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LANDSCAPE MANAGEMENT CHALLENGES ON THE CALIFORNIA CHANNEL ISLANDS

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ABSTRACT

Managing for sustained biodiversity and restoration of natural habitat has become increasingly important over the last two decades, first as mitigation for development (especially in wetlands), and more recently in natural areas. The latter has come about as land managing agencies like the Department of Defense and Bureau of Land Management have seen the need to reverse the impact of past land uses and agencies like the National Park Service and The Nature Conservancy have taken on the responsibility for less-than-pristine lands.

On the California Channel Islands, the need for restoring and managing biodiversity is great, but this restoration and management needs to be based on a sound ecological understanding. By conducting surveys, implementing long-term research and monitoring, and by conducting population and community dynamics research, the necessary data to arrive at such an understanding can be obtained. Once management actions have been taken to effect restoration, monitoring needs to be conducted to determine the success of those actions. The need is to gain enough of an understanding of the islands' ecosystems that we can manage to restore, not just populations of native plants and animals, but also the processes of a naturally functioning ecosystem. The challenges that confront this goal are many and include ecology and population biology, conservation ecology, information management, agency mandates and regulations, the need to build constituencies and consensus among disparate groups, financing, and political pressures.

Keywords: biodiversity, California Channel Islands, ecosystem management, landscape management, population dynamics, restoration, vegetation.

CHANGING RESOURCE MANAGEMENT PARADIGMS

We are privileged to live in a time of a major shift in landscape management policies and procedures, and I believe that we will still see more shifts in the years to come. I have seen resources management move from simple protection ("put a fence around it and it will be okay") or just paying attention to the one item in the system that is being managed (such as ducks, deer, trees, or grass), through a realization that ecosystems are very complex and management needs to be accomplished from an ecosystem perspective. Today managers seem to be heading to where they need to be attempting management of people, places, and resources, all at the same time. As if that weren't enough, we are now wondering if there is going to be any federal research and resource management left after we have reinvented government and Congress has cut the budget and given as many responsibilities to the states as possible.

Agencies were just getting to the point that managers were understanding that long-term research and monitoring were required to understand the dynamics of ecosystems, and now we are off on a track to include as many people as possible in every decision. There also is concern that we not manage resources

strictly for the sake of the natural environment, but that we manage resources from the perspective that humans need a living space and sustenance from the landscape. Some of the specific challenges that we must overcome to manage resources are discussed in the following section.

The California islands present a microcosm of what has been happening on a larger scale in our part of the world: The 1700s and early 1800s: a time of European exploration; the late 1800s and early 1900s: a time of taming and exploitation; and the late 1900s: development of ecological understanding, and ecological management.

CHALLENGES TO LANDSCAPE MANAGEMENT

Current Conditions

On the Channel Islands, a number of management agencies are dealing with the issue of reversing the trend of over 150 yr of grazing and overutilization of the islands' natural resources. Historical accounts of past land uses have been documented in a number of publications (Philbrick 1972; Clark and Halvorson 1987; Halvorson et al. 1988; Clark et al. 1990; O'Malley 1991). The situation is that the islands were used for

sheep grazing from the 1840s to approximately the turn of the century (depending on the island) when, for the most part, a period of more active farming or ranching occurred, including the change on some of the larger islands to cattle grazing. On many of the islands, nineteenth- and early twentieth-century sheep grazing left the land scarred, eroded, and devoid of much of its vegetation.

While the twentieth century has seen some recovery, many of the regressive trends started by sheep grazing are still in evidence today. In addition, military activities and large-scale fires on some islands have also taken their toll, exacting new impacts to recovering natural systems. One of the military impacts was the introduction of European rabbits onto Santa Barbara Island and the subsequent devastation of native shrubs and succulents, and, in some areas, removal of all plant cover (Sumner 1959, Halvorson et al. 1988). Besides sheep, cattle, and goats, other large herbivores that have been introduced to the islands include bison (Santa Catalina), deer (Santa Catalina, Santa Rosa), elk (Santa Rosa), donkeys (San Miguel), and pigs (Santa Catalina, San Clemente, Santa Cruz, Santa Rosa).

Along with introductions of animals came the introduction of many plants. On average, the island flora is composed of about 25% alien species today. The most seriously impacted of the islands are Santa Barbara and San Nicolas with 33 and 48 percent alien species, respectively (Junak et al. 1995). Even these numbers do not really tell the whole story, however. The plant community cover of the islands is even more dominated by alien plant species. If eroded areas are added to the land cover that has something other than a community dominated by native species, the impact on some islands is over 75%.

Added to the knowledge of historical perspectives of what has happened, it is necessary to overcome the remainder of what information we still do not have. The information on what remains is coming through inventory activities that are ongoing on all the islands. In addition, many monitoring programs are in place which are providing information on the status of populations and giving us a sense of the dynamics of island resources (Halvorson and Maender 1994).

Developing a Model of What We Want the Islands To Be

Developing such a model is difficult because we do not have data from before the time of human use of the islands. Since we can not go back in time to develop such a model, we must rely on the historical, inventory, and monitoring data that are being accumulated. With these data sets, a conceptual model can be developed, one which reflects both what we think things must have been like on the islands and what

constraints we must consider in terms of human uses of the islands, today and proposed into the future. The lack of information has meant that we have been using vague, usually undocumented conceptual models in the past. With increasing amounts of information, managers of the future will be able to create ever more accurate and elaborate models. These models should always be viewed as dynamic, and change when additional information becomes available.

One aspect of what we want the islands to be has to do with conservation biology and the protection of natural biodiversity. Biodiversity needs to be considered at a number of scales (Halvorson 1996), all of which are important to the conceptual model development.

Genetic diversity.—Genetic diversity usually refers to the genetic variability within a taxon. Species with little genetic diversity are at greater risk to extirpation because they may have less ability to respond to changing conditions. More widespread species usually have greater genetic diversity.

Species diversity.—Species diversity is usually estimated as the numbers of species per unit area. Species diversity is often described in terms of communities or ecosystems. In general, areas with less stressful environments have greater species diversity; that is, there is a reduction in species diversity from tropical environments to polar or arid environments.

Community diversity.—Usually estimated as the number of ecological communities within a given geographic area, community diversity generally responds to topographic variability; regions that have high topographic variation (e.g., Arizona and California) have higher community diversity than areas with little topographic variation (e.g., Kansas). This also holds true for smaller geographic areas like the Channel Islands.

Trophic diversity.—The complexity of system organization may be relevant to monitoring and managing ecosystems (Primack 1993). It is important to know how many producers, primary consumers and secondary consumers the system has when trying to understand system function.

Keystone or system-directing species.—Such kinds of species have disproportionately large effects on overall system diversity. If removed, these species would have dramatic effects on the system because a number of other species are substantially affected by their presence or absence (Orians and Kunin 1990). Therefore, from an ecological perspective, it is more important to protect these species than those that do not fill such an important role.

Restoration

Restoration initiation.—The work that has been done on the development of a conceptual model of what the islands should be has already lead to the development of restoration programs. The initiation of restoration on each island was the control and eradication of non-native species, both plants and animals, and the physical protection of the more seriously impacted native species (Halvorson 1984).

Restoration research.—Much of the restoration research has been carried out on the northern Channel Islands, but the findings are applicable to and coordinated with information obtained in programs on the southern islands. Surveys conducted during inventories located alien species (human-caused introductions) destructive to native species and communities (Erickson and Halvorson 1990, Halvorson 1992). In some cases, these could be eradicated without extensive planning and research (Erickson et al. 1990; Halvorson and Koske 1987). In other situations, it was necessary to develop native species-management techniques in order to protect and enhance these natives in a milieu of grazing destruction (Clark and Halvorson 1987; Halvorson 1990; O'Malley 1991). It was also necessary to gain an understanding of soil characteristics and of plant/soil relationships (Halvorson et al. 1988; D'Antonio et al. 1992; Belnap 1994). The initiation of restoration, therefore, was the control and eradication of alien species, both plants and animals, and the protection of the more seriously impacted native species.

Examples of programs already accomplished or underway include the eradication of feral pigs on Santa Rosa Island (complete) and their control on Santa Cruz Island (underway), the eradication of sheep from Santa Cruz Island (underway) and San Miguel Island (complete), rabbits from Santa Barbara Island (complete), and donkeys from San Miguel (complete). Programs dealing with alien plant species (weeds) tend to be longer-term than those dealing with animal species because of the tendency of plants to hide out as seeds for long periods. Some of these, like thistles [e.g., *Cirsium vulgare* (Savi) Ten.], Australasian fireweed [*Erechtites glomerata* (Poir) DC.], and fennel (*Foeniculum vulgare* Mill.) can be very invasive and disruptive to native communities. Natural resource managers have tended to wait until the animal problems that they could deal with were solved before starting on the plant problems. Currently, most of the islands have some alien plant-species removal underway. Fortunately, the California Channel Islands do not have many invasive woody species to contend with like some regions of the world, such as south Florida and Hawaii, where alien woody species are an extremely serious problem.

After the initiation of field surveys, natural resource

inventories, and implementation of long-term monitoring, it became evident that full ecosystem restoration, including both the pieces of the ecosystems and their interactions (processes and function), would require an exhaustive research program. Research programs are now being developed on most of the islands.

At Channel Islands National Park, this program has developed along a number of lines of investigation: 1) general community structure and distribution (Clark and Halvorson 1990); 2) population biology of, and management techniques for, native species which need recovery (Clark and Halvorson 1987; Danielsen and Halvorson 1990, 1991; Fellers and Drost 1991); 3) population biology of, and eradication techniques for, aliens for which better information is needed on their impacts and on methods for removal (Erickson and Halvorson 1990; Erickson et al. 1990); and 4) rehabilitation of completely denuded or alien species-dominated areas (Halvorson 1984; Halvorson 1988; D'Antonio et al. 1992). Many of these same sorts of studies are now being conducted by The Nature Conservancy on Santa Cruz Island, by the U.S. Navy on San Nicolas and San Clemente Islands, and by the Catalina Conservancy on Santa Catalina Island.

Community structure.—Our work on general community structure and distribution has included work on lists of flora and fauna. The flora of the islands is highly impacted with introduced species. In Channel Islands National Park, approximately 25% of the plants are alien species (Halvorson 1992). Chain-wide, the islands with the highest percentages are Santa Barbara with 33% and San Nicolas with 48%. Exact percentages keep changing because the lists per island are not static—most survey trips result in new species finds. It is bad enough that the list of plants contains such a high percentage of aliens, but the situation worsens when looking at the composition of communities and landscape-level distributions. The importance of alien species to community structure is such that on many islands, alien species dominated communities cover as much as two-thirds of the island surface (Clark et al. 1990). This is a problem whose solution requires an understanding of long-term species and community dynamics in order to effect a shift in species dominance over time. This will require a long-term monitoring program aimed at determining community composition changes over time and their causes. For instance, given protection from disturbance and normal rainfall, shrub species such as coreopsis (*Coreopsis gigantea* Kellogg), buckwheat (*Eriogonum giganteum* S. Wats.), and coastal sage (*Artemisia californica* Less.) increase regularly in the annual grassland. Coreopsis, especially, recovers noticeably under these conditions, and no restoration management actions are needed to accomplish this. When, however, the island experienc-

es a drought sequence such as the one in the late 1980s, the shrub species do not increase in population numbers; in fact, population densities decline.

Understanding these types of population dynamics and ecological relationships is necessary to develop a strategy for long-term restoration of native species-dominated plant communities. An understanding of other ecological relationships is also needed to understand the function and stability of native island ecosystems. Belnap (1994) has shown the importance of cryptobiotic soil crusts to nutrient flow and soil stability. Other studies have investigated the importance of mycorrhizae to island plants (Halvorson and Koske 1987; Koske and Halvorson 1989, 1990). Knowing what is going on at the boundary between the various levels of ecosystem structure is important, but arriving at a fuller understanding of the interrelationships at many levels of island ecosystems (e.g., Drost and Fellers 1991) will allow for better management of the natural resources of the islands and for restoring naturalness.

Native species ecology.—Many of the native species thought to be threatened or endangered on the islands have been found to be so because of past land use or current impacts from introduced grazing animals (Clark and Halvorson 1990; Halvorson 1992). Once these conditions changed, most of the species studied thus far have shown improvement rather quickly; some, however, have not and have been recommended for active management.

Fellers and Drost (1991) concluded from their study on island night lizards on Santa Barbara Island that the lizards were able to survive episodes of goats (last on the island in 1922), sheep (1937), feral cats (1979), and rabbits (1981). They also survived ten years of farming, the establishment of 40 species of exotic plants, five years of annual burning of crop land, and at least one major grass fire. They found that night lizards on Santa Barbara Island maintained a stable population through the 1980s at a density greater than ground-dwelling lizards in any other area for which there are such reports.

Clark and Halvorson (1987) found that the Santa Barbara Island live-forever [*Dudleya traskiae* (Rose) Moran], a federally listed endangered plant species, was recovering, but not yet out of danger. The problem presented to natural resource managers was that successful recruitment of this species depends on a rather narrow range of moisture conditions over 2–3 yr to allow appropriate seed set, germination, and establishment. This live-forever, like many species of the genus, suffered during the drought of 1986–1991 (Clark 1989), increasing both the need for and difficulty of recovery efforts.

Many woody species on the islands have been

shown to need active management in addition to protection and monitoring. The two subspecies of island ironwood [*Lyonothamnus floribundus* A. Gray ssp. *floribundus* and ssp. *aspleniifolius* (E. Greene) Raven] island oak (*Quercus tomentella* Engelm.), and Bishop pine (*Pinus muricata* D. Don) are all examples. O'Malley (1991) reports on efforts to refurbish ironwood groves on Santa Catalina Island. Channel Islands National Park is currently planning projects for restoration work in ironwood, island oak and Bishop pine stands on Santa Rosa Island (Halvorson 1990). These projects to date have been primarily aimed at stopping erosion and restoring cover of native species; no one has yet made a determined effort to restore an ecosystem of these woodland types because we do not yet have enough information to attempt it.

Rehabilitation.—In 1984, we initiated a series of studies aimed at restoring areas on Santa Barbara Island that were either devastation areas (completely denuded of vegetation and highly eroded), or which were dominated by a cover of the alien annual, crystalline ice-plant (*Mesembryanthemum crystallinum* L.). In 1994, San Nicolas Island was added to this research program. These studies are being conducted because it is clear that natural recovery is not occurring and that active management is required to halt erosion, recontour the land, and reestablish a native plant community. The study of the devastation area started with an analysis of the vegetation and soils surrounding the area (Halvorson et al. 1988) and went on to study revegetation techniques (D'Antonio et al. 1992). Future work will be needed to discover all the connections necessary for restoring a functioning ecosystem in the area.

One difficulty faced by ecologists and conservationists is that even with a considerable amount of research into the effects of adding or removing species from an ecosystem, we still have little ability to predict the outcome to the system after such action. We know that the system will change in most instances but we are hard pressed to say what specifically that change will be.

Information management.—There is a serious paradox happening here: At the same time we have too much information, we do not have enough. In order to make knowledge-based decisions, managers need information. While managers are developing monitoring programs and moving into a better understanding of how the systems they manage work, they, like scientists, regularly come face-to-face with the fact that the particular piece of information that they need has yet to be discovered.

Landscape management ideally must start with an inventory and a map. These tools will help identify areas of high or significant biodiversity and allow one to associate these sites with development patterns.

These distribution maps must have research data behind them to give information on biology, status, and trends. Based on such mapped information, land-use decisions can more easily be made that incorporate the full range of available information.

Information also needs to be shared. Even though there is connectivity through the "Internet" these days, we have a long way to go to get mapped and tabular systems-information to the point that it can be easily shared on even an interagency basis. In order to make that happen, it is necessary to develop ever more sophisticated data management systems. These are needed to make sense of all the data that are being collected and to share information with neighbors and the many constituency groups that are coming together. These nonagency groups are increasingly wanting access to the agency information.

Multiple use mandates.—In a climate of need to manage lands for a variety of uses, it is almost always difficult to justify protection of species as a primary use. Managing the multitude of native species has traditionally been low on the management priority list. We seem to be moving now from a place where the use (grazing, hunting, mining, etc.) was given the benefit of the doubt to a place where good of the land and resources are considered first and where sustainability is an important concept in use. Society is also moving to an understanding that the islands will all be managed for multiple purposes and that these purposes will have to be balanced. For instance, it must not happen that ecotourism become so important that it puts any rare species at greater risk.

There also is a greater understanding today that transboundary forces influence natural area ecosystems and that they must be identified and addressed to adequately protect natural resources. The myth of isolated natural areas and wilderness, separate and apart from the rest of the world, has been deposed by research. The interconnectedness of all was dramatically presented in a recent New York Times article reporting that DDT is causing population problems on Midway Atoll in the middle of the Pacific Ocean. With this understanding, society is beginning to look at multiple use at varying scales, from individual management unit to the landscape. For the islands this means that there will be consideration of individual island use in the context of use of all islands.

Interagency working relations.—Since we are moving away from managers only having to be concerned with management of their own lands and resources, each manager now must develop a working relationship with each of his/her neighbors. For the Channel Islands this has resulted in the development of working groups that come together on specific topics to provide for increased coordination and cooperation. Groups

such as the Channel Islands National Park Marine Advisory Group, the Channel Islands Research Coordinating Committee, and Channel Islands Geographic Information System Working Group are examples of the type of committee structure that enhance our abilities in interagency working relationships. Other committees are currently needed in restoration and wildlife biology.

To have meaningful interagency discussions, it is often necessary to get over feelings that "they" don't understand or do it right, when it comes to management. These relations are often strained just because both sides are making judgments and assumptions. When a dialog begins and understandings start to happen, there is usually more trust and ability to come to consensus.

Building constituencies.—Management today involves a whole community of people. It is as if we are experiencing the ecological principle that all parts are connected to all other parts. Now when someone tries to do something, there are all manner of folks—interest groups, stake-holders, regulators, legislators, etc., etc., etc.—who are there to help make the decision. And these folks tend to get very angry if they are not invited to the table.

Developing the institutional framework that allows all the people who want a say in the decision is a challenge we have yet to master. In a sense that is happening because our representative form of governance is breaking down. There is no longer a trust that the people's representatives are in fact representing them, in the legislative or administrative branches of government. Since people are feeling that their interests are not being represented; they want to be in on the process.

With this tendency to want to have many people and agencies in on any resource management decision, the process of decision-making gets more and more difficult. As we are all involved in more and more committees, we spend less and less time doing research to find answers. It is a real dilemma, to stay involved in the process by being on the management teams and committees or stay home and do research and thereby get more understanding, but get left out of the process. Finding the appropriate balance is going to be a real challenge in the next few years.

Environmental and administrative regulations.—Even though we are going through the process of reinventing government, our collective lives are actually getting more complex and difficult. Some days it seems as if we spend more of our time concerned with the regulations of how we do something than we spend on the actual "doing it." Government regulations are found in every aspect of our lives, whether we are agency staff or private citizens. Many times these reg-

ulations restrict our ability to get the job of resource management done, rather than making it easier to get on with the job, or easier to coordinate our activities.

Financing and politics.—Related to regulation issues, all of us are experiencing the pressure that we are being asked to perform management in such a way that it is impossible to do adequately with the people and money resources we are provided. There is not enough money to do the job. This pressure is so great and causing such frustration and fatigue in other regions of the country that a great number of workers, especially those associated with state and federal governments, have said, “Enough! I’m ‘otta’ here!” and have gone on to other, more pleasant, lives.

We spend far more on helping people to use the islands (including recreational and consumptive uses) than we do on research and monitoring to understand what the impacts of those uses are or on preservation of native species. On the California islands there is barely support for inventories and monitoring of resources because it is so expensive and time consuming. Going beyond to restoration is happening very slowly.

All of these issues come back to people. People live on and manage the landscape. Therefore, it is important that land managers begin to bring psychological understandings into their decision-making processes. Whether we continue to use the term “ecosystem management” or not, resource management has been forever changed to making decisions based on the best scientific information available with frank, open discussions that lead to consensus of a group. The days of making decisions based on the belief of a few are waning. We will all need to make an adjustment to being involved in more meetings as we work for the good of, and with, the many.

SUMMARY

On the California islands as elsewhere in the United States, we are quickly moving from management by belief-based directives of the few to management by scientific understanding and broad consensus. With this change, the idea that natural areas can be protected by simply putting up fences and stopping negative impacts is giving way to a realization that natural areas will only be protected in the context of an ecological landscape-protection plan. That is, the core natural areas must be buffered from damage due to inappropriate or illegal uses.

The management of landscapes that will provide for long-term well being of both natural populations and human populations requires the cooperative efforts of all who live in and manage that landscape. It also requires that decisions be based on scientific knowledge about the health and dynamics of that landscape, in-

cluding all of the systems, natural and man-made, that exist on that landscape.

In order to arrive at this scientific knowledge, extensive ecological monitoring programs must be developed so that information on changes to the systems will be available. Research will be necessary where there is a need to know why changes are happening. The management of the information that is being developed for landscape scale areas, requires a jump in the size and complexity of computer systems to handle the data. Geographic Information Systems and computer networks will be standard fare in the coming years as the demand for data increases.

Lessons learned from managing the islands can be related to the larger scale of the continent and earth as a whole. We are understanding that it is necessary to manage on a landscape scale because of the continued increase in the earth’s population. We must learn to live, on a long-term basis, with what is available. Failure to develop protected landscapes, which give protection to natural biodiversity and provide for conservation of natural resources in such way as to also provide for the harmony of people and nature, will result in the manifestation of the fear that development and exploitation will simply overrun all natural areas. There still is the possibility that our landscapes could be littered with ghost towns and barren eroded lands. It will take continual shifting away from our tendencies toward individualism to come to grips with our needs for community, connectedness, and interdependence to provide for the long-term sustainability of human populations.

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