Biological Control Principles

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Outline

- What is natural control?
- What is biological control?
- What isn't biological control?
- How can biological control reduce pests?
- Who are some of the natural enemies?
- How is biological control practiced?
- Why consider biological control?

What is Natural Control?

- All organisms have natural enemies and environmental constraints that limit their population size, providing natural control — it's why we are not knee-deep in pests all the time.
- Natural enemies: predators, parasites, pathogens keep most potential pests under control.
- Environmental conditions controlling pests and natural enemies: early or late frost, drought.
- Natural control is usually only noticed when it is lost.
- Loss of natural control usually results from some management practices — indiscriminate use of pesticides, changes in agronomic practice, alteration of habitat or other requirement of natural enemy.
- Natural control lets nature take its course.

What is Biological Control?

Simple Definition

"Suppression or prevention of a pest outbreak due to **purposeful manipulation** of natural enemies"

Alternate Definition =three sets of three things:

- **What** — Prevention, reduction, delay of a pest population (the objective)
- **By whom** – Living Organisms: Predators, parasites, pathogens (the natural enemies)
- **How** — Conservation, Augmentation, Importation (the approaches or tactics)

What Biological Control Is NOT:

- *Natural control* — letting nature run its course. Although natural control is important, because it isn't ACTIVE manipulation, it isn't biological control. Think of natural control as necessary, but not enough.
- *Judicious use of pesticides* — just using less pesticides — by itself — isn't biological control. Reducing pesticides is necessary to allow biological control to work. Again, necessary, but not sufficient.
- *Use of Bt or other "natural" products*— There is absolutely nothing wrong with use of Bt or "natural" products, and they offer some of the best solutions. But biological control is the use of living natural enemies. Bt is derived from a living organism (Bacillus thuringiensis) but the product isn't living — it is a toxin made by the organism. So, even though a valuable tactic, and one that is complementary to biological control, Bt is really an insecticide, used like an insecticide, and regulated like an insecticide, just that it isn't produced from synthetic chemicals.
- *A tactic to be used in isolation from other IPM approaches*. That doesn't mean that biological control will be compatible with pesticides or other cultural tactics (often it isn't), but biological control should fit into an overall IPM program that is truly integrated.
- *Integrated pest management (IPM). IPM is a decision making process that considers economical, sociological and ecological effects of each pest management tactic in the decision making process. Biological control and cultural controls should be one of the first tactics considered in an IPM program.*

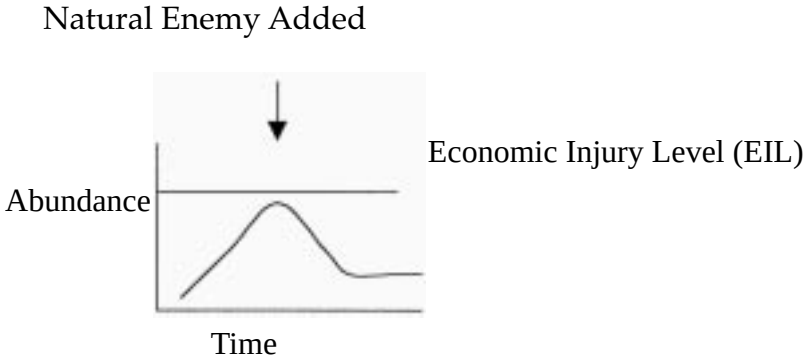
How Can Biological Control Reduce Pests?

Vocabulary

- *Pest*- Organism out of place
- *Target pest*- Organism you want to control
- *Injury*- Physical result of pest presence (eg. defoliation)
- *Damage*- When Injury becomes intolerable (yield loss, ugly plants, etc.)
- *Abundance*- Number of insects present at a point in time
- *Economic Injury Level*- Density of pests that causes economic damage

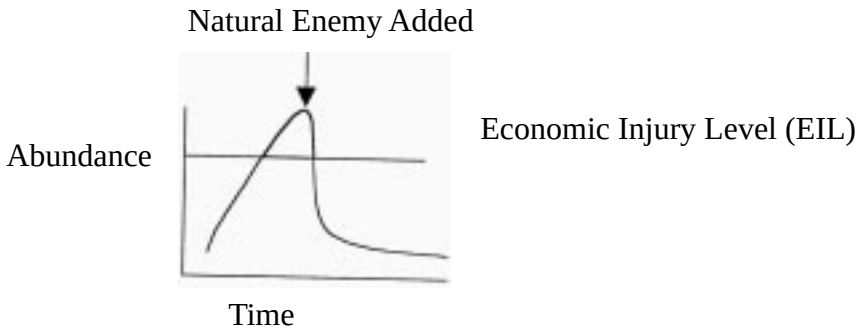
Prevention

- Cause mortality early against target species
- Intervene before pest status is achieved
- Requires early monitoring and intervention
- Useful against regular or predictable pests
- Information-intensive
- Requires understanding system very well



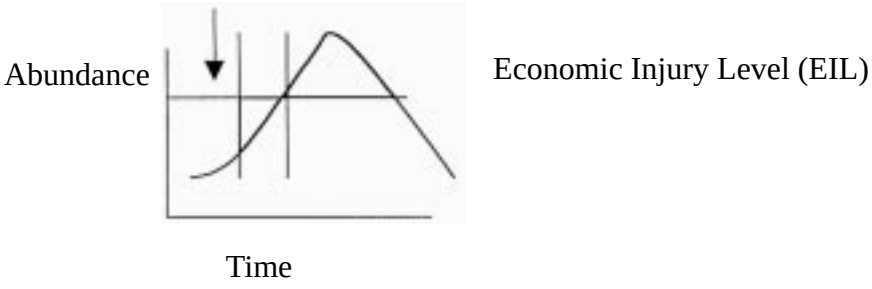
Reduction

- Easiest to consider — often used as a last resort
- Action is taken after pest exceeds a threshold
- Remedial knockdown effect
- Objective is reducing pest to pre-economic levels – for a long time.



Delay

- Counterintuitive — the pest still reaches a high leve, but AFTER it can cause damage.
- Requires early intervention when the pest is at low numbers
- Not always applicable — must be a pest only of certain stages of crop or only at certain times
- Critical window of time during which it is a pest is needed



Who Are Some Of The Natural Enemies?

Predators

- Predators kill multiple prey and often both adults and immatures are predaceous (but this is not true for some predators like syrphid flies and some lacewings).
- Predators may be polyphagous (attack many species) or they may be fairly specific in what species or kinds of prey they will attack.
- Variety of arthropod taxa are predaceous — some estimates are as many as 200 families of insects and other arthropods are predaceous.
- Predators are common in all habitats
- Many are easily recognized — ladybird beetles, ground beetles, spiders, lacewings
- Others are less easily recognized — predaceous mites, syrphid and other aphid-attacking flies (and their larvae)

Parasites (a.k.a. Parasitoids)

- Usually kills only one pest insect as it develops from egg to adult.
- Unlike predators it is almost always the immature that kills the host (prey).
- Insect parasites are primarily certain kinds of wasps and flies
- Every insect (and most other arthropods) have different kinds of parasites that attack them — and usually attack most, if not all, life stages — egg, larva, pupa and adult
- Nobody knows, but there likely are more than 1 million species of parasites. There are something like 60,000 ichneumonids and 40,000 braconids. And they likely are not the most speciose! Remember — every other insect (and likely all parasites) have one or many different species of parasites that attack them.
- They have specialized life styles that allow them to find, attack and kill their hosts (sometime pests) — these adaptations are what we can exploit to use these species for biological control.
- Although host specificity of parasites is variable, as a rule of thumb, parasites attack only one life stage of a host (e.g., egg or larva) and attack fewer species of host or prey than do predators.
- Insect parasites are less familiar and less easily recognized.

Pathogens (diseases)

- Insect pests get diseases just like we do — and the same kinds.
- They are infected by bacteria, fungi, viruses, and protozoa
- Insect pathogens are very common and effective in many situations — many are naturally occurring and provide a great deal of natural control. Epizootics (epidemics) of a disease can knock down a population quickly in a very impressive manner.
- Nematodes often get lumped with pathogens, but nematodes are not a true pathogen — their action is part predator, part parasitic and part pathogen. But it is a pathogen carried in the gut of the nematode that can kill — very quickly — its host.
- Host specificity varies among pathogens — although some fungi (at the species level) are quite broad in what species they infect, there may be strains or subspecies that are very specific. Other pathogens — such as most insect viruses — are usually very specific.
- Insect pathogens play an important role in biological control.

How Is Biological Control Practiced?

Conservation
Augmentation
Importation Biological Control

Conservation
Definition: To keep and enhance those natural enemies that are already present in the landscape.
Tactics:

- Alter management practices
  - strip cropping or polyculture (and gardens already ARE a polyculture)
- Alternative harvestingleaving non-crop habitats — unmowed or unsprayed edges
- *Help natural enemies*
  - provide foods (non-host) like sugar, nectar or pollen sources, which are crucial to attract and retain many kinds of predators and parasites
  - provide hosts to get predators through times of no food
  - plant crop varieties that are "friendly" to natural enemies
- Alter (read REDUCE) use of and timing of pesticides
- Often simple changes can have great impacts.
- Remember the 3 most important things you can do to help natural enemies Reduce pesticide use, reduce pesticide use, reduce pesticide use

Augmentation

- Augmentation means adding to numbers and kinds of natural enemies
- Existing natural enemies may be present but not numerous or effective enough
- Objective of augmentation is not permanent establishment
- Add to mortality of the pest — not replace it with another source
- There are many species of natural enemies that you can buy
- caveat — just because you can buy it doesn't mean it will work

Two approaches to Augmentation:
1. Inundation
   - Mass rear and release natural enemy
   - Overwhelm the pest and provide a remedial, knockdown effect
2. Inoculation
   - Release small numbers early in pest cycle
   - The natural enemy reproduces through a season andkeeps pest numbers low over a longer time — usually over the season

Importation Biological Control

Definition: Introduction of exotic natural enemies to control pests.

- Many of our worst pests are exotic — they become a problem because they arrive without their natural enemies.
- Most native natural enemies do not "switch" to the new species, so natural control doesn't work in this case (or is greatly diminished)
- Importation of an exotic natural enemy can re-establish the relationship between a pest and its long-standing natural enemy
- Idea is to return to the aboriginal home of the pest (where it likely is NOT COMMON) and find one or more of the biotic factors that keep the population in check there.
- Requires quarantine on importing any species — we don't want to introduce any other unwanted organisms (especially pathogens or potential natural enemies of our native species).
- Importation must be done by trained and regulated scientists — not the public

"Classical" biological control has produced hundreds of successes against many kinds of pests; it has been safely used in nearly all cases — the few problems either were early use of vertebrates or attacking native species that was predicted before the introduction.

Why Consider Biological Control?

- There are many problems with over-reliance on pesticides
  - Environmental hazards
  - Occupational hazards
  - Emergence of secondary pests
  - Pesticide resistance

- Biological control is considered environmentally safe and "friendly"
- Effective — there have been hundreds of successes
- Cost-effective — there is great potential return for small investment