Ecologically-Based Integrated Pest Management
Berthoud Board of Trustees
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Integrated Pest Management Program
Rella Abernathy
Overarching Principles

- Protection of biodiversity
- Enhancing ecosystem services
- Adaptation and resilience to climate change
TERRESTRIAL SPECIES DECLINED BY 39 PER CENT BETWEEN 1970 AND 2010

THE LPI FRESHWATER SPECIES SHOWS AN AVERAGE DECLINE OF 76 PER CENT

MARINE SPECIES DECLINED 39 PER CENT BETWEEN 1970 AND 2010
Insects are disappearing

Defaunation in the Anthropocene, Science 345, 401 (2014)
Why does it matter?
Ecosystems are much more than our natural environment. They are communities of living organisms, such as humans, animals, and plants, and the non-living material they interact with, such as water, air, and soil. As the primary regulators of carbon emissions, ecosystems play a key role in our climate adaptation and help mitigate impacts, such as drought, temperature extremes, and food shortages. To achieve our climate goals, we must improve the health and resilience of Boulder’s ecosystems through smart land management and incentives.

Our climate goal: Enhance the ability of urban, wildland and agricultural ecosystems to capture and stabilize carbon in the atmosphere and increase carbon resilience.

**Ecosystem action areas and goals**

**URBAN ECOSYSTEMS**

Goal: By 2050, Boulder’s urban landscape will be planted with trees and plants that can moderate climate extremes, reduce energy and water use, improve water quality, and enhance the beauty and livability of Boulder’s urban environment. More than 50 percent of the land in the developed portions of Boulder will be covered by trees.

Boulder has more than 620,000 trees, about 6 1/2 times our population. Most of these trees are located in our parks and provide a limited buffer against temperature extremes in the areas where we live and work. Due to heat island of the Emerald City’s surface, Boulder is expected to be up to 10 percent more urban tree density in the next five to 10 years. By increasing the number, diversity, and placement of trees in Boulder’s urban centers, we can improve air and water quality, reduce heat island heating and cooling needs, and improve the health of thousands of trees in our community.

**WILDLAND ECOSYSTEMS**

Goal: By 2050, Boulder’s surrounding lands will be managed to maintain a vibrant and diverse natural ecosystems while being able to adapt to significantly different growing conditions and species compositions.

Native plants and vegetation are a good idea, as Boulder’s extensive native vegetation plays an important role in maintaining the beauty and health of our community in the face of climate change. Boulder will continue to be a leader in utilizing native species that will allow the delicate balance of our wildland ecosystems to thrive. Efforts to increase the number of native plants and increase the ability of agriculture lands to capture the climate.

**AGRICULTURAL ECOSYSTEMS**

Goal: By 2050, agriculture on city lands will maximize the health and climate benefits of soil and associated ecosystems while producing more local foods.

The City of Boulder has 4,100 acres of agricultural lands, most of which is used for livestock grazing and a small part of which is focused on local vegetable production. Agriculture accounts for approximately six percent of greenhouse gas emissions. However, agricultural practices can also be used to reduce emissions and create carbon sinks, which help to assimilate the climate and fuel agricultural production and land health. By supporting Boulder farmers in using organic and other sustainable farming practices, we will reduce emissions from agriculture and increase the ability of agriculture lands to capture the climate.
What is Integrated Pest Management or IPM?
“The Golden Age of Pesticides”
“DDT is good for me-e-e!”

Across the continent, housewives quickly discovered Bison DIDIT to be a new and better killer of disease-carrying flies, mosquitoes, bedbugs and roaches...protection against hateful pests...good tidings to most household insect pests. Bison DIDIT, America’s proven insecticide licensed under a U.S. Patent to contain 5% Technical Grade of the amazing wartime chemical EDD, is simple to use...no muss...just spray this concentrated liquid to most household insect pests. The pleasant, mild odor when spraying quickly dissipates, And Bison DIDIT leaves no residue...just an invisible residual toxicity that can continue to kill for days.

THE LADIES KNOW WHAT’S GOOD!
Founders of IPM

Vernon Stern  Robert van den Bosch

Ray Smith  Kenneth Hagen

Rachel Carson

Silent Spring
Working with natural processes to keep ecosystems in balance
Integrated Pest Management

A dynamic, decision-making process that is based on the best available science, and relies on observation and knowledge of the target organism and the ecosystem where it lives.
CITY OF BOULDER
WEST NILE VIRUS
MOSQUITO MANAGEMENT PLAN

February 2006
Prepared by:
City of Boulder
Office of Environmental Affairs
In collaboration with
OtterTail Environmental Inc.
Different groups of mosquitoes

Permanent water or standing water – vector species in Colorado are in this group

- Lay eggs on water
- Can’t dry out or will die
- Usually hatch within 24 hours
Different groups of mosquitoes

Flood water mosquitoes – nuisance mosquitoes

- Lay eggs at edge of water or on mud
- Egg must dry out before can hatch
- Water activates eggs
- Have to stay wet after hatching through rest of life cycle
- Flooding/heavy rainfall can synchronize emergence
Biological Consulting Services
Monitor the number and location of the species of mosquitoes that have the ability to transmit WNV.
Figure 3-3 Vector Index

- Cases by Onset Dates
- Index
Basis for Mosquito Program Development

• Based on sound ecological principles
• Understanding of science, mosquito biology, review of literature, consultation with experts
• Balancing protection of human health and ecosystem function – complementary
• Innovation and common sense
• Not reactionary – calm under pressure
• If tools don’t exist, create them
Management Strategies for each point in the lifecycle

Mosquito Life Cycle (Generalized)
Adulticides

Target adult mosquito

- Broad-spectrum insecticides
- Micro-droplets – must make contact with mosquito in flight
- Affected by wind currents, buildings, trees and other barriers
- Mosquitoes not in area during time and place of application not killed
- Non-target and human health concerns
Adulticides

To spray and hit aerial flying insects, like mosquitoes, is even more difficult because the spray droplets must be only from 2- to 16-microns in diameter. Such small insecticide droplets are not only difficult to produce but many will drift beyond the target area, never touching the target mosquitoes. Based on the estimate that target mosquitoes only receive about 0.0000001% of the aerial spray (Pimentel 1995), 1 million insecticide droplets must be produced to hit one target mosquito. Suppose a city spent $500,000 for mosquito control and only 1 insecticide droplet in a million hits a mosquito. This means that the 50¢ of the tax money resulted in killing 1 mosquito.

David Pimentel and Michael Burgess, Cornell University
Pupacides

Target pupal stage

- Oils and surface films – also used as larvicide
- Pupae and larvae can’t get air and suffocate
- Non-selective – lethal to all surface-breathing insects, including mayflies, aquatic beetles and bugs. Impacts duck eggs.
Larvicides

Target larval stage

- Methoprene – hormonal mimic that prevents larvae from growing – broadly toxic to other insects and invertebrates
- Bacterial formulations – city uses *Bti* – most targeted – kills all aquatic fly larvae
Different types of breeding sites

- Artificial sites created by people in yards, businesses, farms
- Wheel ruts, depressions in vacant lots
- Damaged or degraded wetlands
- Agricultural fields
- Healthy, functioning wetlands
Condut a Healthy Wetland — Destroy Mosquitoes
By Emily Biebighauser, May 2006

Handling the Truth
Would you like to enjoy the many aesthetic and environmental benefits of constructing a wetland on your property — but are worried about West Nile Virus? Then read on, learn the real risks, and find out why healthy wetlands actually lower mosquito populations.

The Real Culprit
Of the many species of mosquitoes, it's usually the Culex mosquito that carries the West Nile Virus. Culex is commonly termed the ‘filth mosquito', as it favors small bodies of water with high organic content for breeding and survival of its larvae. This means that gutters clogged with leaves, puddles on top of woodpile tarp, wastewater outflows, unkempt swimming pools, and bird baths are prime habitat for the next generation of filth mosquito.¹

Tired of swatting mosquitoes in general? Nearly all mosquitoes will breed in any small pool of water created after a hard rain, and because of their short life cycles (from under a week to a month), this makes junked tires, toys left out in the yard, and road ruts their ideal nursery. In fact, one Indiana county found that 66% of West Nile carrying mosquitoes originated from abandoned tires (example in photo above).²

Natural Enemies
So why do mosquitoes prefer these short-lived puddles?

The Two D’s: Drainage and Degradation
But haven't you always heard that wetlands are the biggest source of mosquitoes? True, some wetlands can harbor substantial mosquito populations, but these aren't healthy ecosystems. In fact, they are often critically damaged in two ways: by drainage and degradation.

Drained wetlands may leave hydry depressions in the landscape, meaning that when a heavy rainfall event occurs, a few inches of standing water will pool in the depression. This allows mosquitoes to breed and lay eggs, and even if the pool dries up before the eggs can hatch, they may remain dormant for up to a year, hatching soon after the next rain.

Degraded wetlands, even those considered to be healthy, may be less productive for mosquito breeding, even though they may still harbor the filth mosquito. These wetlands may have lost the necessary biodiversity to keep natural enemies (such as birds) that can help control mosquito populations. So while you may not see hundreds of mosquitoes, there may be a significant number just below the surface.³

Healthy Wetlands in the Real World
In Essex County, Massachusetts, the restoration of a 1,500 acre wetland cut the mosquito population by 90%.¹ Wildlife Biologist Tom Biebighauser has sampled hundreds of natural and constructed wetlands on the Daniel Boone National Forest. He has found few to none contain mosquito larvae, and nearly all contain mosquito predators. An
Risk of West Nile Virus
Drought and immunity determine the intensity of West Nile virus epidemics and climate change impacts

Sara H. Paull\textsuperscript{1,2}, Daniel E. Horton\textsuperscript{3,4}, Moetasim Ashfaq\textsuperscript{5}, Deeksha Rastogi\textsuperscript{5}, Laura D. Kramer\textsuperscript{6,7}, Noah S. Diffenbaugh\textsuperscript{4} and A. Marm. Kilpatrick\textsuperscript{1}

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Drivers for Colorado Human West Nile Virus Cases

- Human immunity
- Drought
- Stable under extreme climate and drought conditions
Annual Boulder County Mosquito Totals vs Annual Greenbelt Meadows Average Trap Count

- **Boulder County Total**
- **GBM Average Trap Count**