Great Basin Insect Outbreaks

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Outbreaks of native and exotic insects are important drivers of ecosystem dynamics in the Great Basin. The following provides an overview of range, forest, ornamental, and agricultural insect outbreaks occurring in the Great Basin and the associated management issues and research needs. For more detailed information, please see the list of references and recommended links.

The mosaic of mountains, plateaus, river drainages, and high-elevation meadows that comprise the semi-arid Great Basin support a wide diversity of native and exotic insect species. These insects often have very specific relationships with vegetation types. Great Basin vegetation includes conifer and hardwood species in the mountain and plateau regions, vast expanses of rangeland brush species (for example, big sagebrush [*Artemisia tridentata*], blackbrush [*Coleogyne ramosissima*], shadscale [*Atriplex confertifolia*], Mormon-tea [*Ephedra* spp.], greasewood [*Sarcobatus vermiculatus*]), agricultural crops, and ornamental plants. Native and exotic insects associated with these plant communities can be important drivers of ecosystem dynamics, but can also negatively impact local economies and ecological stability.

Key Issues

Range insects—Rangeland ecosystems throughout the world are subject to periodic outbreaks of a variety of plant-feeding insects. The ecological and economic effects of such outbreaks are far-reaching because intense and widespread herbivory can lead to complex changes in plant community structure and dynamics, population levels of other animals (for example, insectivorous predators), and rates of nutrient cycling (Watts and others 1989, Evans and Seastedt 1995). The most prominent insect outbreaks in the Great Basin involve grasshoppers and Mormon crickets (Orthoptera) (Sword 2005, Branson and others 2006). An epidemic of Mormon crickets in the past few years, especially in Nevada and Utah, has attracted widespread notice and concern among the general public, with federal and state agencies devoting much effort and expense for control. Periodic outbreaks of beetles (for example, white grubs [Scarabaeida] and leaf beetles [Chyromelidae]), bugs (for example, black grass bugs [Miridae] and false chinch bugs (Lygaeidae)], and moths (for example, cutworms [Noctuidae], and a sagebrush defoliator, the Aroga moth [*Aroga websteri* Clark, Gelechiidae]) also occur on Great Basin rangelands (Watts and others 1989, Evans and Seastedt 1995). The Aroga Moth infested thousands of hectares of sagebrush stands in the Great Basin in the 1960s and early 1970s. It is again threatening extensive stands of sagebrush in Utah and Nevada. An outbreak of Aroga moth began in the summer of 2004 in northern Nevada (Brussard 2007). In 2005, the infestation had moved to central Nevada. In 2006, areas in both northern and central Nevada experienced outbreaks, including new sites as well as sites that had been impacted in previous years. Climate is generally believed to play a key role in determining the timing of insect outbreaks on Great Basin rangelands, but the exact mechanisms are not well understood. Climate can have both direct effects on the metabolism of ectothermic insects and indirect effects on factors such as food quality and predation.

Forest insects—Several species of bark beetles are currently active in mountainous regions along the eastern and western edges of the Great Basin. The Jeffrey pine beetle (*Dendroctonus jeffreyi* Coleoptera: Curculionidae, Scolytinae), a monophagous herbivore of Jeffrey pine (*Pinus jeffreyi*), is currently at outbreak levels in many areas of western Nevada and eastern California. The mountain pine beetle (*D. ponderosae*) is active in high elevation pine ecosystems (for example, *Pinus albicaulis* and *P. flexilis*) scattered throughout the Great Basin and in sugar pine (*P. lambertiana*) stands in the Sierran foothills. Western pine beetle (*D. brevicomis*) is also found infesting ponderosa pine (*P. ponderosa*). Historical land-use management practices and climate change are influencing recent increases in bark beetle activity. Mountain pine beetle activity in high elevation forests, in particular, is believed to have increased in direct response to warming temperatures (Logan and Powell 2001). Similarly, spruce beetle population outbreaks in Engelmann spruce forests on the Wasatch Plateau in the past 10 years (Dymerski and others 2001) are correlated with periods of warm temperatures and increased insect development time (Hansen and others 2001). Drought, insects, and disease are responsible for vast areas of tree mortality in pinion-juniper woodlands in the Great Basin (Shaw and others 2005). Warming temperatures can positively affect lifecycle timing of herbivores such as the pinyon ips (*Ips confusus*) and pinyon pitch mass borer (*Dioryctria ponderosae* Lepidoptera: Pyrallidae), while moisture stress can increase tree susceptibility to insect colonization. Drought periods also increase the activity of the fir engraver (*Scolytus ventralis*) in white, red, and subalpine fir stands throughout the Great Basin. Several insect species in the Great Basin are associated with aspen die-off, including poplar borer (*Saperda calcarata* Coleoptera: Cerambycidae), bronze poplar borer (*Agrilus liragus* Coleoptera: Buprestidae), and the large aspen tortrix (*Choristoneura conflictana* Lepidoptera:Tortricidae).

Ornamental insects—Ornamental landscapes are characterized by highly diverse non-native plant species grown in the lower elevations of the Great Basin. Herbivorous insect pests are predominantly exotic and new introductions to the region are on-going (Johnson and Lyon 1991). Several important forest insect pests have recently increased their presence in urban ornamental landscapes (Alston 2007, Cranshaw and Leatherman 2007). Several species in the bark beetle genus *Ips* have become severe pests of ornamental conifers (*I. pilifrons, I. pini, I. confusus,* and *I. paraconfusus*) (Keyes 2006). The banded elm bark beetle, *Scotytus schevyrewii*, which was likely imported into the region in wooden packing material, is now infesting both native and introduced elm and other deciduous trees in the region (USDA Forest Service 2006). It is believed that many tree boring insects primarily attack trees that are already under stress from other factors (Furniss and Carolin 1977). It has been observed, however, that once an insect population becomes established in a localized area, a high number of host trees may become infested. It is probable that increasing temperature and drought conditions, especially in the spring and fall when supplemental irrigation is often not available, are affecting the success and dispersal of tree boring insects in urban areas (Alston 2007). In addition, the trend for warmer growing seasons increases the number of insect generations per year, thus contributing to higher insect densities and greater tree injury.

Agricultural insects—Agricultural production areas tend to be dynamic with crop rotations across field sites and changes in cropping systems over time. Insect outbreaks tend to be localized, but can be regional and linked to outbreaks in natural systems. In the early 2000s, the army cutworm (Lepidoptera: Noctuidae) infested rangeland, field, and forage crops in the Intermountain region (Worwood and Winger 2003). It was speculated that mild winters and early spring conditions contributed to the outbreaks. Recent outbreaks of curly top virus in tomato were vectored by the beet leafhopper (*Circulifer tenellus*, Homoptera: Cicadellidae) that uses weed hosts along foothills to move northward each spring. Availability of weed hosts has been implicated as a major factor in predicting the outbreak potential for the virus (Creamer and others 1996). Crop plants are intensely managed by humans, and therefore management practices play a major role in inciting insect outbreaks. Pesticides used by agriculture are known to affect insect populations through mechanisms such as pest resurgence, replacement, and resistance (Pedigo 2002).

Management Challenges

Climate change is likely to pose increasing challenges for understanding, predicting, and managing insect outbreaks within the Great Basin. Because insects are poikiolothermic, temperature shifts can have dramatic direct effects on insect population timing and survival. Shifts in moisture that affect host plant vigor will indirectly influence insect outbreaks. These direct and indirect effects of climate patterns on insect outbreaks are expected in all regions of the Great Basin, including range, forest, and agricultural production areas. Increasing human impacts on Great Basin ecosystems is also complicating the dynamics and management of insect outbreaks. For example, fire suppression and land-use management practices within the last century have altered the natural dynamics of many forested ecosystems and their insect populations. Additional knowledge is needed to identify the susceptibility of landscapes altered by climate change and humans, as well as optimal strategies for management of host plants and insects populations residing in these changed systems.

Tools and information for directly manipulating economically important bark beetle populations and their habitats are available (Fettig and others 2007, Samman and others 2000). However, tools are not well developed for those native insects which infest tree species of little commercial value (for example, juniper, pinyon pine, whitebark, and other high elevation 5-needle pines), although their ecological importance may be significant. Large-scale insecticide applications often have been used to reduce infestations of high-profile range insects such as Mormon crickets and grasshoppers. Key management challenges now include determining if and when such tactics are justified or desirable given long-term outcomes and consequences (for example, Zimmerman and others 2004), and if and when other management tactics such as habitat manipulation may provide a better alternative (for example, Branson and others 2006).

Changes in the distributions of insects is a likely outcome of climate change. Introductions of exotic insects into the Great Basin, including those of regulatory concern, such as the gypsy moth (*Lymantria dispar*, Lepidoptera: Lymantriidae), Japanese beetle (*Popillia japonica*, Coleoptera: Scarabaeidae), and banded elm bark beetle may have all been consequences of human activity, but their establishment and spread in western North America may be linked to warmer summers and milder winters. As new exotic species insert themselves into the local ecology, domino and ripple effects are sure to be observed in the future. Impacts on native insects will include competition for niches and alterations to natural enemy-prey webs.

Research and Management Questions

What are the key factors driving population dynamics of outbreak insect species?

Are the effects of climate change on insect outbreaks predictable?

How do insect outbreaks contribute to ecosystem function of Great Basin forest and rangelands?

What effects do insect outbreaks have on biodiversity?

Where, when, and how should insect outbreaks be muted or prevented through active management?

Can such management include non-chemical alternatives such as habitat manipulation?

Existing Programs and Plans

USDA ARS, Northern Plains Agricultural Research Lab, Pest Management Research Unit, Grasshopper and Mormon Cricket Ecology and Management Project http://www.ars.usda.gov/main/site_main.htm?modecode=54-36-05-10 [2007, July 17]

USDA APHIS, Grasshopper/Mormon Cricket, Emergency and Domestic Programs. http://www.aphis.usda.gov/ppq/ispm/grasshopper/ [2007, July 17]

USDA Forest Service, State and Private Forestry. Forest Health Protection. National Website. Contains links to individual region webpages on Forest Health. http://www.fs.fed.us/foresthealth/regional_offices.html [2007, July 17]

USDA Forest Service, State and Private Forestry, Northern and Intermountain Region – Forest Health Protection. Insect and disease reports, management guides and aerial detection survey information. http://www.fs.fed.us/r1-r4/spf/fhp/index.html [2007, July 17]

USDA Forest Service, Rocky Mountain Research Station, Sustaining Alpine and Forest Ecosystems under Atmospheric and Terrestrial Disturbances Project. http://www.fs.fed.us/rm/landscapes [2007, July 17]

USDA Forest Service, Rocky Mountain Research Station, Biology, Ecology and Management of Western Bark Beetles. http://www.usu.edu/beetle [2007, July 17]

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