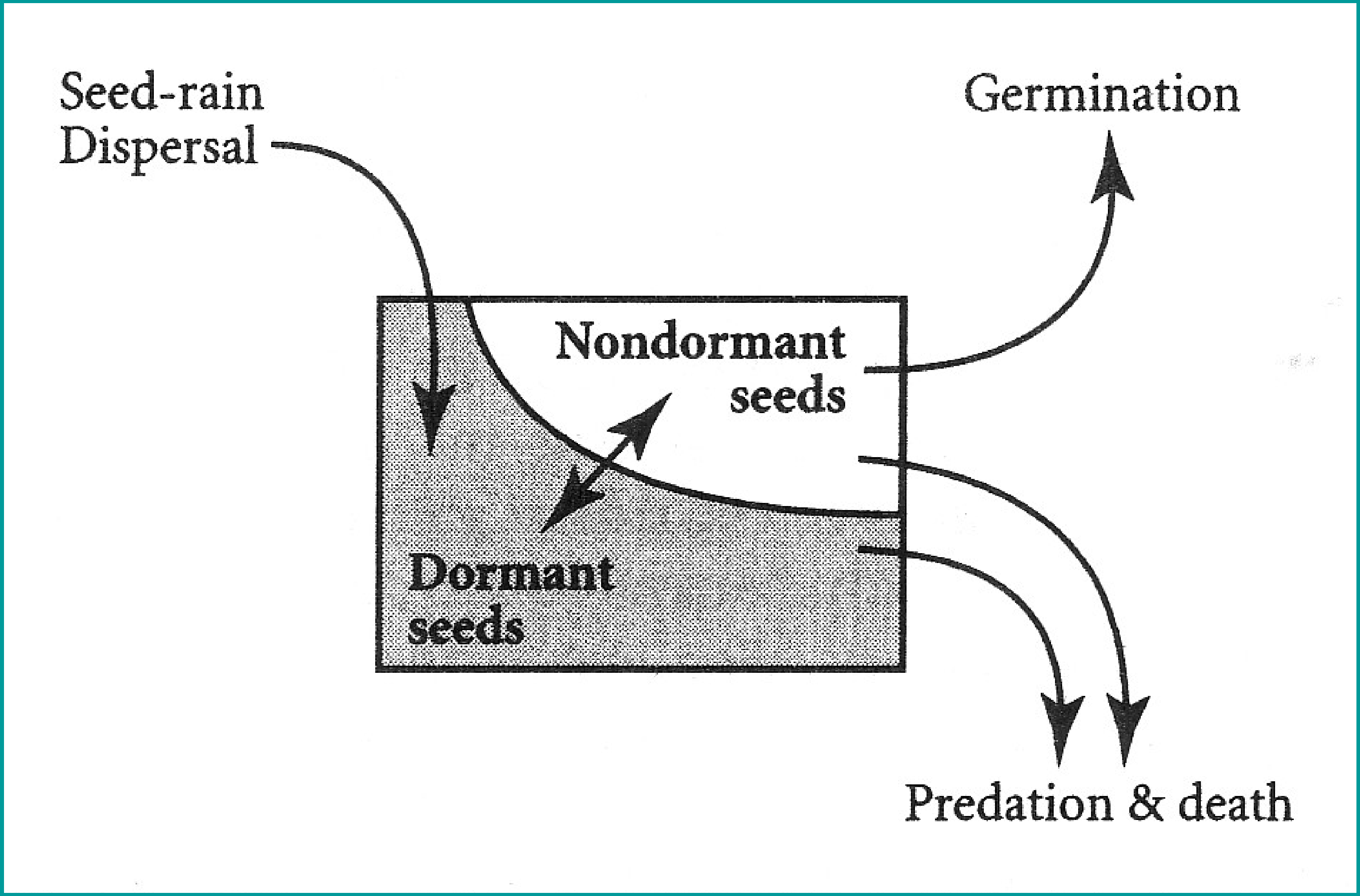
Weed Management Techniques

- Prevention
- Eradication
- Control
  - Biological
  - Chemical
  - Cultural
  - Mechanical, Physical
- Integrated Weed Management

Ecological Principles in Weed Management

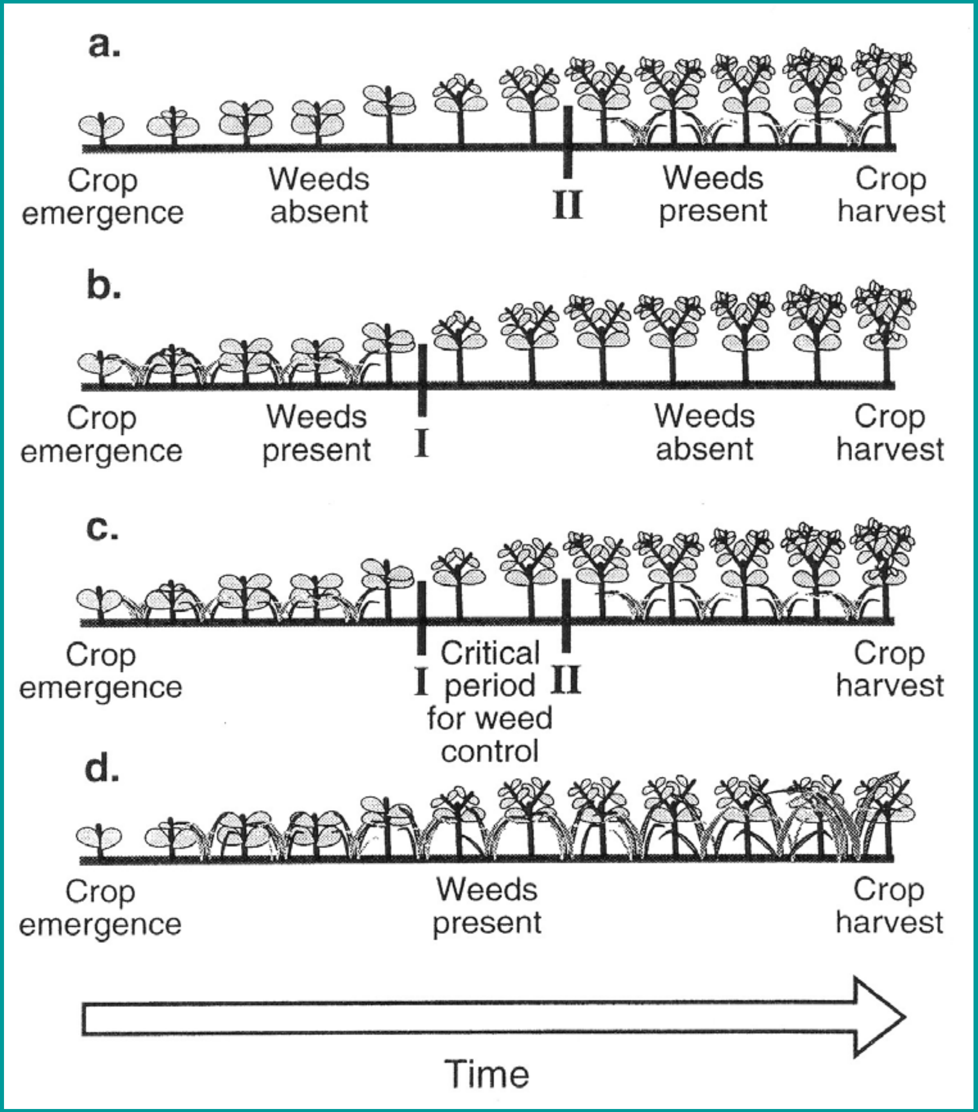
- Ecological principle → Weed control practice
  - Reduce seed bank inputs
    - Prevention, solarization, control before seed set
  - Allow crop (native) earlier resource capture
    - Plant early, cultivate early, plant crop transplants
  - Reduce weed growth and resource capture
    - Cultivate, mow, mulch, apply herbicides
  - Maximize competitive effects of crop (native) on weed
    - Plant smother or cover crops, intercrops
  - Modify environment to make weeds less well-adapted
    - Rotate crops, control methods, herbicides

Weed Seed Bank



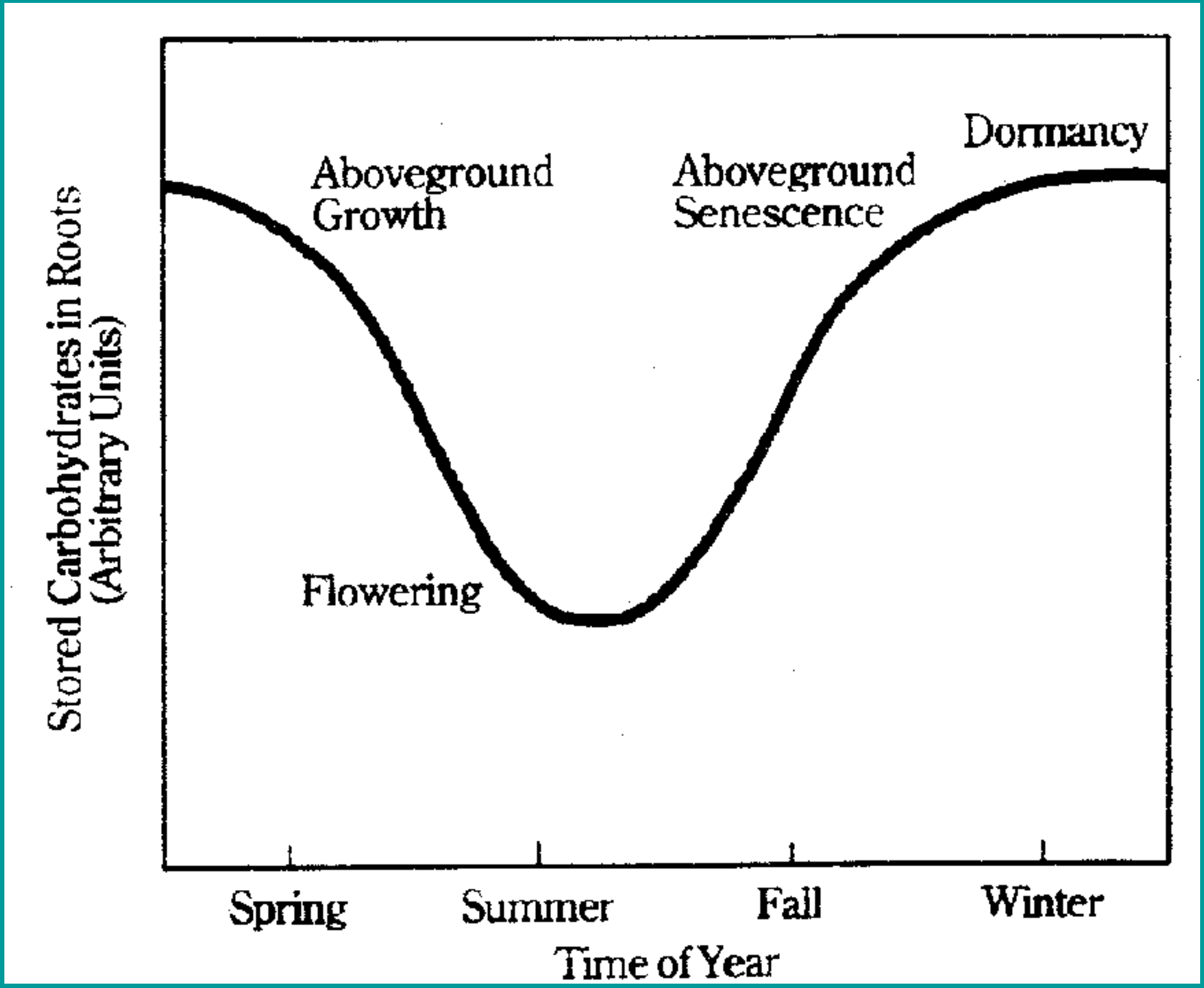
Critical Period for Weed Control

- Cultural control of annual weeds using optimal timing



Carbohydrate Reserves in Perennial Weeds

- Cultural control of perennial weeds using optimal timing



Integrated Weed Management

- Weed suppression by combination of methods
- Based on knowledge of weed biology and ecology
- Cost effective and environmentally sustainable
- Herbicides are one tool among many

Conceptual Framework for IWM

I—Single weed control tool

- Plant-field scale

II—Multiple weed management tools

- Plant-field-farm scale

III—Cropping system design

- Farm-landscape scale

IV—Landscape and regional management

- Landscape-region scale

V—Agro-ecoregion policy management

- Regional-global scale

(Cardina et al. 1999. In Buhler, ed., Expanding the Context of Weed Management)

Innovative Approaches to IWM

- Ecological
  - Management based on weed thresholds
  - – Site specific management
  - – Predictive models
- Agronomic
  - Improving soil quality
  - – Breeding crop competitiveness
- Economic
  - Weed forecasting
  - – Decision models

Examples….
Ecological Approaches for Management

- *Arundo*
  - Mike Rauterkus, M.S.
  - Lauren Quinn (Ph.D. December)
  - Dr. Virginia White, Post doc

- Artichoke thistle
  - Robin Marushia, M.S. (Ph.D. candidate)
  - Dr. Virginia White

Arundo donax Control

- Mechanical removal in monocultures
- Hand removal in sensitive areas
- Herbicide (Rodeo©) in some sites
  - Aerial or ground application in monocultures
  - Selective use in mixtures with natives

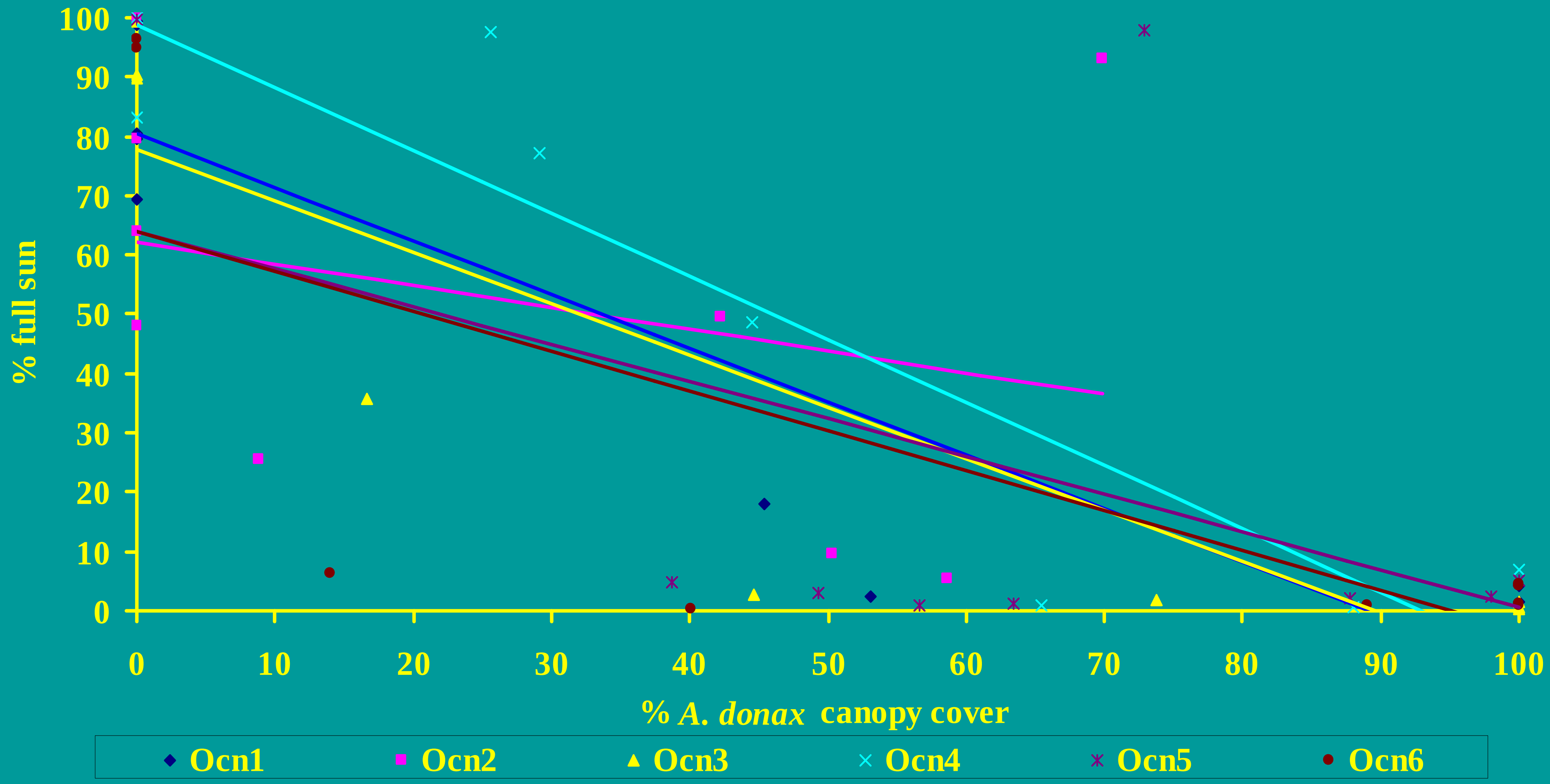
Objectives of *Arundo* Research

- Resource use of *Arundo* and natives
  - Invasiveness of *Arundo*
  - Response of native species
- *Arundo* impacts on riparian habitat
  - Effects on habitat of natives
- Control and habitat restoration
  - Alter habitat to favor natives

Salix gooddingii
Goodding’s willow

Scirpus americanus
American bulrush

Percent Full Sun *vs. A. donax* Cover



y = -0.903x + 80.404 R^2 = 0.8295

y = -0.3666x + 62.131 R^2 = 0.096

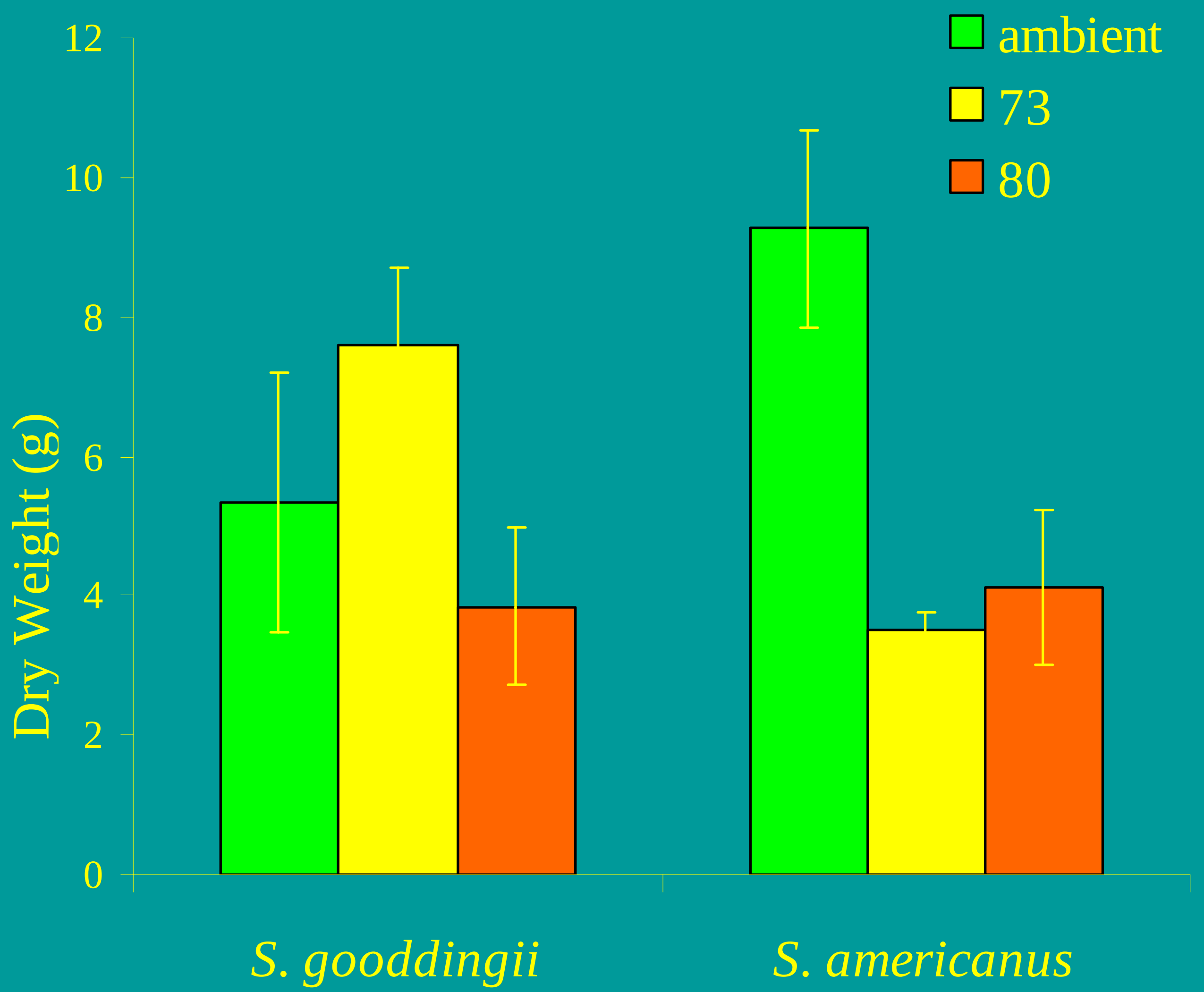
y = -0.8689x + 77.788 R^2 = 0.7922

y = -1.0639x + 98.912 R^2 = 0.8658

y = -0.6334x + 63.971 R^2 = 0.2263

y = -0.6725x + 63.88 R^2 = 0.5671

Light Effects on Biomass Production



Riparian Restoration Experiment

- Objective
  - Test ability of native mixtures to resist invasion by *Arundo*
- Simulated riparian community
  - Tree (*Salix gooddingii*)
  - Shrub (*Baccharis salicifolia*)
  - Rhizomatous sedge (*Scirpus americanus*)
  - Alone and in all 7 possible combinations
- *Arundo* planted into ½ plots in 2003 and ½ in 2004

Summary of Results

- Native species identity determined *Arundo* success
  - Shrubs (*Baccharis*) slowed emergence of *Arundo*
  - Shrubs reduced colonization by native species from adjacent experiment
- *Arundo* success not impacted by community composition or diversity
- *Arundo* grows well at UCR Field Station!

Control and Restoration Experiment

- Objective
  - Design treatments to favor natives and reduce *Arundo* regrowth
- Design
  - Field site with native mixture and *Arundo*
  - 100%, 50%, and 0% *Arundo* removal
    - Cut shoots and treated stumps with (75% glyphosate)
  - ½ plots revegetated with willows, ½ not
  - Data collected before and monthly after treatments
    - Soil temperature, moisture; light; LAI; cover, density

Summary of Results to Date

- Control
  - No resprouting from treated *Arundo*
  - Little to no regrowth from treated *Arundo*
  - Untreated shoots in treated clumps are chlorotic
- Restoration
  - Poor survival of willows
  - Replanting planned following first rains
- Optimal time for control may not be optimal time for restoration

Artichoke Thistle Life History

First years
Later years

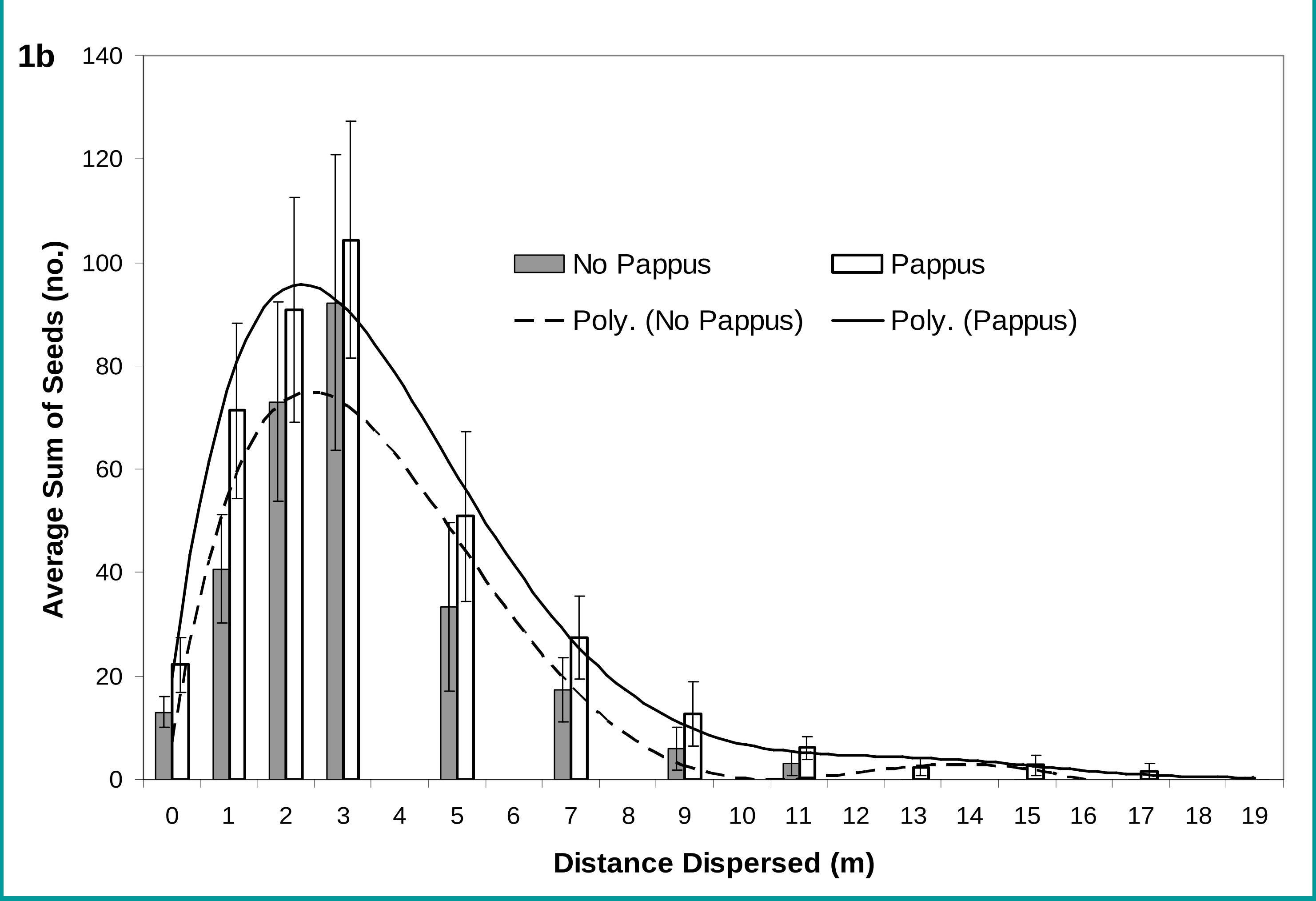
rosette

seed → seedling → juvenile → rosette → tap root → bolting → flowering → seed set & shed

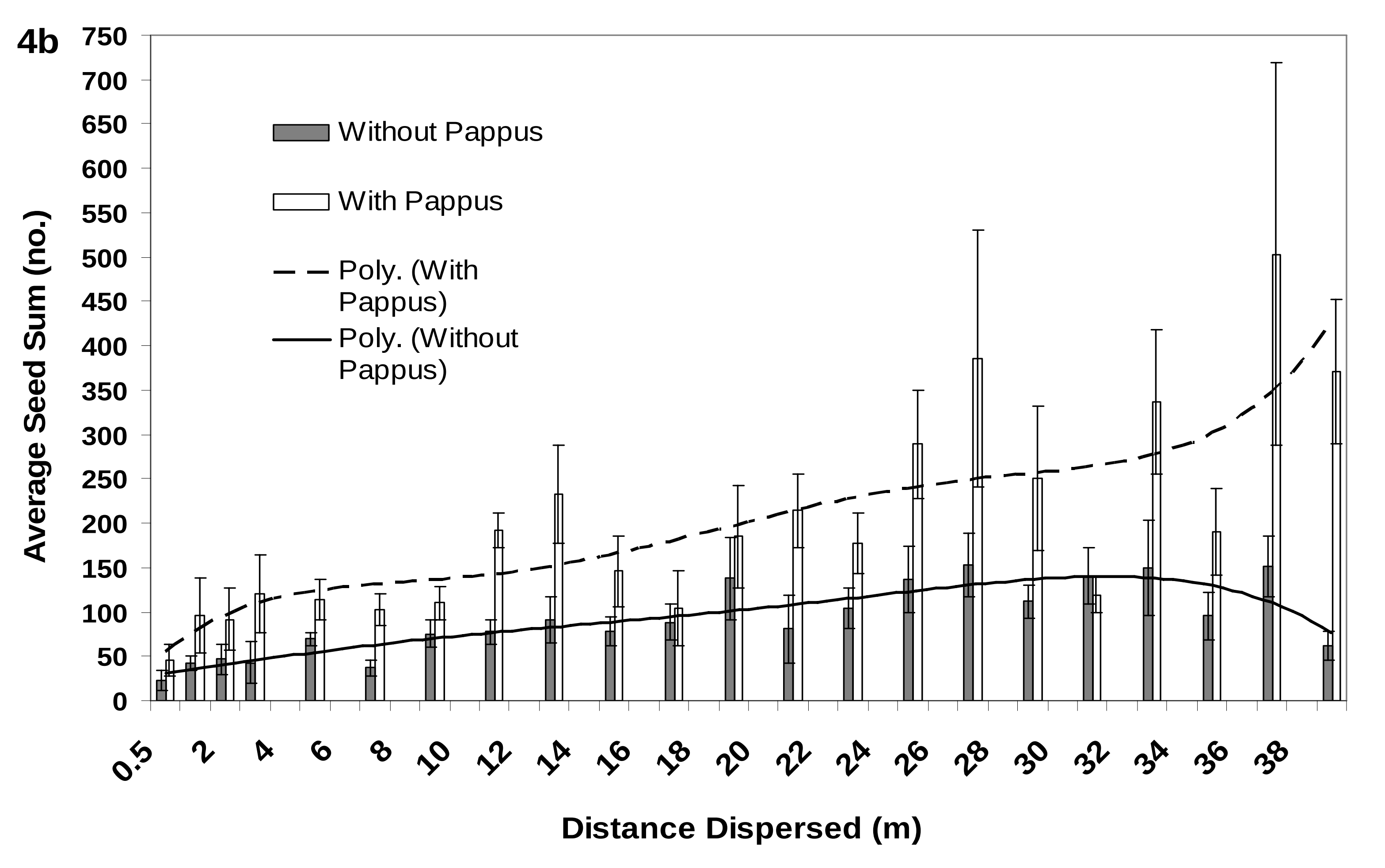
Artichoke Thistle Research Objectives

- Invasiveness
  - Seed dispersal characteristics
  - Demography and phenology
- Control
  - Herbicide, clipping, burning
- Predict *Cynara cardunculus* development
  - Improve timing of control efforts

Downwind Seed Dispersal in Vegetated Site



Downwind Seed Dispersal in Non-vegetated Site



Predictive Management

- Construct phenological model for artichoke thistle development
- Investigate methods of control
- Use phenological prediction to schedule timing of control strategies

Seedling model

Adult resprout model

Conclusions—
Don't Reinvent the Wheel

- Weed Science and research-extension continuum
  - Framework for management of invasive species
- Basic information on biology, ecology, genetics, …
  - Informs management
  - Required for specific recommendations