

Protecting Air, Water Quality, and Security

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Sources of Pollutants from Urban Landscapes

- Fertilizers
- Pesticides
- Pathogens
- Sediment
- Oil, gasoline, and diesel fuel
- Brake residues (heavy metals)
- Emissions from combustion: VOC and NO_x
- Emissions from plants: VOC

Impacts of Pollutants on Security

- Protecting Beneficial Uses of Water
 - Drinking (potable)
 - Agriculture (food production)
 - Recreation
 - Environmental



Protecting Air Quality

Source of air quality information: Dr. John Karlik

Sources of Air Pollutants from Landscapes

➤ Gardening Equipment

- Gasoline-powered mowers, edgers, blowers, rototillers, hedge trimmers, chainsaws, chippers, etc...

➤ Mobile sources

- Landscaper vehicles (gardener, arborist, and deliveries)

➤ Plants

- Release biogenic volatile organic compounds (VOCs) used for a variety of complex ecological function

Types of Air Pollutants

- Ozone (O_3)
 - Secondary pollutant
 - NO_x + VOCs in presence of sunlight
- Particulate matter
 - PM10 (microns)
 - PM2.5 (microns)
- Carbon monoxide
 - Incomplete combustion of fuels



Impacts of Air Pollutants

➤ Ozone

- Human health
- Plant stress and injury (severity depends on species & cultivars)
- Damages materials such as rubber

➤ Particulate matter

- Human health
- Reduces visibility

➤ Carbon monoxide

- Human health

Impacts of Plants on Air Quality

➤ Direct Effects

- Remove CO₂
- Release O₂
- Surfaces for wet and dry deposition of gases
- Surfaces for particulate deposition

➤ Indirect Effects

- Shade trees reduce cooling needs.
 - Homes & buildings
 - Streets, parking lots, etc.

Biogenic VOCs Emitted by Plants

➤ Isoprene

- The VOC emitted in greatest quantity by plants

➤ Monoterpenes

- May form secondary aerosols

➤ Sesquiterpenes

- Very reactive, relatively little known about them

➤ Oxygenates

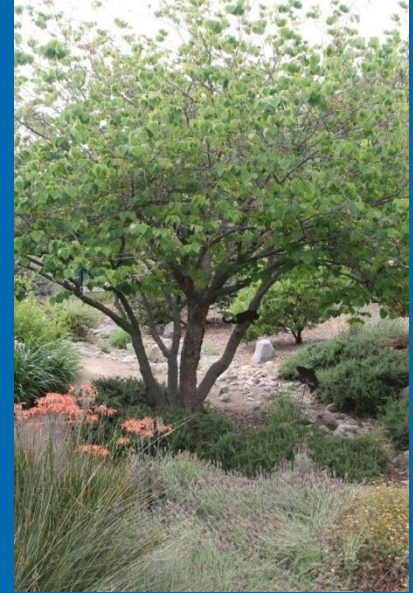
- Alcohols, aldehydes, ketones, esters, carboxylic acids
- Methylbutenol a major emission of some pines

Comparison of Isoprene Emission of Sweet Gum to Spilled Gasoline

- Isoprene emission rate of $26 \text{ ug g}^{-1} \text{ h}^{-1}$ (at 30°C under sunny skies)
- Leafmass of 40.5 kg (medium-sized tree)
- Resulting hourly emission of 1 g isoprene
- Approximately equivalent to 4.5 mL gasoline spilled per hour
- For 10,000 trees, isoprene emission approximately equivalent to 45 L gasoline spilled per hour

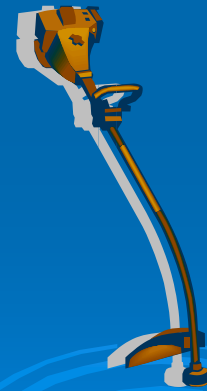
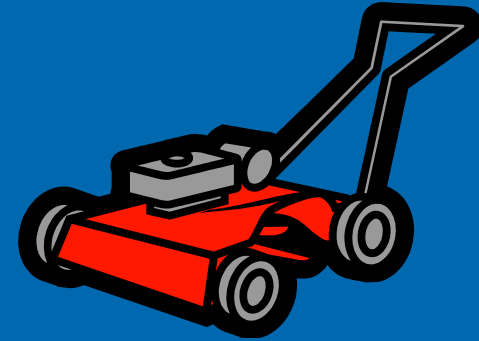
Benefits of Plants

- Many more positives than negatives
 - Plants provide shade to cool structures and surfaces.
 - Plants produce O_2 .
 - Plants absorb CO_2 .



Minimizing Anthropogenic Sources of Air Pollutants

- Reduce or eliminate the use of gasoline-powered equipment.
- Keep gasoline-powered tools in good running condition to reduce emissions and oil leaks.
- Retire garden tools with inefficient high polluting engines.
- Clean up fuel and oil spills immediately using absorbent materials.



Protecting Water Quality

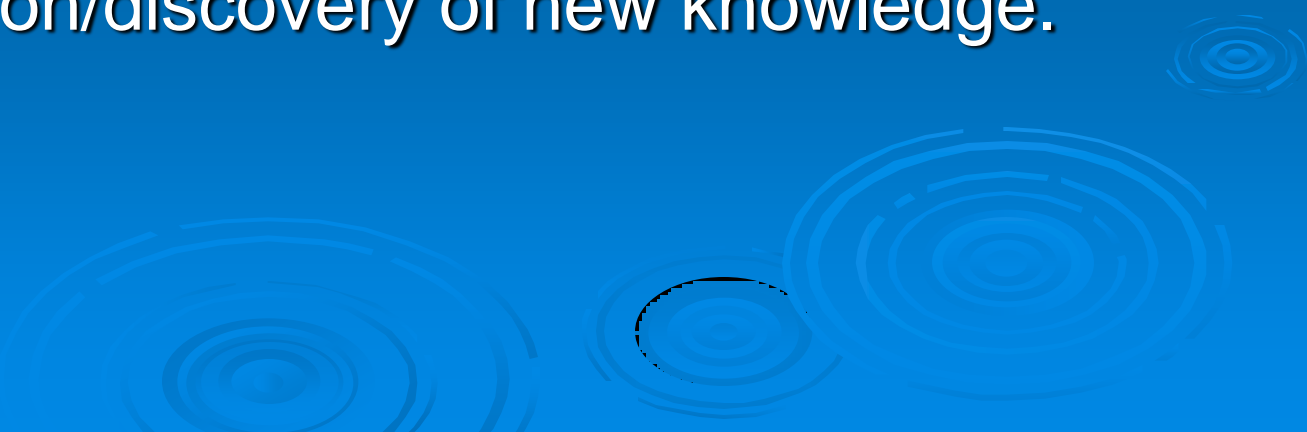
Inquiry-Based Approach



Inquiry and Science

- Places educators in the role of being a facilitator of learning, rather than a disseminator of known information.
- Allows educators to learn more of who their audience is, what they know, interests they have, and how their minds work.
- People learn more than just concepts and facts about science, they learn the processes of discovering and establishing concepts and facts.

Inquiry-Based Learning Includes:

- Active investigation.
 - Open-ended questioning.
 - Observing and manipulating (mentally or physically) objects, phenomena, and/or nature.
 - The acquisition/discovery of new knowledge.
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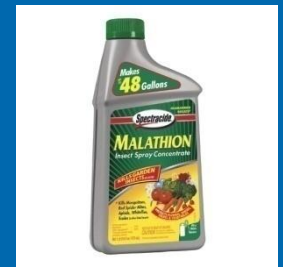
HOW DOES YOUR FOOTPRINT AFFECT THE WATER QUALITY OF LOCAL RIVERS, LAKES AND THE OCEAN?

- Inquiry-based activity
- Small vs. large groups
- Visual representation of the impacts of human activities on water quality.
- Gardening impacts can be significant.



Pesticides


- Organophosphates
- Synthetic pyrethroids
- Phenylpyrazoles



Current Sources of Organophosphates from Urban Landscapes

- Diazinon – residential sales ended Dec. 31, 2004
- Chlorpyrifos – residential sales ended Dec. 31, 2001
- Malathion – majority of remaining OP use in residential settings
- Detection in urban surface waters is declining since residential sales ended.

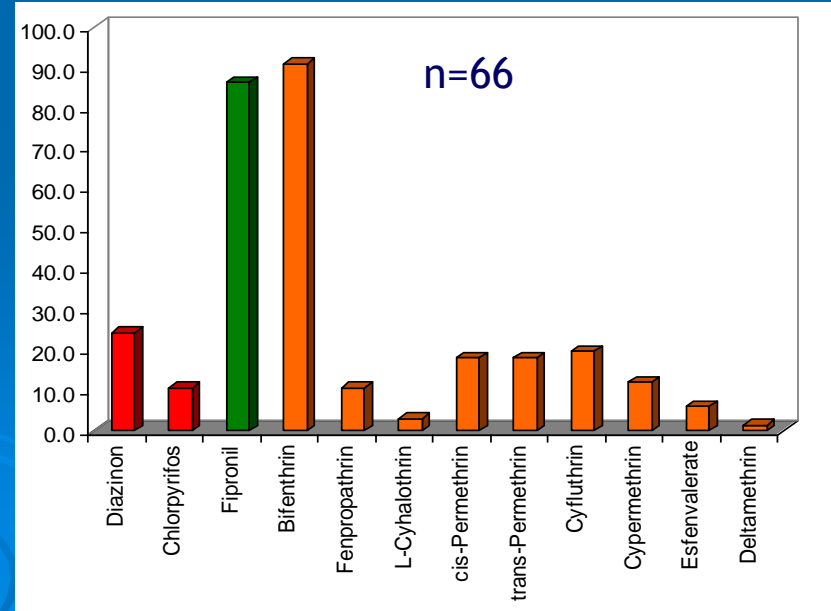
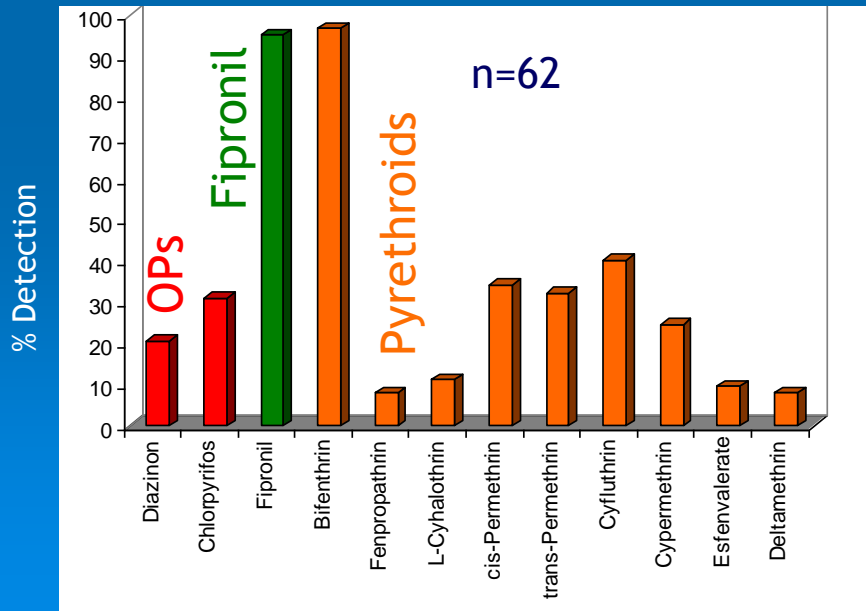
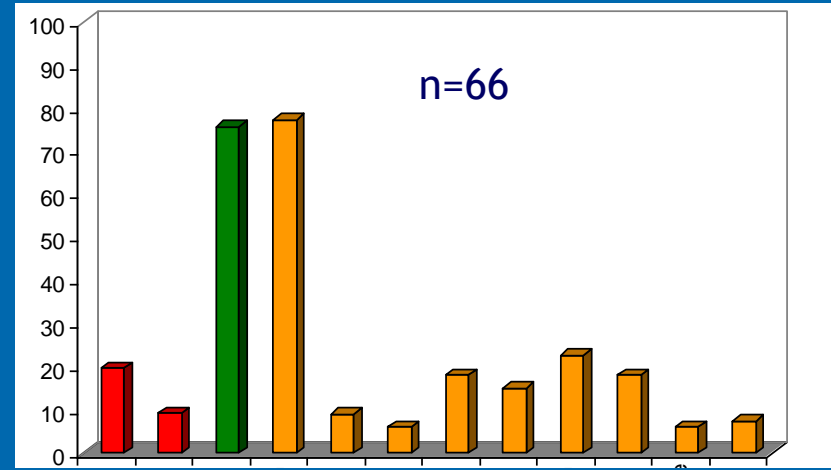
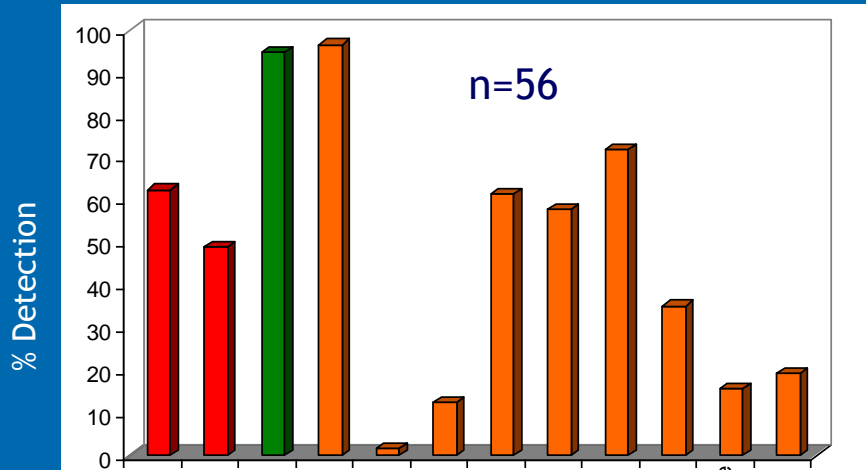
Current Sources of Synthetic Pyrethroids from Urban Landscapes

- Detection in urban surface waters is increasing since residential sales of diazinon and chlorpyrifos ended.
 - Broad spectrum insecticides
 - Bifenthrin
 - Cypermethrin
 - Cyfluthrin
 - Permethrin
 - Lambda-cyhalothrin
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Current Sources of Fipronil From Urban Landscapes

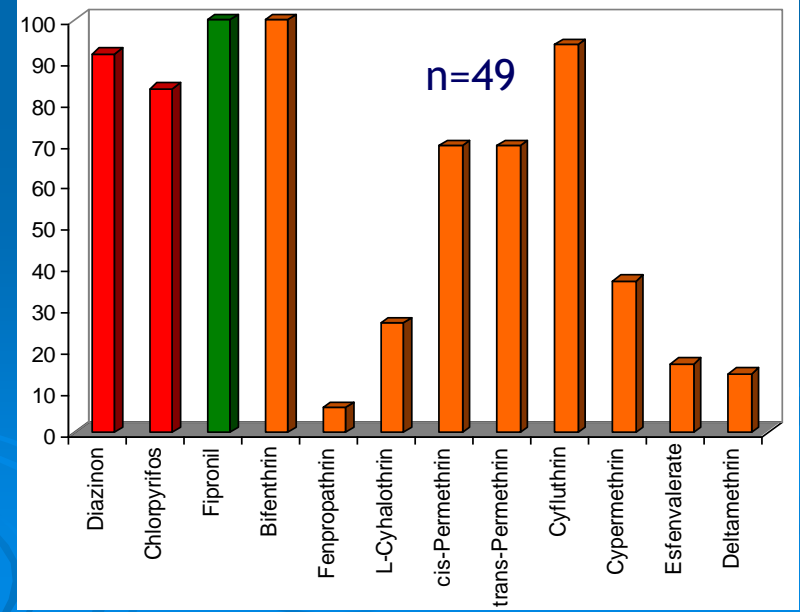
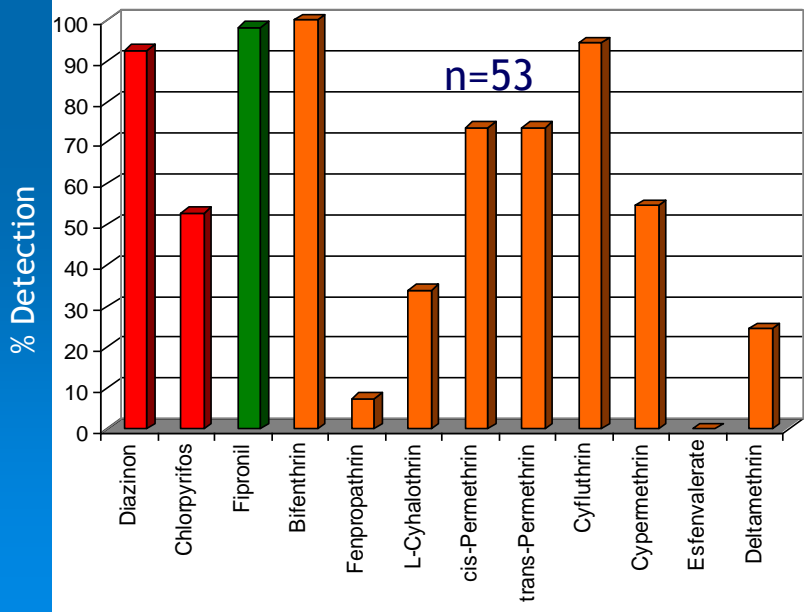
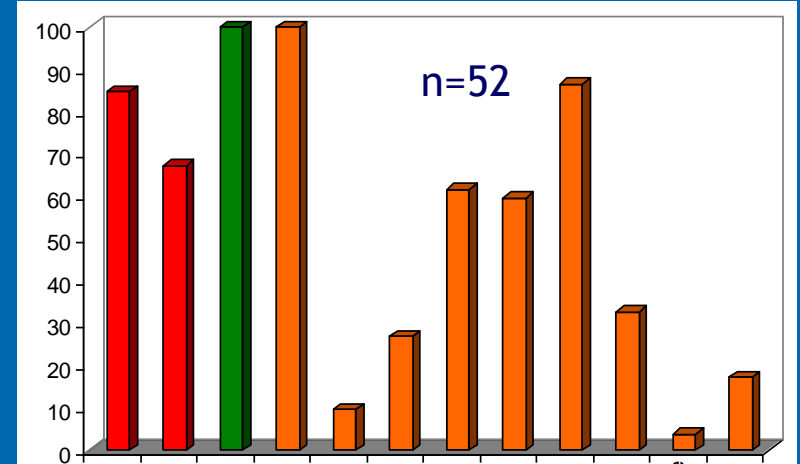
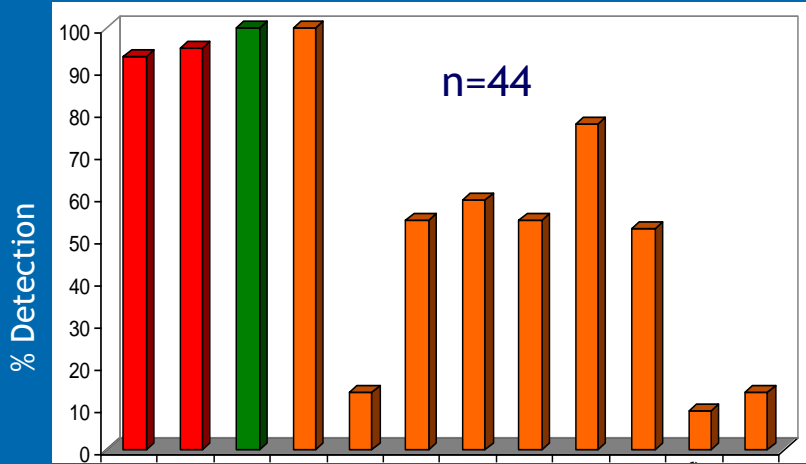
- Frontline
 - Flea control for pets
- Maxforce and Combat
 - Gels and baits for cockroach and ant control
- Termidor
 - Termite and ant control sprays and granular baits
 - Registered for use by Pest Control Operators for structure perimeters and spot treatments

Pesticide Detection Frequency Sacramento County

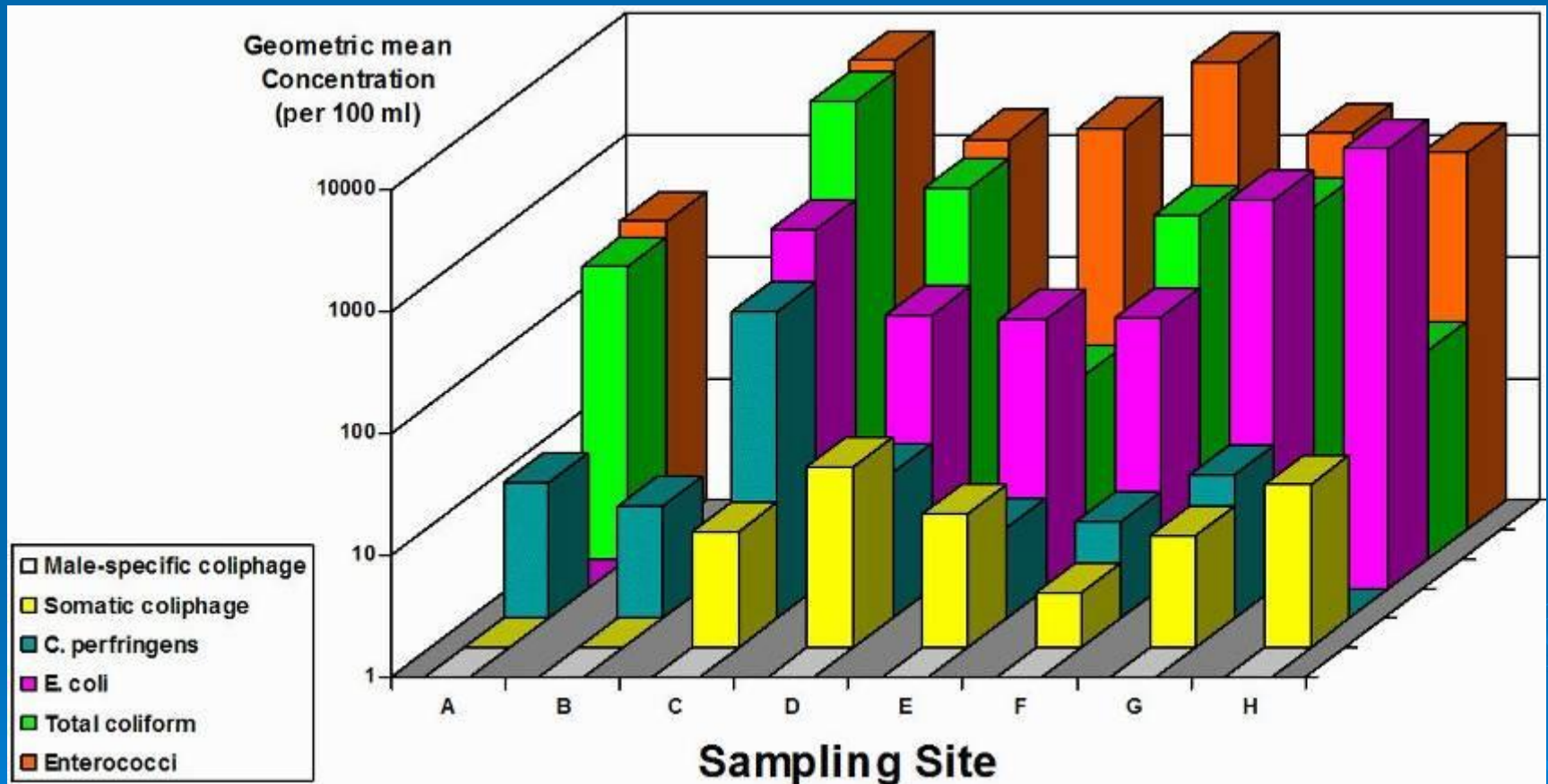


Pesticide Detection Frequency

Orange County



Microorganisms by Site



Impacts of Conventional Landscaping on Water Quality

- Increase in impervious surfaces.
 - Streets, sidewalks, rooftops, patios, driveways, and walkways
 - Rainfall is not retained.
 - Surface water runoff increases to 50-70%.
- Disturbed and Paved Soils
 - Limited ability to filter pollutants due to lack of biological activity.
- Increased use of fertilizers and pesticides often required to maintain high level of aesthetic value.
 - Chemicals mobilized by rain and irrigation.



Protecting Water Quality

Non-Structural Management Practices



What is Responsible Pest Control?

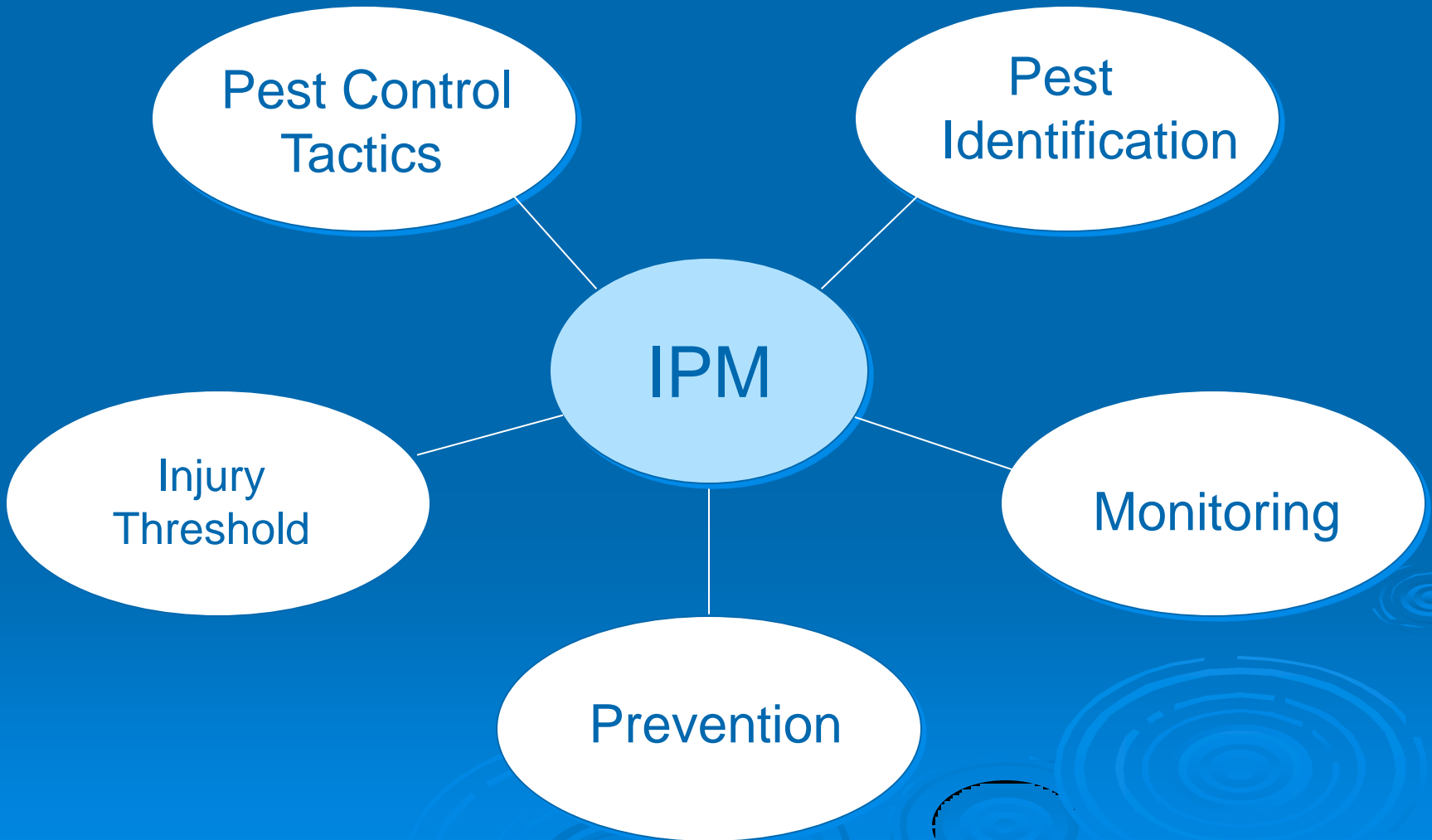


Key Terms

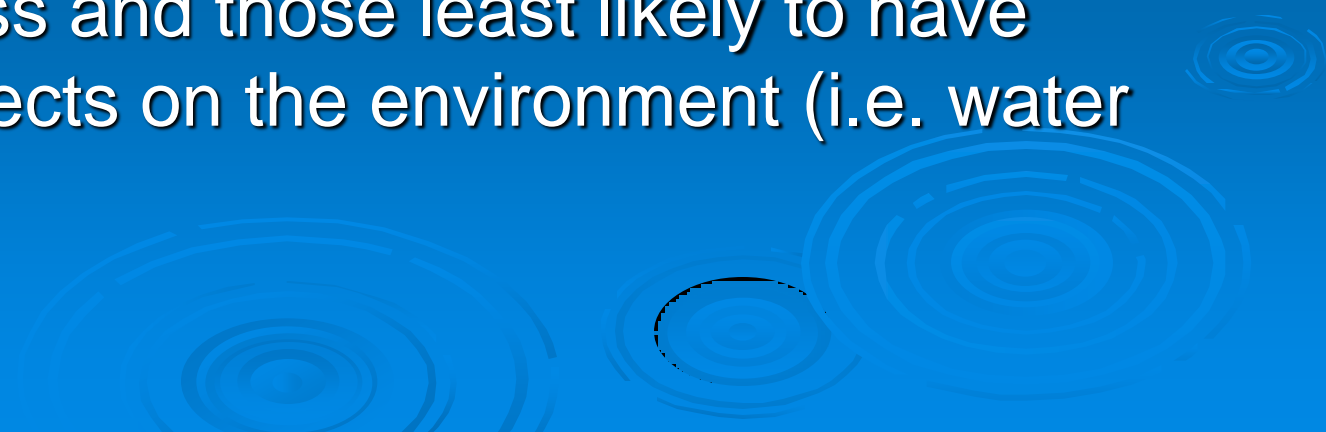
➤ Integrated Pest Management

- a strategy to prevent and suppress pest problems with minimum adverse impacts on human health, the environment, and non-target organisms.

Components of an IPM Program



Putting the Components Together

- IPM reduces pesticide inputs = reducing the potential risk of polluting waterbodies.
 - Example: prevention, proper pest identification, and proper choice of control tactics.
 - IPM methods are selected based on effectiveness and those least likely to have adverse effects on the environment (i.e. water quality).
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Characteristics of Least-Toxic Pesticides

- Effective against target pest
- Low acute and chronic mammalian toxicity
- Degrade rapidly
- Kill a narrow range of target pests
- Little or no impact on non-target organisms

Types of Least-Toxic Pesticides

- Pheromones and other attractants
- Insect growth regulators
- Repellents
- Desiccating dusts
- Soaps and oils
- Some botanical pesticides



Drawbacks Utilizing Least-Toxic Pesticides

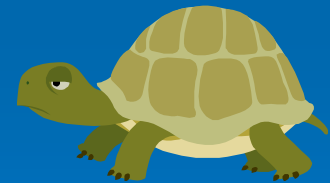
- Are usually more expensive.



- May not be effective when populations are high.



- May work slower than traditional pesticides.



- May be difficult to find products.



Ant Control

- Broad spectrum pesticides
 - Barrier around perimeter of home
 - Short-term control
- Granular Bait
 - Ants forage and consume bait
 - Carrier attracts ants
- Bait Station
 - Ants attracted to bait
 - Pesticide protected from environment



Liquid/Gel Ant Control

➤ Active ingredients

- Boric acid
- Fipronil
- Cleaning products (inside quick control)

➤ Examples

- Terro® Liquid Ant Baits
- Maxforce ® Gel
- KT AntPro ®
- Windex ®, 409 ®, etc...

Placement of Bait Stations

- Install one on each side of structure
- Place near source of water – air conditioner, hose bib, etc...
- Shady and moist locations – North side
 - Avoid full sun locations
- Near trails of ants
 - DO NOT PUT DIRECTLY OVER OR NEXT TO NESTS!
 - > 5 feet away is best
- Avoid areas with runoff such as near downspouts.

Sure-Fire Ways to Reduce the Effectiveness of Least Toxic Pesticides

➤ Key Factors

- Quick versus slow control
- Providing consistent food source
- Excessive watering
- Lack of pesticide rotation (changing active ingredient)
- Failure to implement more sanitary practices in home and yard
- Failure to control 'honeydew' producing insects



Fertilizer Activities Contributing to Water Quality Issues



- Off-target application
 - Poor equipment
 - Poor technique
- Improper timing
 - Leaching/Runoff
- Excess application
 - Leaching/Runoff
 - Poor equipment calibration

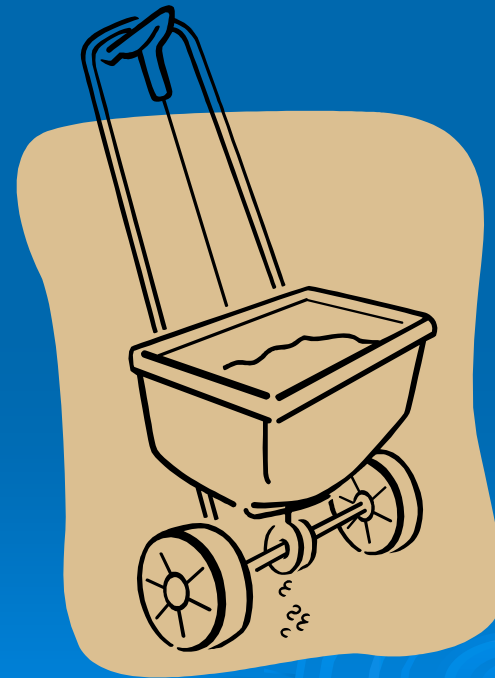
Fertilizer Application Equipment

- Hand
- Handheld Broadcast Spreader
 - Rotary
 - Shaker
- Drop Spreader
- Rotary Spreader



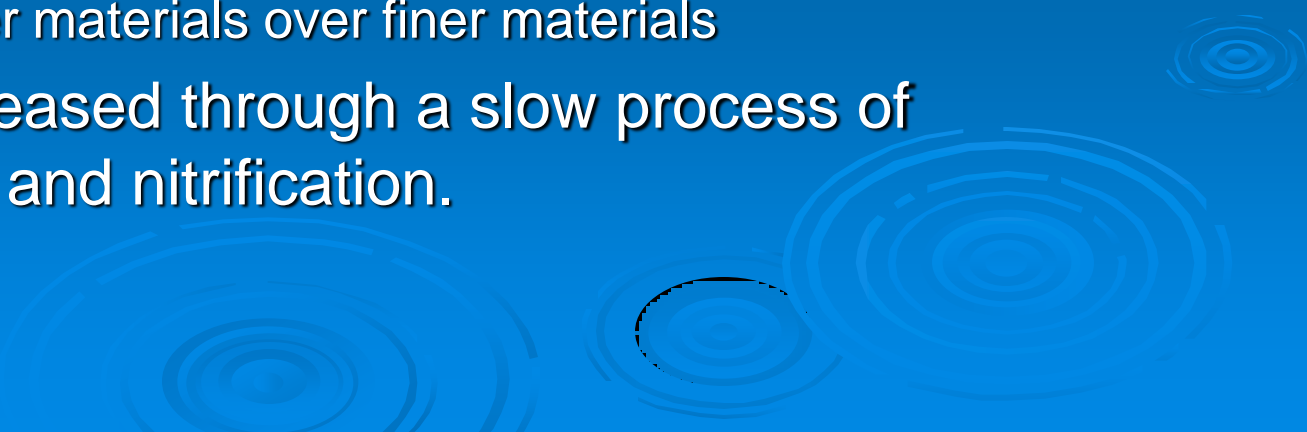
Fertilizer Calibration Steps

- Weigh out 1 lb of fertilizer material
- Set spreader at recommended setting on bag
- Apply material over a tarp or plastic sheet of known dimensions
- Weigh material applied to determine if spreader setting is correct



* Calibration needs to be done for each type of fertilizer used

Benefits of Organic Sources of Nutrients

- Compost and mulch returns a wide array of macro- and micronutrients back to the soil reservoir.
 - Increasing the depth of mulch layers increases the nutrient level of the soil underneath.
 - Apply 6" or more
 - If possible, use fresh material
 - Select coarser materials over finer materials
 - Nitrogen is released through a slow process of mineralization and nitrification.
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Fertilizer Application Tips

- Set the spreader at half the recommended rate and make two passes at 90° of each other.
- Sweep up any off-target granules.
- Stick with the same brand and type of fertilizer if you are not willing to calibrate your spreader each time.
- Pay close attention to the amount of water used to “water-in” the fertilizer.
- Organic > Controlled Release > Inorganic

Protecting Water Quality

Structural Management Practices



Solutions for Controlling Runoff

➤ Rain collection devices

- Cisterns or rain barrels.
- Online vendors currently provide good selection.
- Allows for collection and use of rainwater for irrigation.



Source: Experiments in Sustainable Urban Living

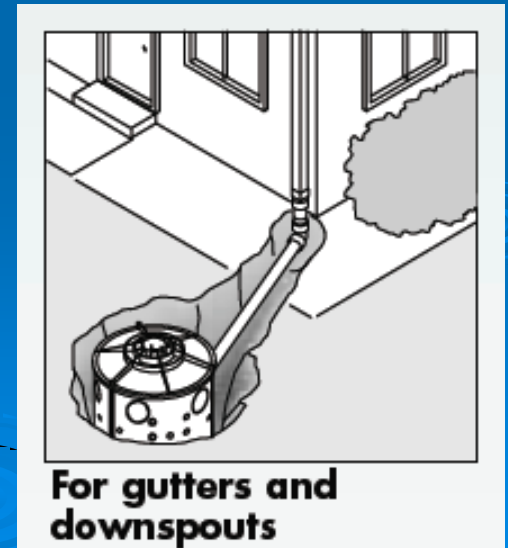




Photo: L.Oki

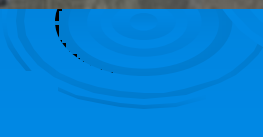
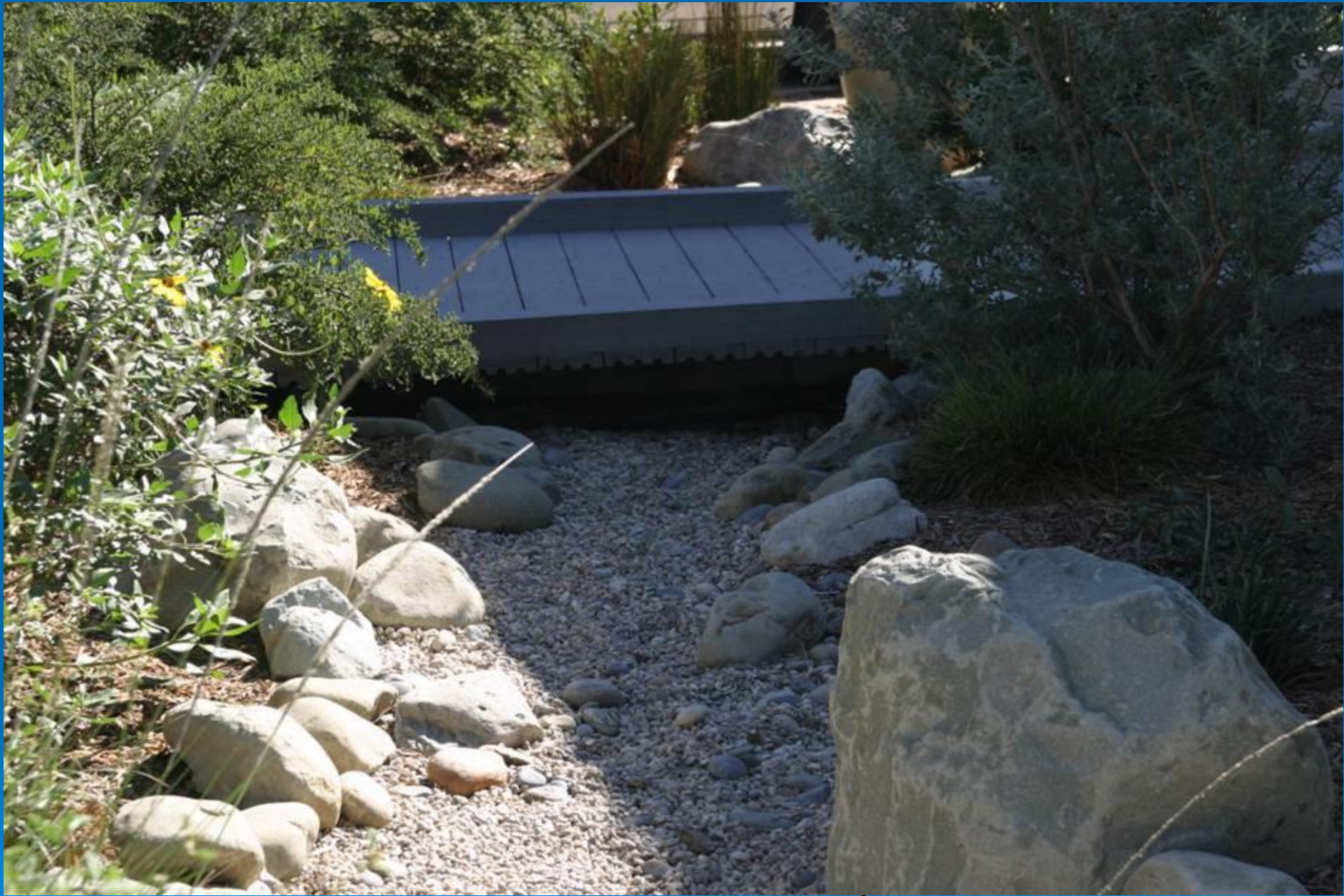
Solutions for Controlling Runoff

- Diversion to mulched or planted areas
 - Proper placement of downspouts.
 - Direct runoff to vegetated areas of the landscape.
 - Integration of downspouts with gravel or plastic manufactured dry wells.
 - Rain chains
 - Example: FLO-WELL Storm Water Leaching System









Pop-up drain



Solutions for Controlling Runoff

- Utilize brick, pavers, pervious concrete, or other materials that allow for some infiltration.
- Slope driveway so runoff drains to vegetated areas of the landscape.



Solution for Controlling Runoff

- Install driveway interceptor or slotted drains to channel runoff into surrounding vegetation.
 - Reduces storm runoff by 65%

(Xiao, Center for Urban Forest Research)



Source: LandscapeNetwork.com



Solutions for Controlling Runoff

- Avoid impervious walkways directly connected to driveways and sidewalks.
- Stabilize flagstone using decomposed granite with a binder instead of impervious concrete.



Flagstone pathway set in decomposed granite with binder



Solutions for Controlling Runoff

- Utilize bricks, pavers, or flagstone stabilized with decomposed granite.
- Slope patio toward vegetative areas to allow infiltration of runoff.





Solutions for Controlling Runoff




- If possible, eliminate mounding of soil that creates downward slopes toward impervious surfaces.
- Slopes planted with turfgrass are difficult to manage and can contribute to surface runoff problems.

Solutions for Controlling Runoff

- At base of slope utilize infiltration trenches or bioswales.
- Select appropriate plant materials for slopes.
- Seek professional engineering assistance on large steep slopes.



Drainage Solutions to Reduce Water Runoff

- Utilize perforated pipe as much as possible.
 - Cover with sock to prevent sedimentation.
 - Direct runoff from impervious surfaces into vegetative areas of the landscape.
 - Incorporate drainage as a design element
 - Vegetated swales
 - Dry wells (French drain)
 - Detention ponds
 - Infiltration basins or rain gardens
- 

French Drains

- Trench or basin filled with a porous material.
 - Perforated pipe is not a requirement.
- Useful in redirecting runoff from impervious surfaces to vegetated areas.
- Unlike a swale, detention pond, or infiltration basin, they can support foot traffic.
- Vegetation should be planted adjacent to French drain and not on top of it.















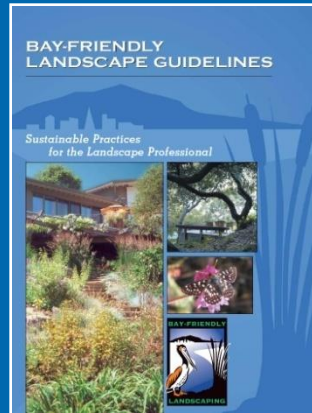
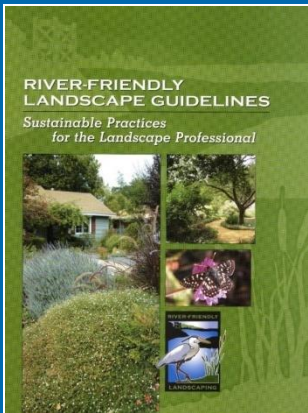
Role of Plants in Improving Runoff Water Quality

- Tree canopies intercept rainfall
 - Reduces runoff
- Plant roots take up soil water and increases storage potential
- Canopies over undisturbed surfaces promotes good soil structure
 - Increases organic matter content
 - Moderates soil temperature
 - Promotes soil biological activity that improves water infiltration

A Few Things to Think About...

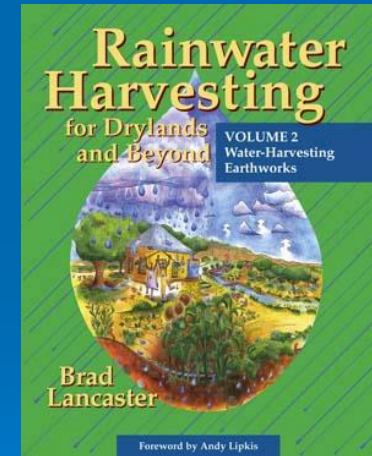
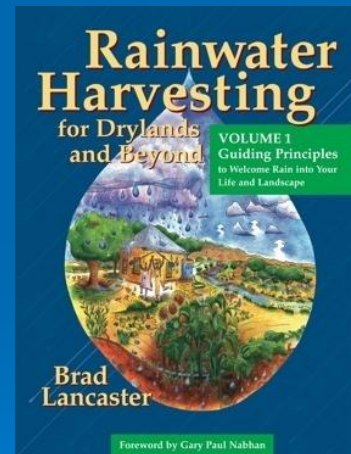
- Infiltration may cause more harm than good
 - Shallow groundwater
 - Expansive soils
- Poor maintenance of water retention design features
 - Stagnant water in rain barrels, cisterns, rain gardens
 - Possible breeding environment for mosquitoes
- Key components to success of a landscape designed to reduce runoff
 - Plant selection
 - Irrigation design and maintenance
- Follow all local, regional, and state laws and regulations when installing structural management practices.

Useful Resources



www.riverfriendly.org

www.bayfriendlycoalition.org



<http://www.harvestingrainwater.com/>

<http://www.cabmphandbooks.com/Development.asp>