Climate Change and Rangeland Insects

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Rangeland Insects

High Diversity & Abundance
- Species numbers
- Individual numbers
- Trophic variety
- Habitat use

Relative Number of Species of Organisms on Earth

- Plants
- Protozoa
- Other Invertebrates
- Mollusks
- Crustaceans
- Arachnids
- Myriapods
- Insects
- Vertebrates

One million insect species

Figure 3.5e: Butterfly richness of ecoregions in the United States and Canada.
Hebivores: chewing insects

- grasshoppers
- caterpillars
- blister beetles
- mesquite girdling beetle
Herbivores: sap-feeding insects

- leafhoppers
- stink bugs
- aphids
- scale insects
Detritivores

- darkling beetles
- crickets
- termites
- dung beetles
Pollinators

- photo
- digger bees
- photo
- moths
- photo
- butterflies
- 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

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 <)

Grasshopper population model from Begon 1996
What do we know about insects and climate change?

Casual observations provide evidence for changes...
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.
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:

3. National Park Service Natural Resource Biological Inventory and Monitoring Program (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.
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)
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.