Climate Change and Rangeland Insects

David C. Lightfoot
Department of Biology
The University of New Mexico
Albuquerque, NM 87131

Rangeland Insects

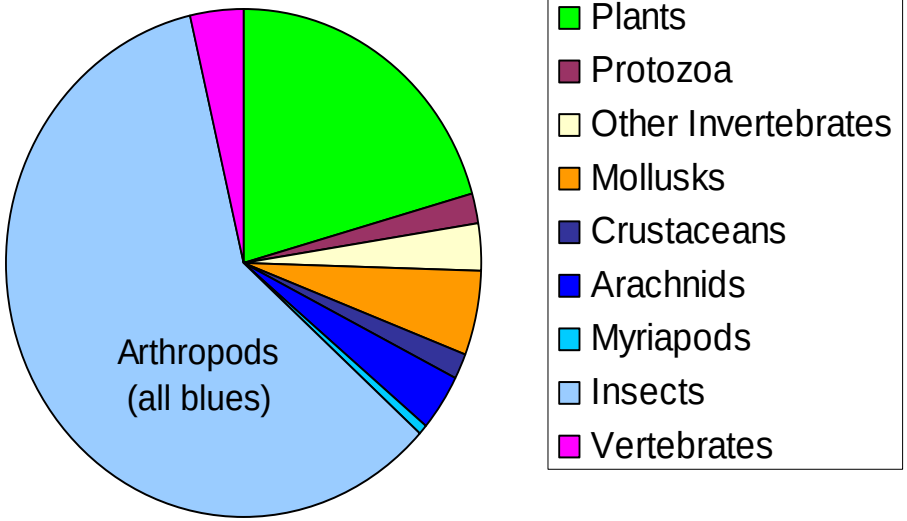
High Diversity & Abundance

- Species numbers
- Individual numbers
- Trophic variety
- Habitat use

Figure 3.5e Butterfly richness of ecoregions in the United States and Canada.

Relative Number of Species of Organisms on Earth

one million insect species



Hebivores: chewing insects

photo

grasshoppers

photo

caterpillars

photo

blister beetles

photo

mesquite girdling beetle

Herbivores: sap-feeding insects

photo

leafhoppers

photo

stink bugs

photo

aphids

photo

scale insects

Predators

photo

scorpions

photo

mantids

photo

robber flies

photo

spiders

Detritivores

photo

photo

darkling beetles

crickets

photo

photo

termites

dung beetles

Pollinators

photo

digger bees

photo

butterflies

photo

moths

photo

bumble bees

Rangeland Insects of Economic Importance

Consumers of human-valued resources
- forage consumption: grasshoppers

Vectors of disease
- West Nile virus: mosquitoes
- bubonic plague: fleas
- blue stain fungus: bark beetles
- anaplasmosis: ticks, biting flies

Exotic / invasive pest species
- few species relative to plants and vertebrates
- major North American range insect pests are native

Climate Change Effects on Economic Insects
- unknown, likely shifts and fluctuations

❖ *most rangeland insect species are not pests*

Rangeland Insects of Ecological Importance

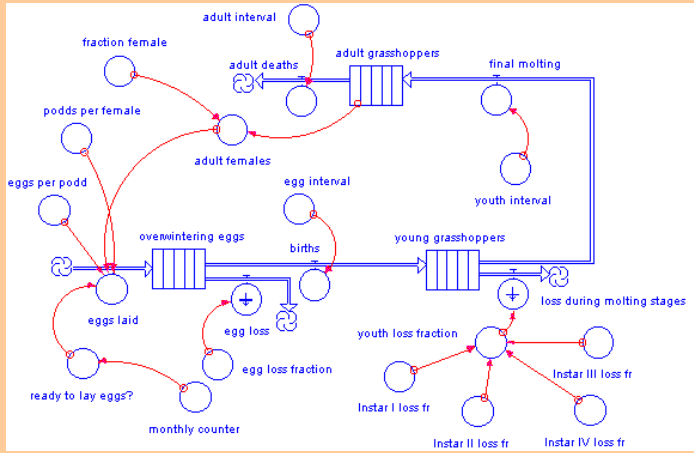
Nutrient / energy processing and flow
- detritivores and folivores
- soil aeration and nutrient transport

Pollinators
- essential to most plants
- many coevolved species

Threatened and endangered species
- few protected insects
- many rare, local endemic species
- many threatened by habitat loss

Climate Change Effects on Ecologically Important Insects
- unknown, likely shifts and fluctuations

Climate Change Impacts on Insects



Grasshopper population model from Begon 1996

Direct

- Temperature (ectotherms)
- Moisture
- Seasonal shifts

Indirect

- Changing plant productivity and quality
- Changing predators and pathogens

Insects Highly Responsive / Good Indicators

- Many taxa / ecological groups
- Ectotherms
- Short generation / life cycle times (many one-year or <)

What do we know about insects and climate change?

Casual observations provide evidence for changes

N.Y. Times shakeup

Two top New York Times editors resign in wake of journalism scandal

NATION ■ A8

Furious fun

'2 Fast' too fun to be ignored

VENUE

COMPLETE MOVIE LISTINGS

Serena loses

Serena Williams' title bid ends in defeat in French Open semis

SPORTS ■ C1

ALBUQUERQUE JOURNAL

HOME-OWNED AND HOME-OPERATED ■ MADE IN THE U.S.A.
123RD YEAR, NO. 157 ■ 136 PAGES IN 13 SECTIONS

FRIDAY MORNING, JUNE 6, 2003

FINAL ★★★★

Copyright © 2003, Journal Publishing Co. ■ Daily 50 cents

'A BUGGY SUMMER'

Damp weather results in more grasshoppers, cockroaches and centipedes in N.M.

BY BARBARA CHAVEZ
Journal Staff Writer

Just when you thought the moth invasion of 2003 was beginning to wind down, get ready for an influx of other pesky bugs.

Grasshoppers — big ones — and more cockroaches, spiders, aphids and centipedes are starting to invade gardens and sneak into homes, said entomologist Dick Fagerlund. In fact, the state is in for more insects than it has seen in the past three years, he said.

"It's going to be a buggy summer," said Fagerlund. "Basically, rain in February and late spring gave plant-eating insects plenty to thrive on. Now we are seeing more of the bugs that eat the bugs that eat the plants."

Residents should prepare themselves for more cockroaches, spiders and centipedes because they feast on plant-eating bugs, said Fagerlund.

If you don't want the critters coming inside, Fagerlund suggests turning off outdoor lights.

"The lights attract the plant-eating bugs, which will attract more of the insects that eat them," he said.

While grasshoppers are not harmful to people, they are destructive in gardens. Grasshoppers, some close to 2 inches long, have already been spotted in large numbers around the state, including in Albuquerque, said Fagerlund, who also writes the "Bugman" column for the Albuquerque Journal.

See RAIN on PAGE A10

HOPPING IN: Grasshoppers are out in force in Albuquerque. Rainfall in February and late spring gave these and other plant-eating pests plenty to munch on.

Climate Change Experiments

Predictive studies

- environmental models: fire ants, malaria mosquitoes

Manipulative experiments

- alter temperature: grasshoppers, leafhoppers
- alter CO_2: grasshoppers

Natural Case Studies

Documented insect response to global warming:

1. High-latitude expansion of butterfly distributions NA, Europe.
2. High-elevation expansion of butterfly distributions NA, Europe.
3. Shifts in life-histories, earlier and later, NA, Europe.
4. Shifts in latitudinal fruit fly genomes from south to north; Europe.
5. Local extinctions of butterflies; Europe, NA.
6. Changes in plant chemistry (defense chemistry, nutrients (C3 vs.C4) affecting herbivory; NA, Europe.
7. Disruption of moth/host tree temporal synchrony; Britain.
8. Changes in the distributions of disease vectors (esp. mosquitoes) and disease; worldwide.

What should be done?
Experiment and Monitor

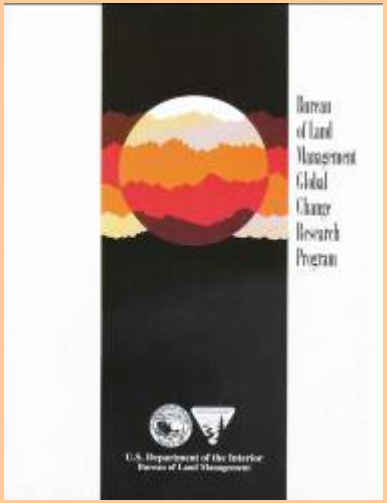
Well designed, quantitative, integrative, instrumented, long-term monitoring studies, scientifically based on hypotheses relative to environmental change.

For example:

1. Bureau of Land Management Global Climate Change Research Program (1990-1996).
2. National Science Foundation Long-Term Ecological Research Program (1980 - ongoing).
3. National Park Service Natural Resource Biological Inventory and Monitoring Program (mostly since 1995 - variable).
4. United States Geological Survey, Biological Resources Division (mostly since 1995 - variable).

Bureau of Land Management Global Climate Change Research Program

Long-term monitoring of rangeland vegetation and grasshoppers on livestock-grazed, and non-grazed rangeland.



Data graphs removed

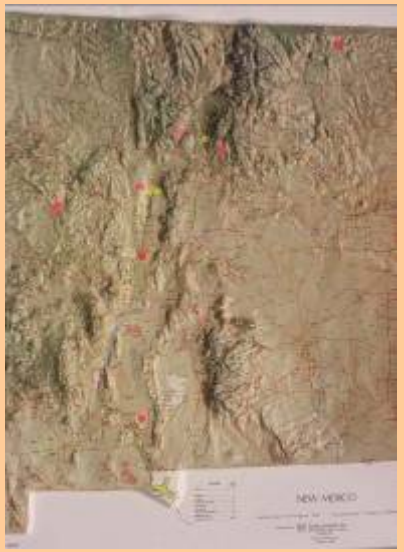
National Science Foundation Long-Term Ecological Research Program

e.g., Jornada and Sevilleta LTER sites, long-term monitoring of rangeland arthropods.

Data graph removed

National Park Service Natural Resource Inventory and Monitoring Program

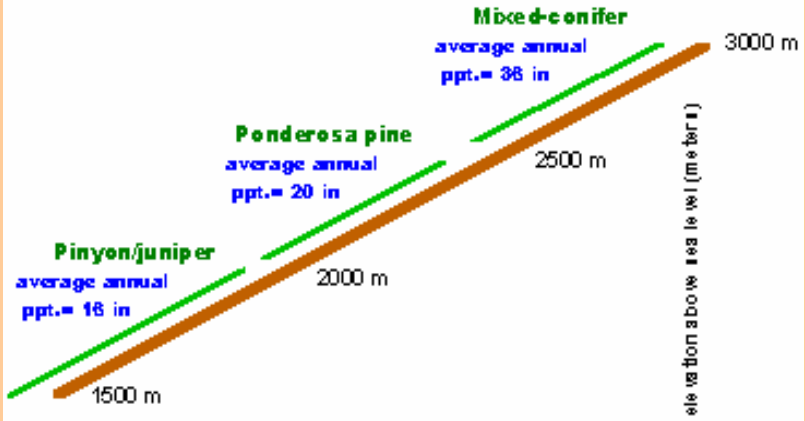
e.g., Inventory and monitoring of ground arthropods across various national monuments in New Mexico



Bandelier National Monument, elevation gradient.

Figure 1. Elevation gradient at the Jemez Mountains study site, New Mexico.

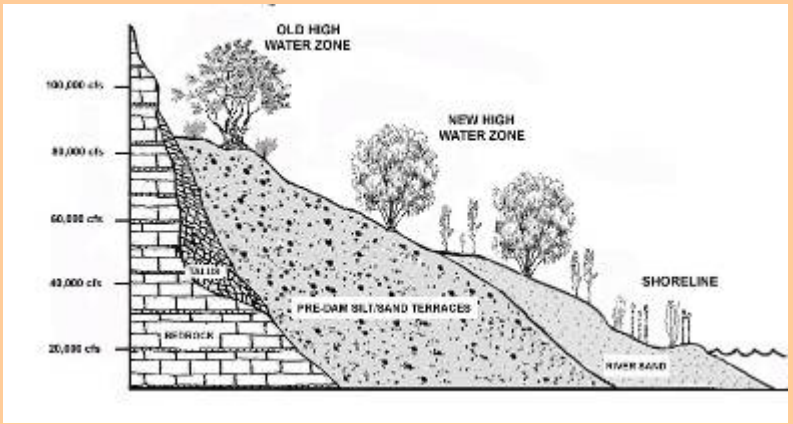
Note long-term annual average precipitation amounts and elevations.



Data graph removed

United State Geological Survey, Biological Resources Division

e.g., Inventory and monitoring of arthropods along the riparian zone of the Colorado River in Grand Canyon (GCMRC)



Data graph removed

Conclusions

Insects (arthropods) represent huge numbers of taxa and individuals, short life cycles, closely linked to temperature, moisture and vegetation. Many ideal indicators for climate change, important components of ecosystems, and potential for economic / health impacts.

Experimental manipulations and predictive models are useful and needed, but results often difficult to interpret and generally lacking entire array of environmental factors and complex interactions resulting from climate change.

Carefully designed, scientific hypothesis testing based, cross-discipline, integrated, long-term, high-frequency **monitoring studies, along with experiments and models, probably the best way to determine the effects of global climate change on rangeland insects**.
e.g., BLM Global Climate Change Research Program, LTER, NPS, USGS.