A scenic view of a forest with a misty mountain in the background. The foreground is filled with dense green foliage, including a prominent tree with reddish-brown branches. The background shows a mountain range partially obscured by thick white mist or clouds under an overcast sky.

*You did not weave the web of life, you are merely a strand in it. Whatever you do to the web, you do to yourself. You may think you own the land. You do not. It is God's. The earth is precious to God and to harm the earth is to heap contempt upon its creator. – ?*



# IPM

## Integrated Pest Management

Steven Swain

Environmental Horticulture Advisor  
UCCE Marin & Sonoma Counties



# Chief Sealth (Seattle)

~ 1786 – 1866

Spoke in Lushootseed  
language, translated into  
Chinook Indian Trade  
language and then into  
English

Pled for Native American and  
Environmental rights  
...but nothing written down.

*Quote: Ted Perry (1971)  
Hollywood  
as: Chief Seattle (1854)  
Washington*



# What is IPM?

- Integrated Pest Management
- Least toxic pest management strategy
  - Prevention
  - Detection
  - Identification
  - Thresholds & Guidelines
  - Treatment
- Synergy in multiple approaches
- Originally developed for agricultural users
- Now used in landscape (also called PHC)
  - Long term view



# IPM has a long history

- Two of the four horsemen:
  - Pestilence
    - Ignis sacer (St. Anthony's fire)
      - Gangrenous ergotism
      - *Claviceps purpurea*
      - Hallucinations: LSD
  - Famine
    - Irish potato famine
      - *Phytophthora infestans*
    - Prehistoric famines recorded in bones



# Cottony cushion scale on citrus

- Biological control vs. IPM
- Problem emerged in California in 1880's
  - *Icerya purchasi*
    - (Not native)
  - Desperate growers cutting and burning trees
  - Orchard land values plummet
- Vedalia beetle introduced winter of 1888-89 (514)
  - *Rodolia cardinalis*
  - Australian
  - Amazingly fast recovery
    - Defoliated orchards on brink of bankruptcy in March had full harvest in August
  - Redistributed ~11,000 beetles by June 12, 1889



©2005 Regents of the University of California

# Pesticide Impact

- DDT use functionally eliminated vedalia from central valley (1950's)
  - 3 years for re-establishment
  - \$1/beetle
- IGR's used on California red scale (molt inhibitor)
  - *Aonidiella aurantii*
  - IGR kills cushion scale slowly, at applied concentration
  - IGR kills vedalia quickly at much lower concentration
  - CCS outbreaks severe on neighboring orchards in 1999
  - Malathion for control
  - > 9 month recovery





# Most important paper of 20<sup>th</sup> century (?)

- Hilgardia 1959 (29)  
81:101
  - Stern, Smith, van den Bosch, Hagen
- Founding of “IPM”
- Rachel Carson
  - Silent Spring 1962

# HILGARDIA

*A Journal of Agricultural Science Published by  
the California Agricultural Experiment Station*

VOLUME 29

OCTOBER, 1959

NUMBER 3

## THE INTEGRATION OF CHEMICAL AND BIOLOGICAL CONTROL OF THE SPOTTED ALFALFA APHID

### The Integrated Control Concept

Vernon M. Stern, Ray F. Smith, Robert van den Bosch,  
and Kenneth S. Hagen

### Field Experiments on the Effects of Insecticides

Vernon M. Stern and Robert van den Bosch

### Impact of Commercial Insecticide Treatments

Ray F. Smith and Kenneth S. Hagen

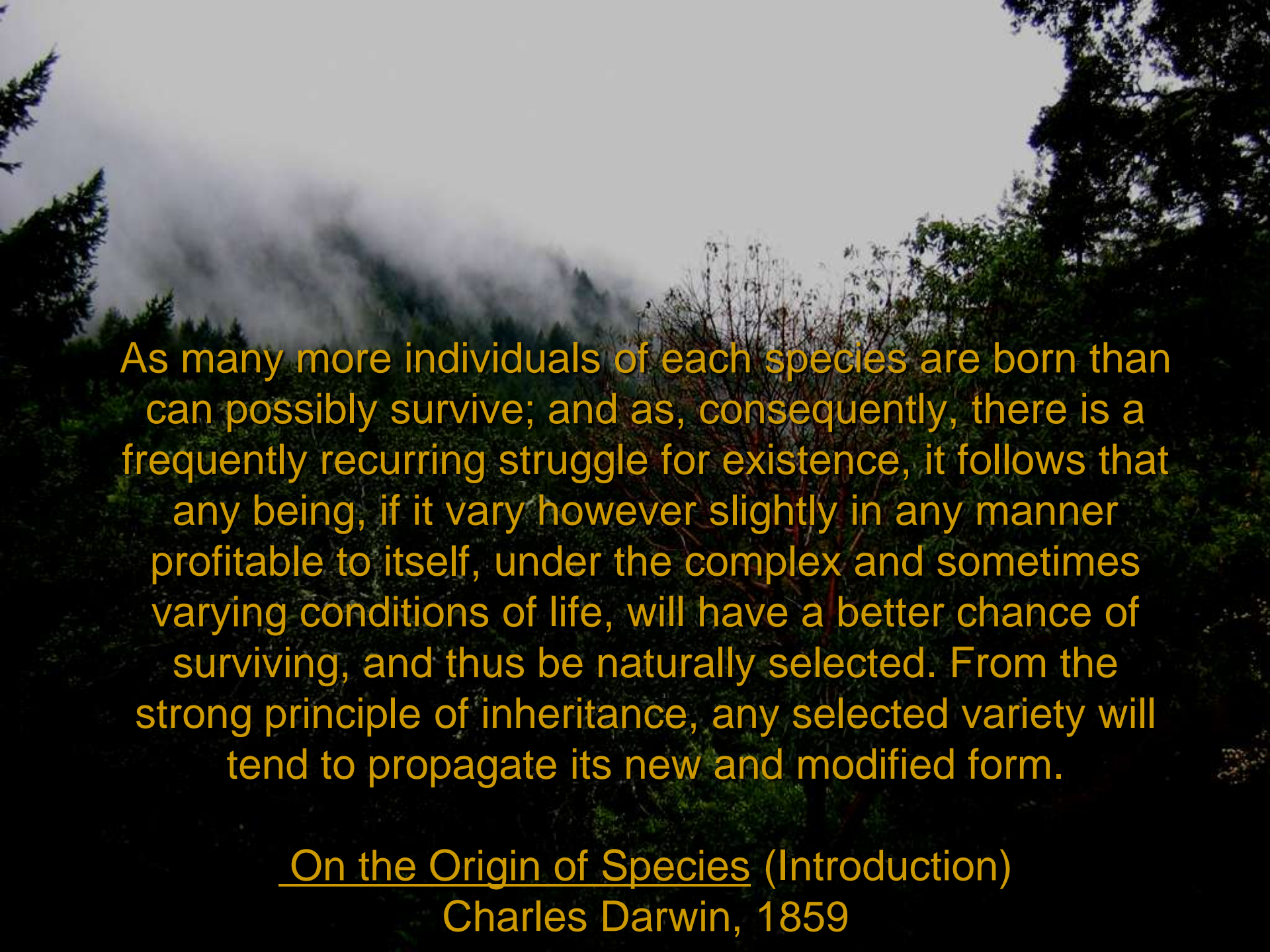
UNIVERSITY OF CALIFORNIA • BERKELEY, CALIFORNIA



# Original goal: resistance management

EIT: Economic Injury Threshold  
AIT: Aesthetic Injury Threshold





As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be naturally selected. From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form.

On the Origin of Species (Introduction)

Charles Darwin, 1859



# Original goal: resistance management

EIT: Economic Injury Threshold  
AIT: Aesthetic Injury Threshold



# What is a pest?

- Insect pests
- Diseases
- Vertebrate pests
- Weeds





# How do we manage them?

- Detection
  - Monitoring
    - Traps
    - Surveys
  - Prediction
- Identification
  - Life cycle
  - Interaction with host
  - Natural enemies
  - Competitors
- Threshold
  - Requires both previous steps
  - Known for:
    - Crops
    - Turf
  - Landscape relevance?
    - How many aphids?
    - How much barnyard grass?
    - By the time they noticed ...

# How do we manage them?

- Prevention

- Cultural practices
  - Clean planting stock
  - Sanitation
  - Irrigation timing & type
  - Crop rotation
- Resistance
- Habitat modification
  - Ivy removal
  - Alternate host removal
- Physical barriers
  - Tanglefoot

- Treatment

- Mechanical control
  - Traps
  - Picking
    - Leafminers
- Natural enemies
  - Nursery plants
    - Food
    - Shelter
- Biologicals
- Botanicals & soaps
- Chemical



# Why have IPM?

- We need IPM because we are
  - forcing plants into unnatural lines of development
  - and into unnatural locations of growth,
  - and under unnatural conditions.
  - Law of unintended consequences



Washington State wheat fields in July







Japanese Maple







**Native California Landscape?**







# Law of Unintended Consequences

- Not a scientific law
- ... a warning against the hubristic belief that humans can fully control the world around us.

# ***IPM tools and techniques***

- Synergy**



**Prevention**  
**Physical/mechanical**

**Cultural practices**

**Biological control**

**Pesticides, only if needed**

**Monitor to detect and assess problems**

**Use least-toxic materials**

# What exactly is a Pesticide?

EPA: A pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest.





# **When are pesticides needed?**

**When pests are causing intolerable damage**

**Non-chemical methods aren't effective**

**How to know?**

**Identify your pest**

**Assess the problem**

**Research and consider alternatives**

# Does IPM = organic?

- IPM

- “Least toxic” approach
- Based on knowledge of
  - pest
  - biology
  - habitat
- Right plant, right place
- Emphasis on prevention
- Pesticides limited
  - Synthetics allowed
    - Low toxicity
    - Degrade slower
      - » Bio
      - » Photo
      - » Thermo
- A technique

- Organic (pest mgmt.)

- “Natural” approach
- Based on knowledge of
  - pest
  - biology
  - habitat
- Right plant, right place
- Emphasis on prevention
- Pesticides limited
  - No synthetics
    - Natural = rapidly biodegradable
    - Highly toxic?
- A legal classification

# IPM/Organic overlap

IPM, non-organic:  
Effective control  
achieved using  
synthetic (and  
potentially  
non-sustainable)  
inputs

Overlap: effective  
control using  
organically approved  
methods

Organic, non-IPM:  
Ineffective control  
or  
Control at high  
environmental or  
safety costs  
(non-sustainable)



# Sustainability: The 3 E's

- Ecological
  - Does it cause lasting damage to the biological systems on which it's based?
- Economic
  - Can it be done profitably?
- Equitable
  - Is the system unjust to others?

# 2009 east coast tomato and potato failure

- Late blight
  - *Phytophthora infestans*
  - Afflicts
    - Tomatoes
    - Potatoes
    - Others in Solanaceae
- In a well-managed farm:
  - Typically shows up late in the season
  - More of an annoyance than a problem
  - Organics: manageable





# When it's not so well managed ...

- Poor quality control at one (?) big nursery
  - Thousands of infected tomato starts
  - Small gardens > farms
    - 36 million gardens 2008
    - >43 million as of Aug 2009
    - Not a lot of education
    - Pathogen can travel 40 mi
  - Early start to late blight
  - Impact on tomato and potato crops:
    - Conventional: barely manageable
    - Organic: crop loss



# When you choose your garden You choose your pests

- Research your plants, and their potential pests, before problems appear
- UC IPM lists problems by plant
  - [www.ipm.ucdavis.edu](http://www.ipm.ucdavis.edu)
- You'll know what to look for
- Weeds can be another issue though ...
  - Barnyard grass can produce >10,000 seeds per plant per season



# Be on the lookout

- Monitor regularly



Mice droppings



Rat droppings



## Monitoring devices



Yellow sticky trap for whiteflies or aphids



# Identify your pest

Understand its  
life cycle



Damage to lawn  
from improper  
watering



Crabgrass



Dallisgrass



Lady beetle larva



Beneficial insects

Syrphid  
fly larva





# Resources to help you identify pests

[www.ipm.ucdavis.edu](http://www.ipm.ucdavis.edu)

Pest notes



Weed photo gallery



Key to weeds in turf



• UC Cooperative Extension Office ([www.ucanr.org](http://www.ucanr.org))

UC IPM Publications



# Prevent pests from invading

*Get rid of sources of food, water, and hiding places*

Remove plants close to buildings

Trim trees

Get rid of fallen fruit

Remove woodpiles

Keep moisture away from buildings



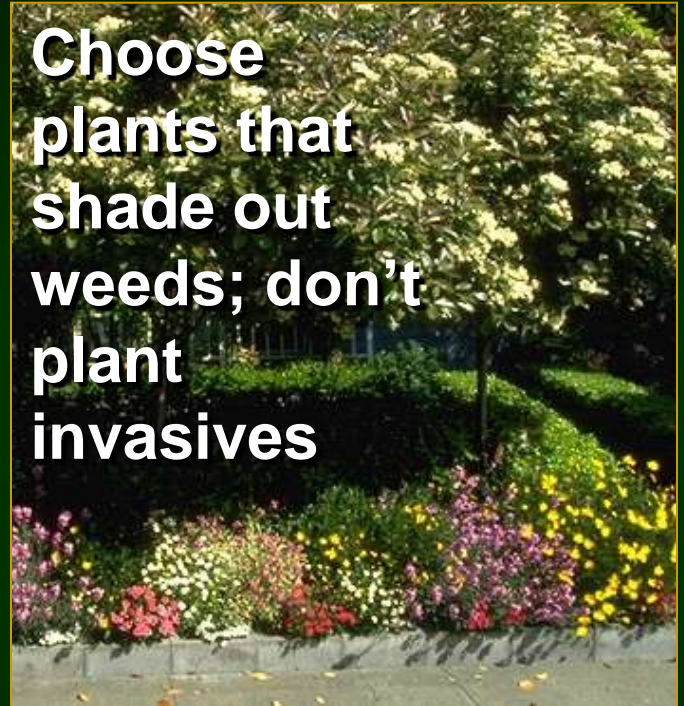
# Reduce problems with cultural controls

Select well-adapted and pest-resistant plant species

Provide adequate water



Consider drip irrigation



Choose plants that shade out weeds; don't plant invasives

Keep lawns competitive with proper irrigation, fertilization, and mowing height

# Destroy pests with physical or mechanical methods





# Remove pests with physical or mechanical methods

Hand pick snails

Reduce aphids with strong spray of water

Hose off aphids



Traps

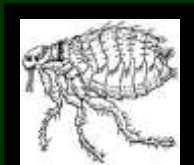
Yellowjackets



Mice



For fleas



Use a flea comb

Vacuum larvae, eggs, debris

Snails





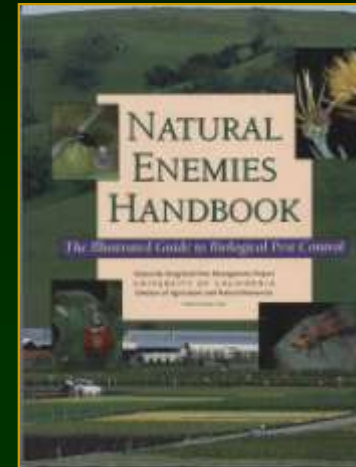
# Conserve biological control



**Avoid pesticides that kill natural enemies**

## **Predators**

**Attack, kill, and feed on other prey**



## **Pathogens**

**Cause disease**

## **Parasites**

**Live and feed in a larger host**



**Parasites attacking aphid and caterpillar**

**Armyworm killed by virus**



# Enhancing biological control

Control ants and keep them out of trees and plants

Choose plants that provide nectar, pollen, and shelter

Release purchased natural enemies in limited situations

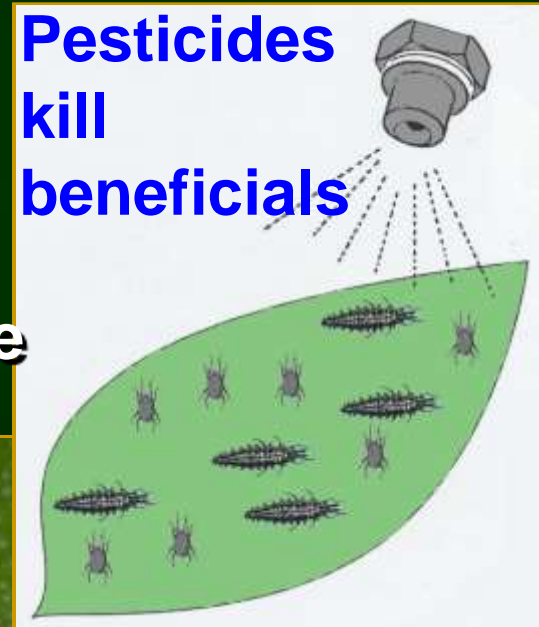
Lacewing larva



Predatory mite and spider mite



Pesticides kill beneficials



Ant protecting a scale





# Intercropping & Nursery Crops

- Small, clustered flowers with overlapping blooms
  - Achillea (yarrow)
  - Asteraceae
  - Native buckwheats
- Perennial ornamental grasses





# If you use pesticides

Use in combination with other methods (IPM!)

Follow label directions carefully

Consult UC IPM Pest Notes



[www.ipm.ucdavis.edu](http://www.ipm.ucdavis.edu)

# What materials are best?



Prepackaged bait



Refillable bait station

Choose pesticides carefully and make sure they target your pest

Use least-toxic material

*Bacillus thuringiensis* (Bt)

Horticultural oils and insecticidal soaps

Botanicals like neem

Spinosad

Iron phosphate for snails and slugs

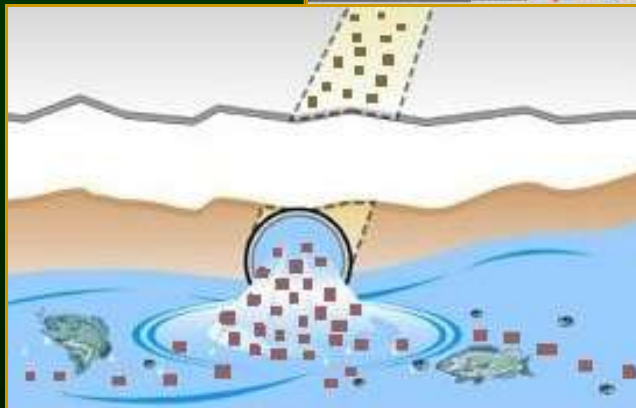
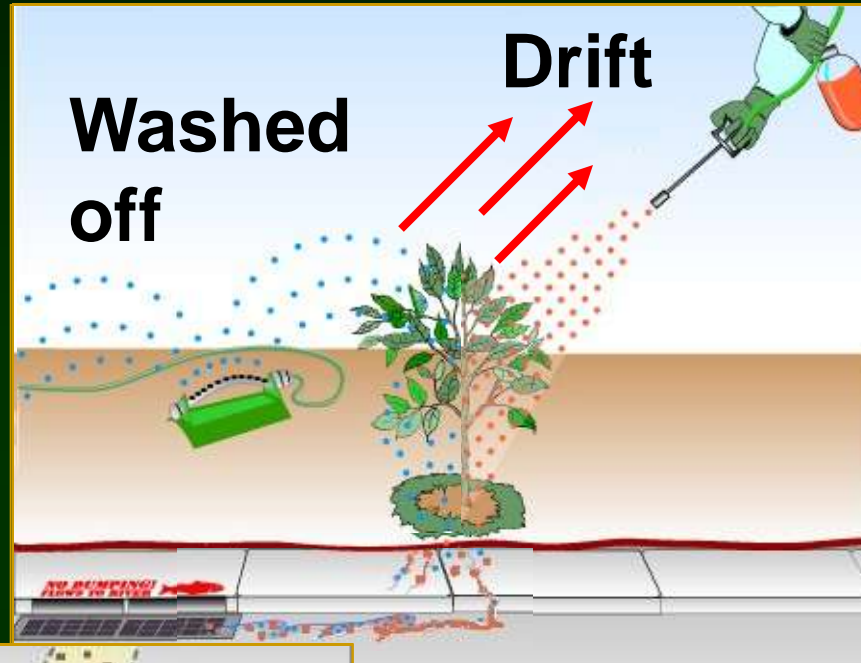
Insect growth regulators

Apply materials in ways that reduce exposure

# Manage your water

*Protect the environment*

Run into storm drains



Leads to rivers, streams, and other waterways



# Remember these points:

1. Do some homework ahead of time
2. Monitor regularly
3. Correctly ID pests & beneficials
4. Determine if management is needed
5. Change conditions so they don't favor pest population development
6. Consider nonchemical controls first

# Acknowledgements:

**Ladd Sievenpiper**

**Marin Master Gardeners**



**Cheryl A. Reynolds, Mary Louise Flint, and Joyce F. Strand**

**University of California Statewide IPM Program**

*Developed in part with funding from the Elvenia J. Slosson Endowment Fund  
and Cooperative State Research, Education, and Extension Service, USDA*

## **Advisory Committee:**

**Bethallyn Black – UC Cooperative Extension Contra Costa County**

**Pamela Geisel – UC Statewide Master Gardener Academic Coordinator**

**Judy McClure – UC Cooperative Extension Sacramento County**

**Photography:** Jack Kelly Clark, Cheryl Reynolds, Statewide IPM Collection, String trimmer damage courtesy of Pamela Geisel

**Illustrations:** Chris O'Connor, Celeste Rusconi