

Sampling, Thresholds, and Decision-Making

The “text” for this lecture is “*Economic Thresholds and Economic Injury Levels*” (<http://ipmworld.umn.edu/pedigo>) in *Radcliffe's IPM World Textbook*. For links to chapters that cover a range of specific topics, use <http://ipmworld.umn.edu/chapters>.

Methods of sampling insect densities differ for specific pests and commodities. A variety of sampling methods are presented in conjunction with specific insects in the lab. Those methods include (but are not limited to) direct counts of insects on plants or animals, counts or ratings of plant damage, counts in sweep net samples, extraction from soil samples, aerial assessment of defoliation or other plant damage, counts from pheromone traps (and other traps), measures of frass, and more.

This outline on economic thresholds focuses on farm-gate economics ... don't forget that lots of costs related to pesticides are absorbed outside the realm of the simple economics of spray costs and yield in a single field. These include "environmental externalities:"

- US EPA budgets for pesticide programs, clean-up, Superfund, etc.
- USGS groundwater monitoring
- State regulatory and Pesticide Applicator Training budgets
- Fish kills & bee kills
- Pest responses... resistance, resurgence, secondary pests

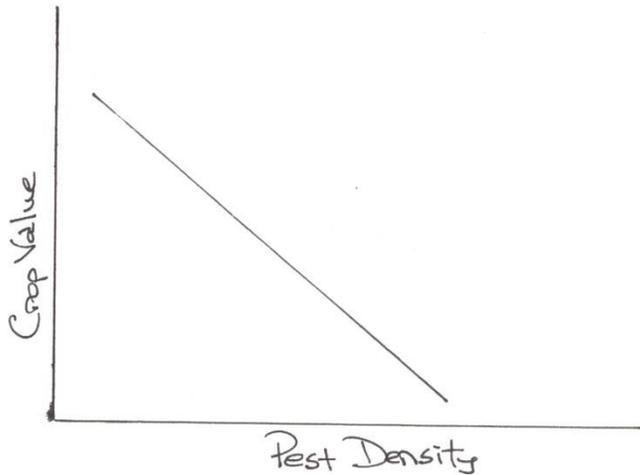
Many economists would suggest that ...

1. The costs of pesticides plus application underestimate full social costs, therefore net benefits of pesticide use are overestimated. (Existing market equations do not incorporate all impacts of production or pest management [environmental damage/cleanup, regulatory agencies, etc.]. These external cost impacts are absorbed outside the commodity's market equation.)
2. But, external benefit impacts are also absorbed (enjoyed) outside the commodity's market equation. ("Cheap food" and contributions to the balance of trade [problem here with agricultural commodities vs. technology]).
3. To remedy market failure, external costs should be internalized ... by assessment of pesticide fees and taxes (obvious political problems).

Field or Farm-Gate Economics

Farmer: "Is this infestation severe enough to reduce crop yield?" Will controlling it (preventing the loss) save more money than the cost of control?"

Answering these questions to make a control decision requires knowledge of the relationship between pest density and loss in crop value (damage). The simplest (but not real) relationship would be a straight-line graph, but that is usually inaccurate for several reasons (discussion to follow definitions).



Pedigo (<http://ipmworld.umn.edu/pedigo>) summarizes important components of the relationship between pest densities and crop values, and the "real" damage curves that result. Some important terms/concepts:

Injury:

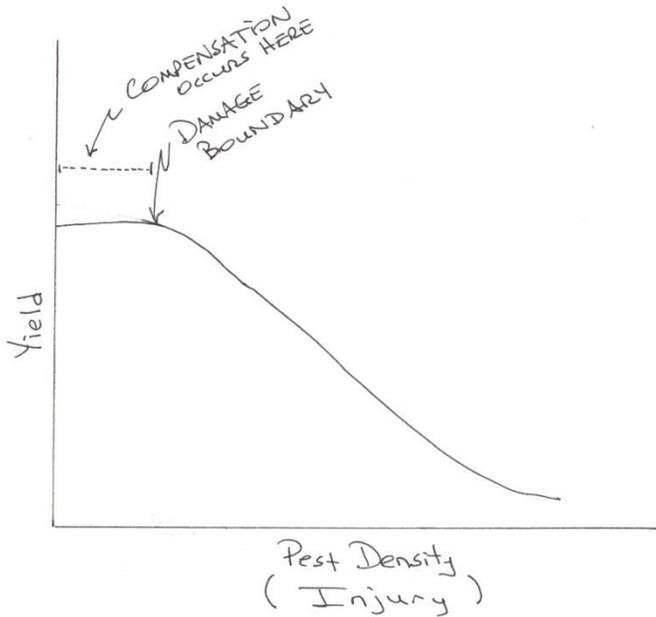
Damage:

Damage boundary:

Direct Pest:

Indirect Pest:

So the damage curve for most indirect pests (at least theoretically) might look [like this](#).



The crop tolerates some infestation & injury without damage (plants compensate for the injury or may even overcompensate); then suffers minor losses with incremental increases in pest density (& injury) (some compensation still occurs); then a linear phase occurs in the loss function; finally a leveling off.

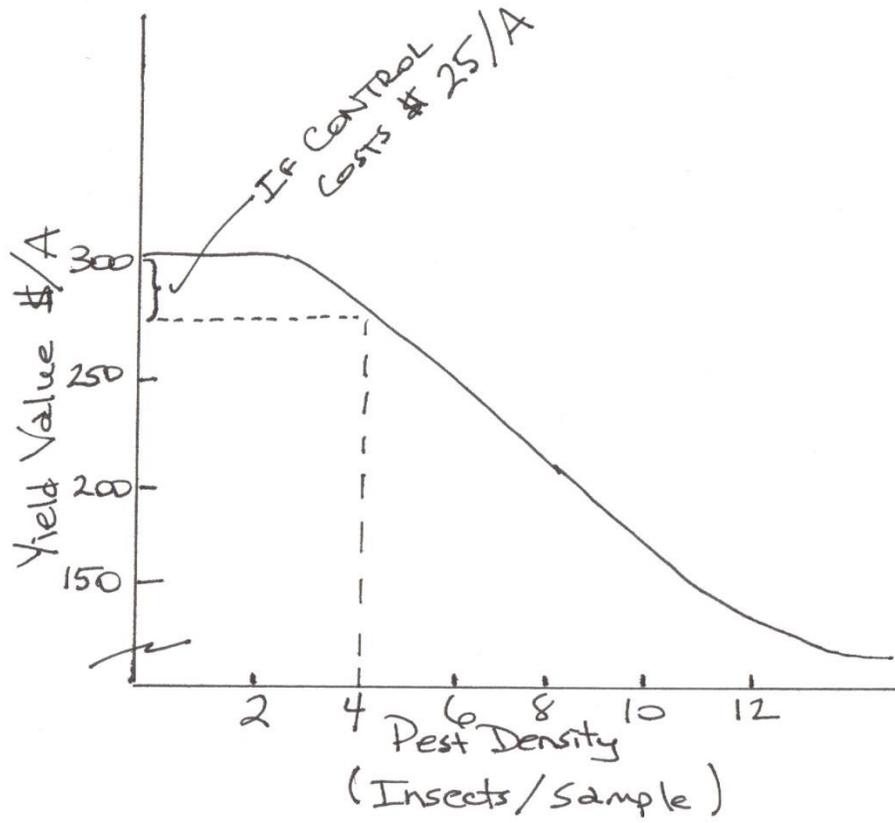
Damage curves like the one above are based on: (1) injury per pest; (2) damage (yield and therefore \$ loss) per unit of injury.

The **economic injury level (EIL)**

The **economic threshold (ET)**

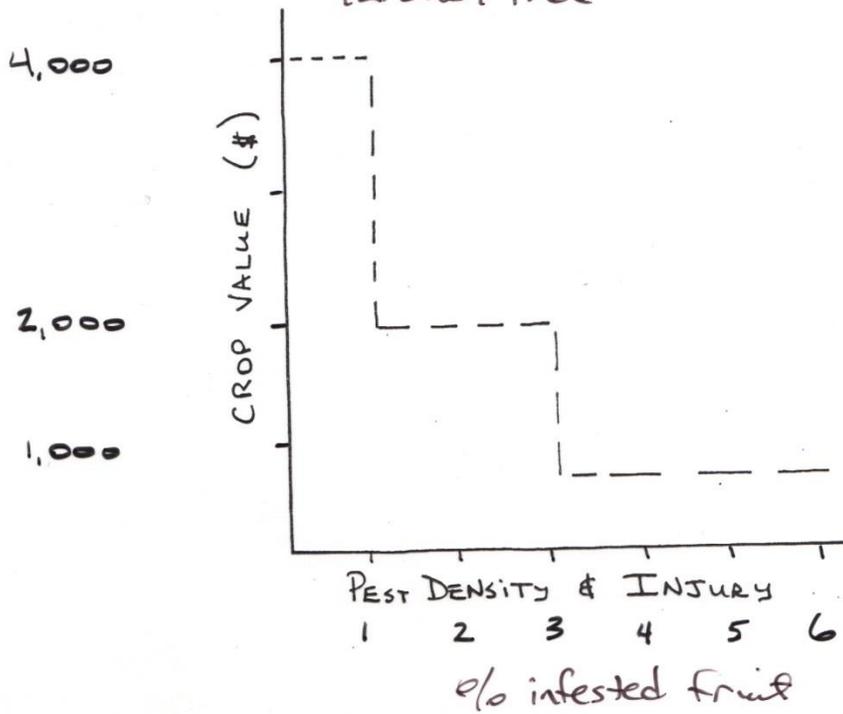
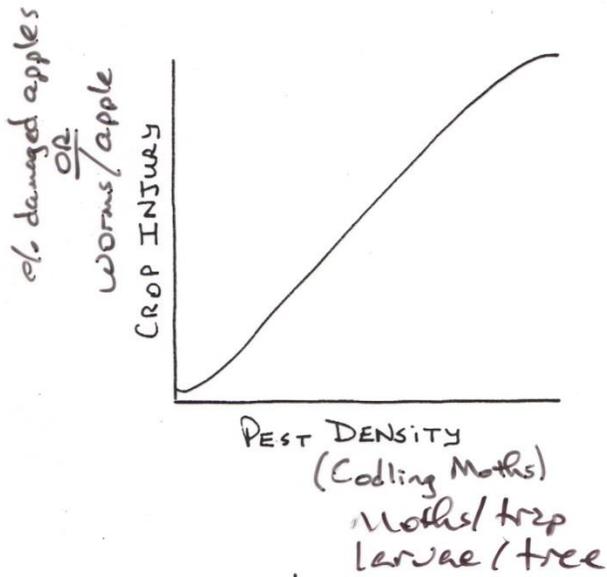
Key ideas: compensation, damage boundary.

How do you identify the EIL from such a graph?



Other relationships between pest density and damage:

Cosmetics or grade limits cause abrupt changes in crop value



Static vs. dynamic thresholds:

Static thresholds are based on averages for yields, control costs, and crop prices.

Dynamic thresholds vary with anticipated yield, costs of controls, and price of the crop.

[European corn borer decision-making guide](#) (a dynamic approach)

Related ideas:

Action thresholds, action levels, control thresholds, aesthetic thresholds... all have somewhat vague derivations, and density-damage relationships may be undefined or poorly defined. These ideas substitute for a “real” EIL.

Complications:

- Pests of humans and animals -- economic values? [How do I determine the threshold for flea control on my dog Sam?](#)
- Pests on ornamental plants -- aesthetic value?
- Cockroaches in the kitchen cabinets – [aesthetics?](#)
- Multiple pests -- related injury or not (includes weeds, pathogens, etc.) ... [How does one weigh and respond to a combined infestation of a root pest and a stem pest?](#)
- Pest/weather interactions ... [Is the ability to compensate for defoliation reduced during drought?](#)
- Ease of control of different stages of a pest ... [If I wait to control grasshoppers on rangeland until I know that late instar nymphs and adults exceed the threshold, are some insecticides less effective than they would have been against earlier stages?](#)
- What if a decision must be made before an infestation can be monitored?

[All of these complications pose the need for more research to better define sampling methods, thresholds, and decision-making for insect pest management.](#)

Environmental EILS:

Some researchers have attempted to assess the environmental risks associated with different insecticides and incorporate those risks into the insecticide costs and use those calculations in equations to determine the profit or loss associated with an insecticide application. A chapter by Higley and Peterson is available on the web at:

<http://ipmworld.umn.edu/higley>

It includes two tables that illustrate the different environmental costs associated with individual insecticides

<http://ipmworld.umn.edu/higley-spreadsheet-1>

<http://ipmworld.umn.edu/higley-spreadsheet-2>

Take-home message: Crops and other “hosts” of insects do not need to be kept pest-free. Monitoring populations and understanding the relationship between pest density and ultimate crop (host) value allows decisions based on thresholds – even though the economic threshold concept has limits.