VII.11 Implications of Ecosystem Management and Information-Processing Technologies

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Ecosystem Management and Public Lands

A very large portion of the millions of rangeland acres in the 17 Western United States resides within the boundaries of what many refer to as the public land trust, or federally managed lands. Voters have demanded that the public servants who manage these lands employ "ecosystem management" to provide, among other things, a safe food supply while not compromising natural resources like clean air, clean water, productive soils, and biodiversity. Private interests who lease grazing rights from the various public agencies charged with managing our national land treasure must comply with the public's wishes regarding resource management issues or risk losing the opportunity of using those public lands.

At present, agencies involved in managing the natural resources on public lands are struggling to define just what constitutes ecosystem management, how to manage ecosystems whose limits do not agree with political or ownership boundaries, and how to conduct such management with dwindling agency resources. For example, there is general agreement throughout public land-management agencies that an ecosystem focus is desirable in managing the natural resources of public lands. There also is a nagging concern that agencies don't have a very clear vision of just how much information is necessary to meet national objectives. Furthermore, it is obvious that agencies will have to make natural resource management decisions without complete information. Unfortunately, just what constitutes "enough" or "sufficient" ecosystem management will likely emerge only after and as a direct result of a series of court decisions.

Agencies cannot predict with absolute certainty what the result of the ecosystem management consensus-building process will be, nor can they forecast the specific impacts ecosystem management will have on integrated pest management (IPM) of public lands. The executive branch of the Federal Government has provided some expected outcomes, at least in general terms (Gore 1993, National Research Council 1993).

In the case of rangeland grasshopper integrated pest management (IPM), many believe that the amount of information needed to conduct management action (for example, chemical, biological, or cultural control) will be staggering in an effort to satisfy the need of policymakers to feel confident in presenting results for public viewing. Add to this the challenge of a short interval between problem identification and the time when action must be taken if it is to be effective for rangeland grasshopper IPM on public lands. It is clear that scientists and land managers face an information-gathering and -processing crisis. The remainder of this chapter will focus on ways that agencies can address this crisis that is already upon the country.

Present and Future IPM Technologies

In spite of the information crisis faced with IPM on public lands, there are technologies available that agencies managing public lands can use in an attempt to comply with societal mandates. Other chapters in this Handbook discuss global positioning system (GPS) and geographic information systems (GIS) for aircraft guidance (see section II) as well as for IPM in general (see chapter VI.9). The current role of modeling and decision support systems (DSS) also is discussed in the Decision Support Tools section. This chapter will focus on information processing technologies and a new paradigm (example or model) in the context of IPM systems to be developed for rangeland grasshoppers on public lands.

There are at least five areas of information-processing technology that deserve additional attention in the development of IPM systems for rangeland grasshoppers on public lands, under the umbrella of ecosystem management. These are GPS, GIS, remotely sensed information, DSS, and networks. Three of the five areas—GPS, GIS, and remotely sensed information (see details in chapter VI.9) can be classified as technologies that assist land managers in collecting and storing information about the ecosystems that they are responsible for managing. On the other hand, DSS and networks will be central to actually processing the mountains of available information and developing the most appropriate management of a rangeland grasshopper problem on a particular piece of public rangeland.

Fortunately for public land-management agencies, there is a very competitive software and hardware market associated with GPS, GIS, and remote sensing technologies at present. This competition is likely to continue well into

the future. Such competition in the private sector of the U.S. economy will result in a steady and timely stream of products for use in collecting and storing information about the ecosystems that must be managed. Similar statements can also be made for the networking industry as everyone anticipates "information highways" of the future.

Perhaps the most serious challenge that agencies face in attempting to implement ecosystem management in general, and rangeland grasshopper IPM in particular, is the development and maintenance of DSS. DSS such as Hopper, developed from funding provided by the Grasshopper Integrated Pest Management (GHIPM) Project, must continually be updated and expanded to have any hope of processing the ecosystem information that is accumulating. In addition to defining who will be responsible for the continued development of DSS, agencies need coordinated planning to ensure that research emerging from Federal, private, and State laboratories will continue to support DSS improvements.

We must note that, although technologies may be sufficiently well developed for implementation and public land-management agencies may be interested in adopting such technologies, costs will increase. This is true because of the significant increase in the information-processing tasks presented by the implementation of ecosystem management on public lands. The efficiencies of operation with the equipment that is available today exceed even wild dreams of 10 years ago. Public land-management agencies are working feverishly to embrace new technologies. There now is uncertainty whether the resources will be forthcoming to do the job right.

Getting Organized

In this section, we offer some specific suggestions on how to coordinate future rangeland grasshopper IPM with Federal land-management agencies. First, the concept of ecoregion—regional areas (fig. VII.11–1) with similar environmental resources, ecosystems, and sensitivities to human impacts (Bailey 1980, Omernik 1987 and 1995) is useful for organizing information concerning all aspects of grasshopper management. This is a somewhat different use of the concept than was discussed in the environmental impact statement that governed the GHIPM Project (U.S. Department of Agriculture, Animal and Plant Health Inspection Service [APHIS] 1987).

Instead of simply acknowledging that there are broad ecological differences in the Western United States, agencies should use the concept of the ecoregion as a fundamental organizational paradigm. Bailey (1980) suggested that the regionalization (for example, fig. VII.11–1) that results from accepting this paradigm helps "(1) planning at the national level, where it is necessary to study management problems and potential solutions on a regional basis; (2) organization and retrieval of data gathered in a resource inventory; and (3) interpretation of inventory data, including differences in indicator plants and animals among regions." In our opinion, the capabilities that agencies have with GIS presently permit them to apply the ecoregion concept in ways that have until now escaped scientists and land managers.

"Ecoregion" relates to the ability of the land to produce goods and services that humans can use. Furthermore, historically sustainable activities related to grasslands have to a large extent been molded by the prevailing conditions—expressed by ecoregion. For example, the differences in ranching styles and associated economics across the Western United States that economists have been talking about are no doubt related to the fact that ranching has evolved in each region in response to the environmental limitations (again, expressed as ecoregion).

Currently, Hopper (see VI.2) has been developed for only a part of the total area over which there is the opportunity to use it. Furthermore, when land managers look at rangeland grasshopper economic injury levels (EIL) for widely separated areas, such as Wyoming and New Mexico, it is becoming more and more clear how important the regional perspective can be. For example, recent results suggest that it may take three to four times as many grasshoppers in New Mexico versus Wyoming before management treatments would be justified economically. In any case, whether agencies call them ecoregions or rename them as management regions for the needs of APHIS, Plant Protection and Quarantine (PPQ) activities, figure VII.11–1 represents a scale that is a good first attempt to capture the variability across the grasslands of the United States without overburdening people with too much detail.

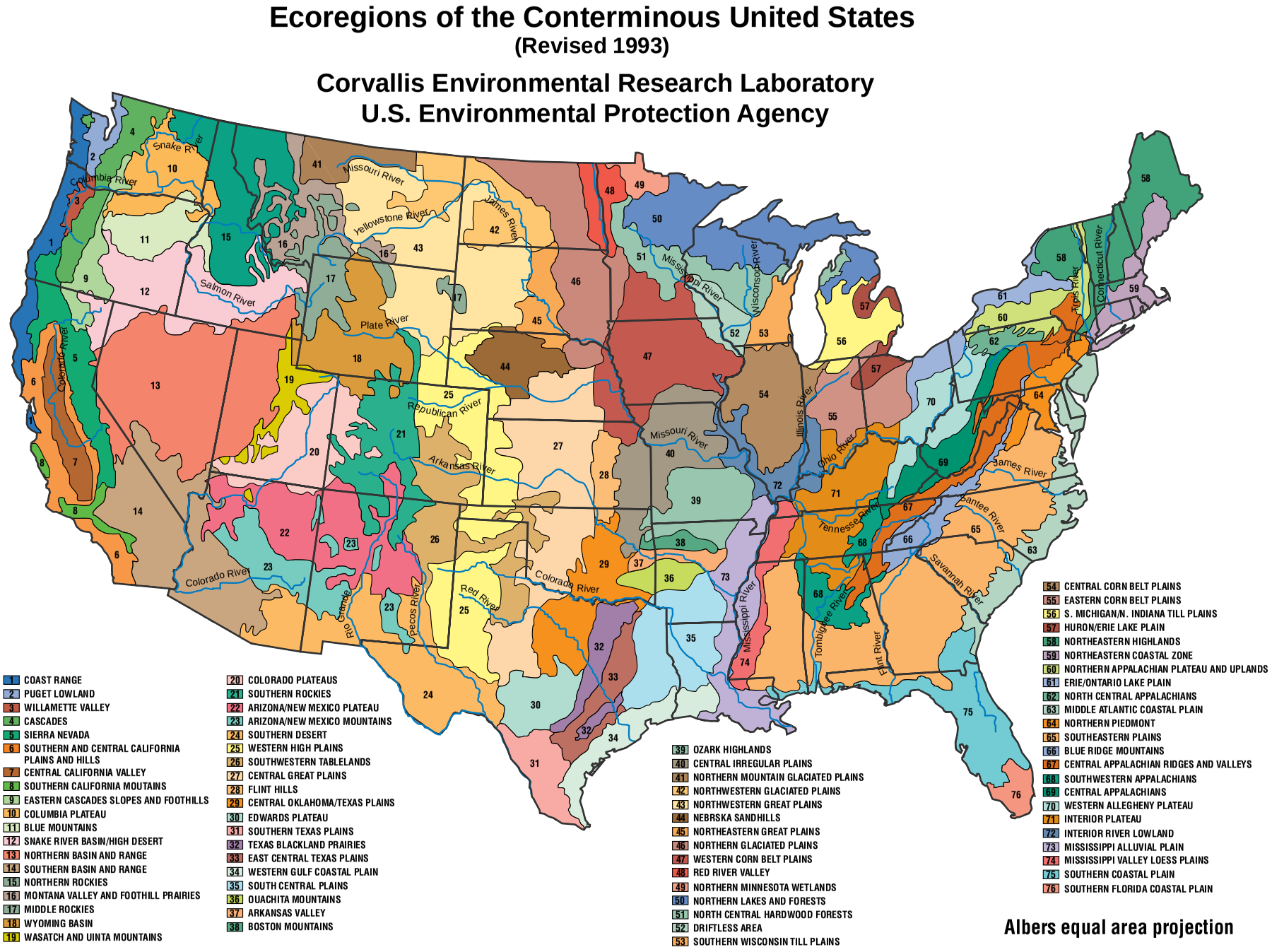

Figure VII.11–1—Ecoregions of the conterminous United States (adapted from a map in Omernik 1987 and 1995.)

The ecoregion concept is useful for exchanging information about environmental conditions, plant production, ranching, and grasshopper ecology and management (from hatching to outbreak frequency and probability and more). There is a credible argument for the use of the concept of ecoregion as a framework for the development of future rangeland grasshopper cooperative management program final environmental impact statements (FEIS's). The ecoregion concept also has potential application for other pest-related issues (for example, noxious weeds) with which APHIS, PPQ and Federal land-management agencies must deal.

In the development of any future FEIS activities, pest managers first should organize rangeland grasshopper IPM activities to be responsive to the situations recognized within each ecoregion. Next, agencies should acknowledge that IPM is the collection of options (including no action) and philosophies most appropriate for addressing grasshopper management. Considering the variation in grassland vegetation and climate depicted in figure VII.11–1 and associated variations in grasshopper populations (for example, Kemp et al. 1990), it is very unlikely that all management options will be equally viable (as viewed by environmentalists, economists, and the public) or of constant efficacy across the rangelands of the 17 Western United States. If this approach to management is acceptable, then there is a logical manner for studying and determining what to emphasize in terms of IPM components at the ecoregion level.

Using this approach as an example, the tabulation in the right column illustrates one way to organize an FEIS.

Organization scheme for a Final Environmental Impact Statement for a Rangeland Grasshopper Cooperative Management Program

Level 1: Ecoregions—regional variations in climate, vegetation, and landform. This is the basis for organizing what agencies know as well as what and how agencies will manage.

Level 2: Things that are likely to be different by ecoregion and that should be considered in any future activities related to the Rangeland Grasshopper Cooperative Management Program FEIS (this list is not meant to be all-inclusive):

- Grasshopper community species composition,
- Likelihood of grasshopper outbreaks,
- Spatial extent of grasshopper outbreaks,
- General insect–animal community composition,
- Grassland plant community composition,
- Forage production on grasslands,
- Economics of ranching and farming (and thus land use and human population density),
- Economics of grasshopper control and EIL,
- Endangered species,
- Soils (and thus water and pesticide movement), and
- Water resources.

1993 Grasshopper Survey

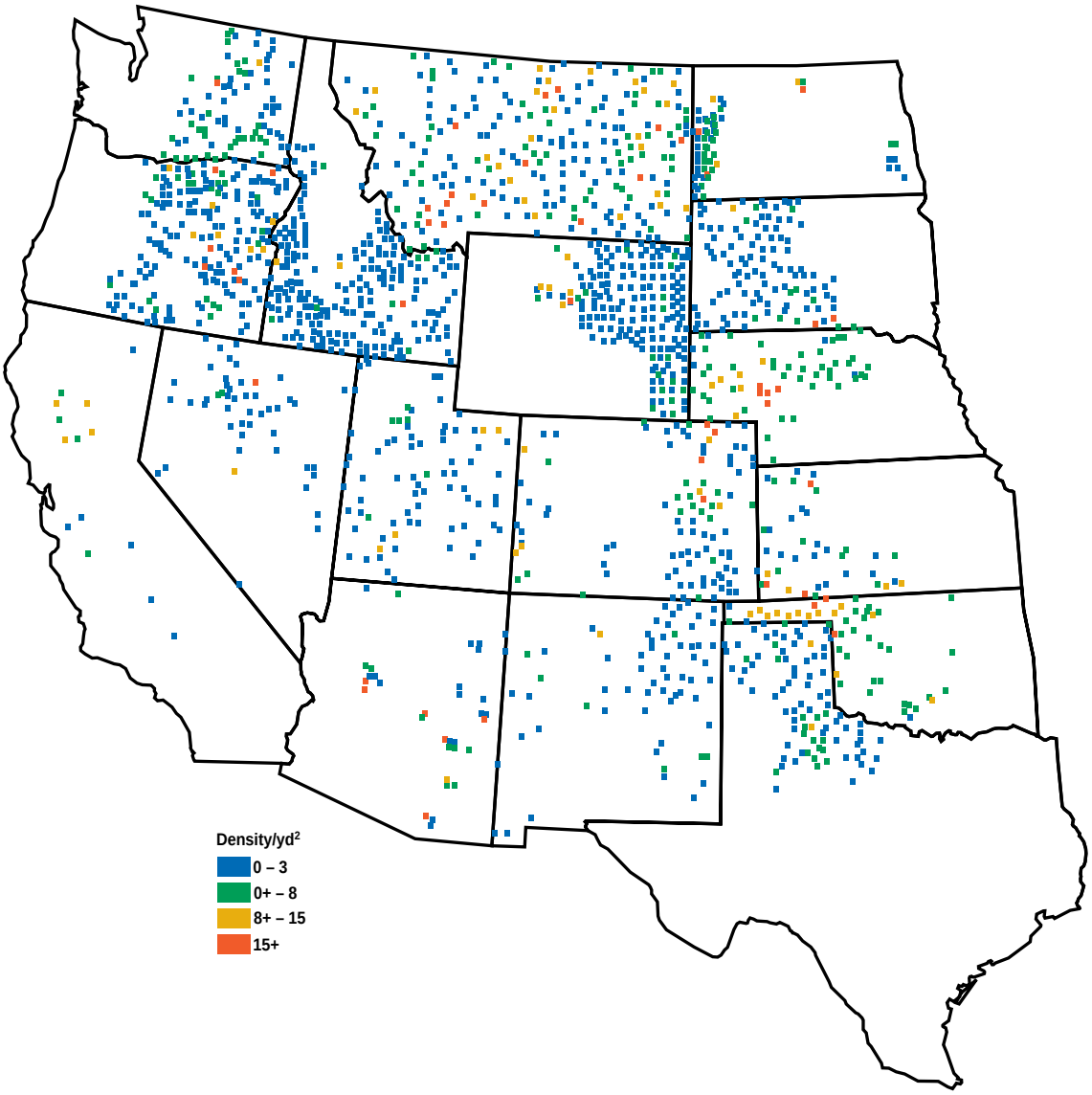

Figure VII.11–2—Locations in the 17 Western United States where (starting in 1993) rangeland grasshoppers were sampled annually for density and species composition by USDA, APHIS, PPQ and cooperators for the Grasshopper Common Dataset Project. Colors indicate grasshopper density at each location in 1993.

The ecoregion paradigm, in addition to being politically and environmentally acceptable (see Gore 1993, National Research Council 1993), can provide Federal land management agencies and APHIS, PPQ with a powerful tool for organizing and interpreting research results relative to rangeland grasshoppers. For example, discussions among a number of GHIPM Project participants and APHIS, PPQ staff eventually resulted in the initiation of the Grasshopper Common Dataset (GCD) during 1993. Scientists now are monitoring rangeland grasshopper communities annually at more than 1,500 locations throughout the 17 Western United States (fig. VII.11–2). Results from ongoing research by GHIPM Project cooperators, with data from the GCD, will tell to what extent grasshopper communities are sensitive to the ecoregion boundaries shown in figure VII.11–1. Given that scientists are able to identify ecological boundaries that are in some way meaningful to the insects, scientists and land managers should apply this concept to assist them in organizing the way that they think about things like rangeland grasshopper management on grasslands west of the 100th meridian of the United States.

In summary, the four main points that we wish to emphasize are

1. GPS, GIS, remote sensing, networking, and DSS will be necessary for ecosystem management of public rangelands.

2. The ecoregion concept is useful, deserves additional consideration by Federal land-management agencies and APHIS, PPQ, and could serve as a useful paradigm for organizing future environmental impact statements related to rangeland grasshoppers (and possibly other insects).

3. By accepting the ecoregion concept, agreeing that IPM is the basis for all grasshopper management, and accepting that IPM consists of all possible alternatives and philosophies as above, agencies eventually could develop ecoregion-specific IPM prescriptions for rangeland grasshopper management.

4. Given 1–3, the regionality provided by the ecoregion concept has great potential for clarifying the goals and objectives of research that Federal land-management agencies and APHIS, PPQ should obtain through contracts and cooperative ventures.

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