17.

ECOSYSTEM MONITORING, RESTORATION, AND MANAGEMENT IN HAWAI'I: A SUMMARY

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The speakers in this session dealt with practical and philosophical approaches to the protection and management of Hawaiian ecosystems. Problems in monitoring and restoring ecosystems were considered; allowances for fundamental natural processes such as succession, cohort senescence, gene transfer and bottlenecks, and natural selection were discussed; and the immense problem of preserve design in the light of minimum population size, genetics, and other biological, sociological and economic constraints was considered. The need for more knowledge is apparent in all of these areas, but the demand for directed action to preserve what remains is immediate.

MONITORING WITH EXCLOSURES

Exclosure studies have been and will continue to be a very important method of monitoring ecosystem restoration and management. Such studies have helped in determining and demonstrating impacts of feral ungulates and, in some cases, non-native plants. Loope and Scowcroft encouraged continuation of exclosure research and pointed out the importance of timely publication of results.

The recovery potential of a number of native ecosystems has been clearly demonstrated by the results of exclosure studies. In other cases the existence of such potential is unclear, due either to a lack of data or to the fact that available data do not clearly show that recovery potential exists. For example, ecosystem recovery has been good in some rain forest exclosures, poor in others. It is clear that exclosure studies should continue for 2 reasons. First, some ecosystems have not been studied at all; and, second, more time is needed to monitor ecosystem response in existing exclosures.

In addition to demonstrating potential for ecosystem response, exclosure studies provide ungulate-free areas in which experiments may be conducted. They also provide areas in which non-native plants can be successfully controlled. The success of exclosures for preventing the extinction of species, particularly plants, also has definite possibilities. The authors emphasized the need for careful planning in this regard.

Exclosures can be particularly valuable if constructed before alien plants invade and before feral ungulate damage becomes severe. Management and control of alien plants and animals within exclosures is usually a necessary adjunct to using exclosures to protect ecosystems from disturbance.

'OHI'A DIEBACK

Mueller-Dombois presented a comprehensive summary of the 'ohi'a (Metrosideros polymorpha) dieback phenomenon, including a review of previous research results dealing with types and characteristics of dieback. Potential causes of dieback currently under investigation were identified and included climatic instability, soil and stand factors.

The results of 'ohi'a dieback research have some important and interesting implications for preserve design, management and our understanding of 'ohi'a forest ecology. Because dieback occurs in mosaics, 'ohi'a forest preserves must encompass stands made up of a spectrum of different life stages of 'ohi'a. Such preserves, which would have to be large, would accommodate the dieback process itself. Results of dieback research clearly show that there is no need to replace dying trees because they are actually in the process of replacing themselves. Dieback appears to be a natural successional process rather than a symptom of disturbance or poor health. Different forms of 'ohi'a are adapted to different conditions and naturally replace forests in different stages or areas. 'Ohi'a dieback cannot be successfully stopped by soil fertilization, and attempts to do so are likely to encourage the abundant growth of alien plants otherwise ill-adapted to dieback soil conditions.

Mueller-Dombois mentioned 3 areas where further research could contribute to the understanding of dieback in relation to preserve design and management. First, there is a need for complete mapping of physical habitat types. Second, studies are needed to elucidate the effects of dieback on rare plants. Finally, scientists need to have a better understanding of the effect of dieback on alien plants.

In conclusion the author stressed that effective preserve design aimed at the conservation of 'ohi'a forests must recognize that 'ohi'a dieback is a dynamic geographic process and, consequently, adequate size and strategic distribution are very important considerations in the design of rain forest preserves.

ECOSYSTEM RESTORATION

One of the most difficult aspects of ecosystem restoration in Hawai'i is the definition of goals, that is, establishing a clear description of what constitutes a restored ecosystem. The principal reason for this difficulty is that scientists and managers lack information about what ecosystems were actually like in their natural or near-natural state. Another major problem is posed by the ecosystems themselves, inasmuch as they are constantly changing: individual species are evolving, natural and artifactual loss and recruitment of species are ongoing, succession is continuing, and long-term ecological changes are inevitable.

In spite of these difficulties most scientists, managers, and others agree that ecosystem restoration is desirable. Perhaps the most appropriate goals of this process are the retention and restoration of genetically and ecologically diverse entities. Results of ecosystem restoration have been varied. For example, human attempts at the restoration of habitat on Laysan Island seem to have had little effect: the ecosystems largely recovered from disturbance on their own. On the other hand, exclosure studies show that fencing to exclude feral ungulates may have a significant positive effect on the restoration process in some ecosystems. In other cases, it is too soon to tell whether or not human intervention has aided in the restoration process, and in a few cases, for example, that of the nene (Nesochen sandvicensis), human efforts to date have not been entirely successful.

There have been almost no cost-benefit analyses of ecosystem restoration in Hawai'i. While some may consider this a disadvantage, unique ecosystems and their component elements have intrinsic values that are difficult to quantify. Placing dollar values on the benefits of restoration encourages the thought that some alternative use of the ecosystems may provide more financial gain and is therefore better. Such reasoning, if applied to watersheds for example, could be ecologically disastrous.

Lamoureux's recommendations reinforce those of previous speakers in the Symposium as well as years of research on the topic. Alien herbivores and aggressive plants should be removed and kept out of ecosystems we

are attempting to restore. Replanting and restocking should be carried out with genetically similar forms or species. Finally, to the extent possible, detrimental changes should be anticipated and stopped or arrested before, during, and after programs for ecosystem restoration are conducted.

PRESERVE DESIGN: GENETICS AND POPULATION SIZE

Schonewald-Cox indicated that conservation may have several different objectives, for example, the conservation of species, the conservation of genetic variability, or the conservation of ecosystems and their life processes. Conservation of ecosystem processes is the objective of many, though not all, natural preserves being designed today.

A number of limitations should be acknowledged regarding the preservation of genetic and ecological diversity:

1. For the most part, sizes of protected habitats will not increase significantly in the world, although the effectiveness with which they are protected may increase.
2. There will continue to be increased pressure from the human population for resource use, space, etc.
3. The contrasts that exist or seem bound to occur between natural preserves and land uses outside of them are likely to evoke boundary and land use disputes.
4. Most rare species will never exceed their minimum effective population size (i.e., self-sustaining population size) in our lifetimes. Therefore it is worthwhile to attempt to establish self-sustaining ecosystems.

In choosing species for consideration for artificial propagation, one must ask the question, what is a small population? The answer cannot be described solely in terms of numbers but must be based on how genetic diversity is manifested and maintained. If there is too little natural genetic variability present to allow the population (regardless of its size) to adapt to changes, then the population is too small. Such populations are highly vulnerable to extinction.

In Hawai'i, many species populations are naturally small, having evolved from small founder populations, so that small population size is not necessarily a disadvantage. Such species may already be adapted to inbreeding, that condition regarded until recently as one of the most severe roadblocks to successful artificial propagation programs. Recent research, for example that accomplished by Templeton on the Speke's gazelle

(Gazella spekei), has shown that even in species where inbreeding depression can be a problem, it can be solved by a breeding program aimed at adapting the captive population to inbreeding itself.

The author made several recommendations regarding the management of species close to extinction but which still have some chance of recovery:

1. Determine whether the population is adapted to inbreeding.
2. If the population is adapted to inbreeding, separate and isolate several small founder populations in available habitat and allow them (with appropriate management, if necessary) to increase.
3. If the population is not adapted to inbreeding, establish a captive propagation program using several different populations. When enough plants or animals have been produced, release the inbred lines into suitable habitats.

These recommendations are aimed at establishing or allowing to exist, populations that are adapted to being small in size, even if they were not naturally so to begin with. Such adaptation should increase the chances of survival.

PRESERVE DESIGN: SIZE, SHAPE, AND DISTRIBUTION

There are some very special problems of preserve design in Hawai'i. For example, many Hawaiian ecosystems are very limited in size, especially at low elevations. The problem of alien organisms is tremendous and pervasive. Unfortunately, the fact that irreversible changes have occurred in some ecosystems renders it impossible to restore some and difficult at best to protect others.

Franklin suggested that although ecological theories and models may provide guidelines for preserve design, they have their limits. In many cases good ecological studies and basic natural history are equally, if not more, important in preserve design and management. Common sense and intuition are usually of great importance also. In this regard scientists and managers must acknowledge economic and social considerations to be successful conservationists.

Although conservation problems in Hawai'i are considerable, a number of positive factors exist. There are many individuals and institutions sincerely committed to conservation. Hawai'i already has an initial set of preserves in the form of natural areas, national parks, wilderness areas, etc. Our scientific data

base, though not complete, is of high quality, in some respects.

Specific recommendations regarding preserve design and management seem clear. It will be necessary to apply triage strategy to preserve design. It is simply not possible to attempt to conserve all remaining ecosystem types, and a system of priorities should be developed without delay. Establishment of regional programs for preserves should help in the overall planning process. Although the preservation of ecosystems is an excellent goal, management aimed at the preservation of individual species should not be neglected. Species, especially those of a charismatic nature, may serve as rallying points for the public, may be prized for their intrinsic value, or may be important ecological indicators.

Intensive management efforts are extremely critical. The control of alien plants and animals must be a part of any successful preserve program. In this regard Hawai'i should be a leader in the area of ecosystem restoration because we do not have the choice of simply leaving things alone and hoping they will recover without any efforts to remove the initial cause of disturbance. The inclusion of extensive buffer areas at the perimeters of some preserves is an effective management tool.

To effectively conserve ecosystems, scientists and managers must deal with realities in the socioeconomic realm. Public opinion, political aspects of conservation issues, efforts at compromise and the like, all play an important role in successful implementation of ecosystem preservation and management programs. In this regard, large private land owners may be much more willing to commit themselves to conserving native ecosystems or species if they are compensated with rights to use of public lands or other suitable trade-offs.