

Research and Management of Animals in Mediterranean-Type Ecosystems: A Summary and Synthesis¹

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Summarizing a session as diverse as this one has been challenging. The papers deal with animals as different as insects and Mountain Sheep, from five different parts of the world, both domestic and feral, and from the perspective of both research scientists and land managers. The only thing these papers have in common is that they all deal with animals in Mediterranean-type ecosystems. In the summary that follows I have drawn inferences which may not be in accordance with the professional opinions of all session participants. It is my intention to stimulate further thought on the subject at hand, not to have the last word, and I am solely responsible for what follows.

This session has accomplished its two major goals: 1) it has been a truly international exchange of ideas bringing together researchers from all five parts of the world having Mediterranean-type ecosystems and 2) in the presentations there has been a productive balance between research and the application of that research to management situations.

The summary and discussion below treat topics in approximately the order they were presented, with small mammals first, followed by insects, deer and Mountain Sheep, and finally domestic goats. I conclude with a few remarks about future research on the animals of Mediterranean-type ecosystems.

SMALL MAMMALS

The influence of fire on small mammal communities was analyzed for Australia (Fox; Catling, Newsome and Dudzinski), and South Africa (Willan and Bigalke). Using a most innovative approach, Fox showed that despite being members of distant phyla both small mammals and ants can be used as indices of disturbance in Australian heathlands. In both cases the patterns of replacement of one

species by another showed the importance of the changing structure of the plant community in ordering corresponding changes in the structure of the animal community. This relationship between the habitat structure and the community structure of small mammals was stressed by Catling, Newsome and Dudzinski for the dry sclerophyll forests of southeastern Australia, by Willan and Bigalke for the montane fynbos of South Africa, and by Glanz and Meserve for the sclerophyll shrublands of both southern California and central Chile. In the case of Catling and coworkers, fire intensity was also found to be important to the structure of the small mammal community, but this too was interpreted in terms of the resulting structure of the plant community rather than the direct effects of the heat of a fire on the animals.

This consistent connection between the structure of the habitat and the structure of the small mammal community is interesting in two respects. First, to the researcher it suggests that in Mediterranean-type ecosystems it is the physical structure of the habitat, not the presence of particular species of plants, that causes the presence or absence of particular species of animals. Secondly, to the manager it suggests that when the successional changes in the community of small mammals are well understood, as they are in California chaparral and southeastern Australian heath, diversity and abundance of the small mammal community can be predicted from measurement of readily determined parameters of the habitat, such as the size of the plants, age of the plant community, or the presence of rock outcrops. Conversely, the condition of the habitat can be assessed by sampling the community of small mammals, which in some cases may be more easily accomplished than more direct measurements of the environment.

In montane fynbos Willan and Bigalke found that diversity, abundance, and biomass for the community of small mammals peaked within the first several years after fire. This finding is typical for fire-prone, Mediterranean-type ecosystems. Similar post-fire population peaks are reported in this session for southeastern Australia by both Fox and Catling and coworkers, and for southern California by Wirtz. The remarkable thing about the South African pattern, however, was a second peak in these community characteristics in very old (38 years) fynbos. This increase seemed to be related to a secondary recovery of the plant community after earlier senescence, which in turn caused it to once again develop those attributes which supported the first peak.

Bigalke and Willan emphasized the importance of nearby refugia as centers of dispersal for small mammals back into recently burned areas. Dispersal between patches of vegetation of different ages was also discussed by Catling, Newsome and Dudzinski. This dispersal phenomenon has management implications, suggesting that not only the time interval between fires but also the size and pattern of patches burned (or unburned) are important in the community dynamics of small mammals. Catling and

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coworkers also arrived at the rather surprising conclusion that intense fires in the sclerophyll forests of southeastern Australia, rather than the cooler fires favored by managers, are the best way to maximize the abundance and diversity of the small mammal community!

Glanz and Meserve made comparisons between the structure of small mammal communities in the sclerophyll shrublands of central Chile and southern California. They found that convergence of community structure between paired communities of the two continents was rather weak, with differences being more notable and intriguing than similarities. This lack of close convergence amongst the small mammals is consistent with the general conclusions of comparisons of many other taxa between these two ecosystems. There were differences in trophic organization and the range of habitat preferences between the two faunas. They also reported low and highly variable population densities in Chile when compared to California, and lesser community diversity as well. It is interesting that Catling and coworkers also found low densities and diversity in the sclerophyll forests of southeastern Australia, as did Bigalke in some circumstances in montane fynbos. The relatively high diversity and abundances found by Wirtz in California chaparral were comparable to the findings of Glanz and Meserve for the same region. It may be that for small mammal communities in Mediterranean-type ecosystems, low abundance and diversity are the rule with California as an exception.

Wirtz observed a pattern of resilience and stability in a community of birds and small mammals following a chaparral wildfire. Although some species appeared and others disappeared, and the relative abundances between species changed rapidly, there was a steady increase in biomass to 2-3 kg/ha after three-and-one-half years. By contrast Catling and coworkers reported a small mammal biomass of 1.5-2.5 kg/ha, which was reached 5 years after fire. In Wirtz' study if either rodent (or bird) diversity or biomass is used as an index of community recovery, the burned plots exceeded the controls in less than 2 years. The changes that Wirtz found are consistent with the structural habitat preferences of the individual species of small mammals.

Fuentes and Simonetti found that mammals in the Chilean matorral not only responded to the structure of the plant community, but also played a rather important role shaping that structure. Furthermore, the impact of exotic herbivores was quite different than that of native species. These phenomena, although not surprising, have not received sufficient attention by researchers. It is important for both pure and applied ecologists working in Mediterranean areas to remember that herbivores, including small mammals, can act as agents of change within an ecosystem. Fuentes and Simonetti presented evidence that herbivores, especially goats, exert pressures upon the plant community which are potentially drastic and undesirable.

INSECTS

The opening statement of Force's paper is the most important--the study of insects in chaparral (and other Mediterranean-type ecosystems) has been largely neglected. In view of the strong influences insects have over the plant community (especially reproduction), and their importance as a food resource, this oversight is unfortunate. Force clearly showed that some groups of insects responded with remarkable rapidity to the equally rapid changes in the plant community after chaparral fire. In the early years after fire these insects were sufficiently abundant to constitute an important food resource for birds, as was shown by Wirtz, and for phytophagous insects to damage plants as was found by Force for aphids on lupines. Wirtz reported that of 55 species of chaparral birds, 35 belonged to guilds that feed largely or exclusively upon insects. Fuentes and Simonetti mentioned that insects, not vertebrates, are the most important defoliators of matorral shrubs to the extent that they change shrub densities by altering the competitive equilibrium between populations of shrubs.

In Australian heath slowly recovering from mining disturbance, Fox found that groups of ant species replace one another in response to changes in the plant community, and that this replacement process is influenced by competition between the dominant species of ants.

CHAPARRAL DEER AND MOUNTAIN SHEEP

Thornton described a herd of black-tailed deer (*Cervus hemionus columbiana*) living in chaparral that, after a long period of decline, experienced a 300-percent increase in numbers over a period of 7 years. This increase was the result of a fuel management program which, among other things, greatly improved the extent and quality of deer habitat. This highly successful management program has produced numerous benefits at a relatively low cost.

Bleich and Holl emphasized the importance of the physical environment, rather than vegetation type in defining desirable habitat for the Mule Deer (*Cervus hemionus*) and the Mountain Sheep (*Ovis canadensis*). They presented models which predict the potential of habitats to support populations of these two species, and provide guidelines for the systematic improvement of habitat for either species through manipulation of the vegetation.

DOMESTIC GOATS

Recently goats have been used experimentally to manage vegetation in the chaparral of California and Arizona. The interactions between the goat herds and the vegetation were reported by Knipe, and Sidahmed and coworkers. The emphasis in both studies was to use goats as a tool for reducing fuels and for type conversion of the vegetation

on public lands. Knipe has found that under careful management, herds of goats can assist in fuel reduction, type conversion from shrubs to grasses, improvement of water output, and even in the planting of grass seeds by trampling: Although goat herders may profit from such a project by selling goat products, these economic benefits were secondary to the study.

Sidahmed and coworkers clearly showed that goats are selective herbivores that both browse and graze. These feeding habits were also shown by Knipe's data, and both studies emphasized that regular goat grazing can be a powerful agent of change in the composition of plant communities. Liacos pointed out that in Greece, where goat grazing practices have been determined by tradition and short-term economic gains, there has been degradation of the forage value of the plant community over the long term. Only recently have scientists like Liacos analyzed the changes in management practices that would be necessary to improve the forage value of the brushlands in which goats graze, so that the scope and magnitude of long-term economic benefits could be increased.

Fuentes and Simonetti described the desertification of the more arid parts of Central Chile from long-term goat grazing. More recently the introduction of large numbers of goats into evergreen matorral has caused shifts in the composition of that plant community due to selective feeding. In more extreme situations, matorral degradation has been accompanied by soil erosion and by a declining economic return from goat products. Fuentes and Simonetti agreed with Liacos; additional research and more careful management practices are needed if goat grazing is to continue indefinitely as a productive economic activity.

THE FUTURE

The Mediterranean climate areas of the world are places that already have relatively high population densities, and these populations are growing rapidly. A pleasant climate, growing urban areas and productive agriculture will continue to attract ever more people to these areas during the foreseeable future. The cultural history of the Mediterranean Basin has shown us repeatedly that neither the pristine nor modified ecosystems of Mediterranean-type areas are especially resilient. The dismal cycle of deforestation, overgrazing, soil and watershed degradation, deterioration of plant communities, and wildlife loss has been seen all too often to be ignored. In regions where the vegetation has been less degraded, there is the problem of destructive and uncontrollable wildfires raging through sclerophytic vegetation in close proximity to densely urbanized areas.

With all of the above in mind, it is altogether proper that the attention of research scientists

and managers should be devoted to the understanding and management of these ecosystems, and that public agencies should sponsor international symposia of this kind. It is appropriate that the greater part of these research and management activities should be focused on the pressing problems of fire management, watersheds, soils, nutrients, and vegetation, so long as this approach does not overlook the effects of management practices upon the fauna.

These communities of animals are an indispensable element of our understanding of Mediterranean-type ecosystems. A few animals are relatively well studied because they are of particular interest to the public, such as the spectacular and endangered California condor (*Gymnogyps californianus*), the hunted Mule Deer (*Cervus hemionus*), and the admired and rare Mountain Sheep (*Ovis canadensis*). These species and a handful of others like them, however, are exceptions. We remain woefully ignorant of the biology of most vertebrates in Mediterranean-type ecosystems and know next to nothing about the invertebrates. Many of these species do not simply respond to the condition of the plant communities in which they live, they also influence both its structure and function. Animals influence plant reproductive patterns as pollinators and by their dispersal and consumption of seeds. Animals can greatly modify the structure of plant communities by selective herbivory, as was shown by several of the papers in this session. Additionally, animals are frequently useful as indices of the condition of the community as a whole.

All management activities are an expression of values. I would like to conclude with a plea for a value that rests in the heart of many of us who call ourselves scientists and managers, but one which is more difficult than the others to reduce to an annual budget item, cost benefit analysis, or research proposal. We must always remember that the presence of native animals in Mediterranean-type ecosystems is an important goal for its own sake. Many people enjoy seeing these animals or even just knowing that they are there, unseen. What importance they might have in maintaining the integrity of the ecosystem is often unknown. That is not the point. Even if they play no known role in the system they are nevertheless important, for their own sake. In the press of what we believe to be more immediate and therefore more important issues, we must not lose sight of the right that other species have to exist. In the grand scheme of things they have lived in these marvelous, small, fragile, Mediterranean-type ecosystems far longer than we--and if we are wise they will be present long after we have departed.

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