SONORAN DESERT CONSERVATION PLAN

STEERING COMMITTEE

EDUCATION SESSION

September 18, 1999 (9:00 - 12:00 a.m.)
Arizona-Sonora Desert Museum (Gallery)
2021 N. Kinney Road Tucson, Arizona, 85743

CONSERVATION BIOLOGY

The Science of Conservation Planning
Reed Noss

INTRODUCTORY REMARKS

If you would all take your seats we will get started and have the close of the session at approximately 12:00 o'clock. Again, I would like to welcome everyone to this session. This session is on Conservation Biology. I'm Chuck Huckelberry, County Administrator and I welcome you on behalf of Pima County. We think today's session will be extremely interesting and what I'd like to do is introduce the Chair of the Board of Supervisors. Sharon.

SHARON BRONSON

I want to welcome you all, I'm Sharon Bronson and as Chuck indicated, I am Chair of the Pima County Board of Supervisors and I want to welcome you all once again to this fourth session of the steering committee. I think you are going to find this session one of the most exciting. We have some terrific speakers, very, very knowledgeable -- just tops in their fields and one of those presenters today is someone I am going to introduce now, someone who probably does not know it but he is somewhat responsible for my being up on the eleventh floor of the County Administration Building and he is Dr. William Shaw. I first got involved in environmental politics, if you will, because of that map that Dr. Shaw put together. How many years ago?

Dr. Shaw:Fifteen.

Fifteen years ago of critical sensitive habitat here in Pima County. Dr. Shaw is Professor and Chair of Wildlife and Fisheries Science in the School of Renewable Natural Resources at the U of A. He has been there since 1974, he has a degree from UC Berkeley and Utah State as well as the University of Michigan in Natural Resources. As I said, he has combined biology with urbanization, with things that deal with both people and animals not only in Pima County but throughout the world and he has just finished hosting, I think in May of this year, was that the first wildlife symposium on urban wildlife?

Dr. Shaw:Fourth.

Fourth wildlife symposium here in Tucson, Arizona and that was a very, very interesting symposium so without further ado, let me introduce to you Dr. Shaw who will tell you a little about what's going to go on today and introduce our presenters. Dr. Shaw.

DR. BILL SHAW:

Thank you Sharon, it is a real pleasure to be here today and see so many people interested in wildlife conservation in Tucson in the surrounding areas. As you know, the Sonoran Desert Conservation Plan includes a number of working groups, one of which is the Science and Technical Advisory Team which I have the honor of chairing and it includes representatives from Science and Natural Resource agencies throughout the Tucson area. As a group, we felt it was very important early on in this process to ensure that we have the best outside expertise that we could concerning the process of developing Comprehensive and a Multi-Species Habitat Conservation Plan for this community.

With the help of the County, we have been probably far more successful than we ever imagined we could be in that regard and I am really pleased today to introduce two speakers that are by any definition preeminent in the field of Conservation Biology. If you were to ask anyone to list a handful of names that have been prominent in efforts to integrate conservation into human activities from a scientific perspective, these two individuals would invariably come up so our first speaker is Reed Noss.

Reed is the President and Chief Scientist for Conservation Science Incorporated, he is also the Science Editor for a new magazine that is attempting to integrate Conservation Biology and Science Advocacy called Wild Earth. He is the President of the Society for Conservation Biology, he has a long history of involvement in Conservation Biology issues and I know on his bio here he also has some skills that could be quite handy in this field as well. He has a black belt in karate which was another reason we wanted him here for today's meeting. I could go on and on, he is the recipient of a Pew Fellowship in the Edward LaRoe Memorial Award which is the highest award of the Society for Conservation Biology gives. I won't go any farther than that because I think we are all more interested in hearing what he has to say. Reed.

THE SCIENCE OF CONSERVATION PLANNING: REED NOSS

It's great to be back in Tucson. I was here just last spring for a symposium and I thought it was a great meeting. Like most biologists, I am going to show slides so we will get into that here in just a moment. Bill mentioned my martial arts experience. There is actually a lot of similarity between martial arts and Conservation Biology. You have to learn to roll with the punches over the years. They are both somewhat combative disciplines in some ways. I am going to talk a little bit today about the history of Conservation Planning. Julia Fonseca, who invited me, suggested in particular that I kind of lead you through how we got to where we are today with these regional scale, ecosystem level Habitat Conservation Plans and other similar types of projects. So if I could have the slides, we will get right into that. I guess I have the changer here....okay. Now these are either left slides or right slides. (Right slides). Okay.

Conservation as we know it on this continent began with not the protection of the ecosystems but with the protection of particular favored species from over-harvest. So for example, the first law that we know of on this continent for wildlife management was an ordinance passed in 1639 in the Colony of Rhode Island establishing a closed season on white-tailed deer. Other colonies followed suit over the next few decades. These first laws had to do with protecting particular favored species from over-harvest.

It was recognized without some kind of regulation, these species might be driven to extinction and, in fact, many colonies in the states did lose their deer populations, wild turkey and other game species for awhile.

Now it is ironic that a lot of these early measures to protect certain species were accompanied soon thereafter by measures to eradicate other species. For example, Massachusetts late in the 1600's established a closed season on deer and at the same time established a bounty on wolves. So we had some definite favoritism shown right from the beginning about which species were kind of important.

Now the effort to protect land in North America came somewhat later. This is fairly obvious why we concentrated first on species--- because land seemed inexhaustible. Here we were in a continent that was fairly lightly populated by Native Americans, maybe at the most ten million people on the continent at the time Europeans first arrived, and their impacts were relatively benign. So we had what a lot of people saw as wilderness, although we do know that in some regions the Native Americans had tremendous influence on the landscape.

In other regions it was probably very, very minor. But when we first started setting aside land--- which we did in a big way when we established Yellowstone National Park in 1872--- biology and other scientific considerations really did not enter into it. We were interested in protecting for all time, the wonders of nature. The Yellowstone National Park Act of 1872 ushered in an era that historian Alfred Runts has called monumentalism. We wanted to protect these monuments, these scenic wonders.

I am glad we did. But obviously, from a biological standpoint, we found that they were not enough. When then did science first become involved in conservation planning? This is really the theme of today's session--- biological science and its contribution to conservation. Well there were some scientists involved in some of the early national park designations, but I think that science became involved in a big way in 1917 when the Ecological Society of America was founded. One of the first actions of this professional society of ecologists was to establish a Committee for the Preservation of Natural Conditions. They established this committee in response to a request from the National Research Council to compile a list and map of all the preserved and preservable areas on the continent that still remained in relatively natural condition, so that was in 1917.

This committee was chaired by a prominent ecologist, Victor Shelford, and operated for nearly 30 years. It had probably a relatively minor influence at the time on what lands were acquired for national parks, wilderness and other areas, but in the long run, its impact turned out to be quite substantial. This group of ecologists then was concerned with representation of all of our major ecosystem types in North America in some kind of system of protected areas.

That was their main theme and they were not just thinking about little postage stamps or pieces that you stick on a shelf and look at later on. They were interested in maintaining entire ecosystems. This was really an ambitious kind of effort at the time. They emphasized, for example, large carnivores and the role that they play in ecosystems and sought to maintain areas large enough that could support populations of these species over the long term. So again, this was a very forward thinking group for back in the teens and the 1920's here on this continent.

The great conservationist, Aldo Leopold, was also a member of these committees. As I mentioned, this committee of Victor Shelford's operated for about 30 years until 1946, when the Board of the Ecological Society of America determined that this kind of applied conservation work was a little bit too radical. It was too much advocacy. They voted to disband Shelford's Committee. Undeterred, Shelford immediately established a separate organization which he called the Ecologist's Union, which in 1950 was renamed the Nature Conservancy. Today, the Nature Conservancy is, of course, the major land protection organization working on this continent.

The Nature Conservancy, though, shifted quite a bit from this early emphasis of Shelford's Committee on large areas and complete ecosystems. They turned to a more practical way to protect things. During the 1970's in particular, while Bob Jenkins at that time was Vice President of the Nature Conservancy for Science, the Conservancy established the Natural Heritage Programs. Most states now have active Natural Heritage Programs incorporated into their state agencies. As many of you know, these programs keep track of what are called the elements of diversity, which are primarily rare species, rare plant communities, and where they are distributed across the landscape. Again, for practical reasons though, they tended to focus on relatively small areas and on rare plants because it is easier to track these occurrences of rare plants than, say, grizzly bears across the area of a state.

The modern science of Conservation Biology as we know it developed during the 1970's largely in response to the increasing awareness of an extinction crisis; that we are losing species at a faster rate than would go extinct naturally. Now, biologists had ve been aware of course that of human-caused extinctions for some time. Consider the last Passenger Pigeon, which was once the most abundant bird it is thought in the entire world, billions of these birds. The last Passenger Pigeon died in 1914 in the Cincinnati Zoo. Still at that time, extinction was not a major concern of most scientists or conservationists.

It was not until the 1960's that scientists and some conservationists began to become aware that the rate of extinctions was really increasing pretty dramatically over time. This graph is from an article in the 1960's by a German author, showing the increase in the extinctions of birds and mammals, (the mammals in white bars, birds in blue bars) in relation to the human population from 1615 to 1950. This provided a pretty compelling argument, and there were other demonstrations of this that the increasing impact of humans on the earth was having an effect that most of us would not consider desirable.

It was this kind of awareness that is responsible for the emergence of Conservation Biology as we know it. Early Conservation Biology, in say the 1970's and 1980's, was concerned largely with incorporating lessons from Island biogeographic theory into conservation planning. Island biogeographic theory begins with the an observation that goes way back-- that bigger areas have more species. This is known as the species- area relationship, and is one of the best documented laws of nature in biology.

We know that as the area increases, the number of species increases. There is probably a number of factors that contribute to this, we know there is a number of factors. Probably the biggest one is that larger areas have more habitats, and with more habitats, you have more species. The first person, (at least in writing) to acknowledge this species/area relationship was Johann Forrester, who was Captain Cook's naturalist on Cook's second voyage around the world. In the 1790's he wrote that, "As the perimeter of an island increases, so does its number of species," and this has been formalized in these kinds of relationships.

Well, Island biogeographic theory provided a general explanation for the species/area relationship. It suggested that the number of species on any island or island-like habitat, for example, any isolated piece of habitat whether it is naturally isolated or isolated by human activities, that number of species represents a balance between the number of species that immigrate or colonize that habitat and the rate of extinction of populations or on that piece of habitat and so, try to make sense of this.

Those two curves that are coming down from the upper left represent colonization rates and they are showing the relationship where the number of colonization is higher for islands with nearby islands. This means islands that are near to a source of species, like a nature continent. The curve is lower for those that are further away. Extinction, on the other hand, is higher; more extinctions on small islands because population size will be smaller. The curve is lower for large islands. Where that colonization curve and extinction curve intersect, would the number of species you would expect to find. So for example, here is the highest number of species that would be where the near and large island curves intersect. The smallest number of species would be found on those islands that are far from a source of colonists and they are very small.

Well, this was a very interesting theory, it was put out in the 1960's, but it has not, unfortunately, held up too well to scrutiny. When you really look at it, there have been very few cases where an equilibrium number of species determined by these two factors has been borne out. However, what this theory did was get biologists and conservationists interested in the effects of habitat size and habitat isolation on species diversity, and these are tremendously important features. Some of the early detractors of this theory of Island biogeographic theory pointed out that it does not necessarily apply to all species. On the other hand, at the same time, there was evidence accumulating that, in general, in this top graph is the percent of the fauna extinct for birds on the California Channel Islands in relation to population size and you can see that the larger population sizes, the extinction rate, the percent of the birds that have gone extinct is much lower. As you go down in population size, with smaller populations, you have more extinctions, and so this can be related to island area. There are birds on Northern European Islands, the larger islands have lower extinction rates than the smaller islands up here.

Other kinds of evidence was accumulating on continents to support this kind of theory about extinction rates being higher on small islands. A number of studies beginning in the 1950's proceeding mostly through the 1980's, but they are still going on, have shown that many species of birds are only found on larger pieces of habitat, and they are missing in what might seem to be appropriate habitat when those pieces of habitat are too small.

This is one example of the kind of relationships that were shown for birds and this is mostly from the eastern deciduous forests where a lot of these studies were done but these are all common birds of the eastern deciduous forests. These are area forests, these are in hectares and hectares are two and a half acres, going from .03 hectares to 3,200 hectares. This is the probability of finding a breeding pair of one of these bird species on a block of habitat of these various sizes and you can see the probability eases measurably as you sample larger blocks of forest. Again, these are all birds that you would expect to find in these forests but they are not found. Drawing on these kinds of studies, a biologist named Jared Diamond, in 1975, proposed the rules for design of nature reserves. What he was suggesting here is that large reserves, one large reserve is better than several small reserves of for the same total area. Reserves that are close together are better than those far apart. Reserves in a compact pattern are better than those strung out, reserves connected by corridors are preferable to those that are disconnected, and relatively round or otherwise compact reserves are better than long narrow ones that have a lot of edge, have a lot of habitat edge.

Now again, these rules were built from experience, largely on birds, mammals, and a few other kinds of organisms. Dan Simberloff, an ecologist in Florida and several others, immediately pointed out that there were many species that these rules did not apply to. Many plants, many insects, and even some kinds of birds did better in different kinds of configurations than those suggested as better by Diamond in some cases. However, this was answered by Jared Diamond and some of the other defenders of these rules, by the observation that the kind of species these people were thinking about (that did better, in say, in small reserves versus large reserves) species that really are not threatened by human activities. There are species that do great in developed landscapes, whereas the species we need to be most concerned about tend to be those that require large, unfragmented, connected habitat.

Okay, back to the practical side of things. This was all going on mostly in the scientific journals, from Shelford's work beginning in 1917 all the way up to Diamond's applications of Island biogeographic theory. This was not really hitting the street much in conservation. During this time, conservation was pretty much proceeding within the same kind of monumentalism direction that it always had been, but with more of a recreational spin on it. Most of the wilderness areas for example, that were established first in the 1960's when the Wilderness Act was passed in 1964 but also through the 1970's and 1980's, even up into the 1990's, are high elevation, isolated pieces of habitat. They are not the areas that are representative of the broader landscape, but they tend to be those areas that are actually poorest in species number, with few species. Generally as you go uphill the number of species declines. So in practice, the kind of areas we are setting aside for conservation are set aside for recreational and scenic reasons, not for biological reasons and they did not make a lot of sense biologically....with some exceptions.

Also during this period in the late 1960's we had an Endangered Species Act. First one version in 1966 and another in 1969 and now the version we have today more or less was passed in 1973 with amendments since then. The Endangered Species Program in the United States started right out focusing on those species that are extremely rare, which makes sense because they are the closest to extinction. An example is the California Condor, which went extinct in the wild, with the last few individuals put into a captive breeding program to try to raise them in a more sheltered environment so we could return them to the wild. It began to eat up a fair amount of money; we have spent over a million dollars annually on the California Condor Program, with still no assurance that we are ever going to see condors back in the wild as a viable population.

We now do have condors in Arizona as you know, and in Southern California. Whether they are really going to be able to last is still an open question. Now of course I hope they do, and I personally think the money was well spent. But when we have endangered species lists numbering literally in the thousands now, obviously we cannot do this kind of intensive effort for all species.

Furthermore, as it became very evident during the Northern Spotted Owl conflict in the Pacific Northwest, sometimes you do have conflicting societal goals. The goal of protecting species and nature on one hand, the goal of providing for a viable economy on the other.

Now it turned out this was really kind of a false choice. Even though the issue was framed by the press as owls versus jobs, it turns out that the Pacific Northwest has the lowest unemployment rates now in the country and a blooming economy, and all that has happened since we started protecting forests for the Northern Spotted Owl. So that owls versus jobs dichotomy was really not accurate. But nevertheless, it did alert people to the fact that there are tradeoffs in conservation, sometimes tradeoffs that could amount of multimillion dollar economic decisions.

Recognizing that we do not have enough money and enough willpower to protect every species one by one as it becomes endangered, people began to think that maybe we ought to be more proactive. Maybe we ought to go beyond endangered species and start thinking about protecting habitats and multiple populations of many species before they get to the brink, when they need something as intensive as an Endangered Species Act kind of approach.

This does not necessarily suggest that we forget about Endangered Species, rather it suggests that we augment Endangered Species Act kind of projects with a more proactive kind of conservation planning. That kind of brings us to where we are today. In fact, what we are trying to do with Habitat Conservation Planning and other ecosystem level conservation acts is really spelled right out as one of the major goals, the first stated goal of the Endangered Species Act-- to provide a means whereby the ecosystems upon which Endangered Species and Threatened Species depend may be conserved.

Many people kind of forget that this is, in fact, the first stated goal of the Endangered Species Act, even though we have tended to focus in practice on individual species when they are at the brink.

It is noteworthy though that this is the only time that the word "Ecosystem" appears in the U.S. Endangered Species Act, in the goal statement of the preamble, and so no direction was ever given by Congress to the agencies on how they might actually implement this broad goal.

One way it might be implemented, of course, is through Habitat Conservation Planning. Over the last two or three decades that Conservation Biology has started to make real contributions to conservation on this continent, we have seen a multitude of different approaches suggested. Most of them I think though fall into three major groups. The first approach , what I might call special element mapping, is kind of the approach that the Nature Conservancy pioneered---mapping locations of rare species, rare plant communities, and other special habitats. Another approach is representation--- and again, this is what Victor Shelford's Committee of the Ecological Society tried to do long ago; to get a network of areas representing all of the major ecosystem types in North America established. We see this being followed today with the Gap Analysis Program, sponsored by the U.S. Department of the Interior.

The third major approach is Focal Species Analysis. This is where we look at the needs of particular species. What I do is go through each of these and offer some examples to show you how they might be applied, but I want to emphasize is that these three tracks or streams have usually been applied separately, in isolation from one another. That makes a big difference, because one comes to different conclusions and different sets of priorities, depending on which of these tracts tracks that you follow. Someone interested in rare plants or rare reptiles or whatever we might name, we will come to a very different list of conservation priorities than someone who is using an GAP analysis approach or someone who is looking at a population viability of say Sonoran Bighorns or Sonoran Pronghorns or Desert Bighorn Sheep. Very different kinds of priorities will merge from these three tracts tracks.

Now I am going to provide examples in large part from a study that some colleagues and I have recently completed for a region on of Northern California and Southwestern Oregon where we have tried to combine these three tracts tracks of conservation planning into one comprehensive approach. Now I would like you to be thinking about how you might apply these kinds of approaches here in the Sonoran Desert. I would not be so presumptuous to talk to you about what should be done here in the Sonoran Desert, not being native to this area and not having conducted any research in this area myself. But I think you will find some parallels between what we have done and what other people have done in some other areas with what might be done here.

First, special element mapping: here we looked for those special things in the landscape. We looked for what some biologists have called hot spots, places of concentrated conservation value. This is in line with the generalization that biodiversity, however we measure it, is not distributed randomly or uniformly across the landscape; rather it is concentrated in particular areas. These areas have been called hot spots. So for example, here in the Amazon Basin, biologists familiar with a lot of different kinds of plants and animals got together and they mapped out areas that contained high numbers of species that were found nowhere else (these are endemic species). The red areas are areas where the most endemic ranges overlapped, okay? So it makes sense that we would focus on these areas. There is one problem with this approach, you might be able to recognize right off. We have not really surveyed the entire Amazon Basin, have we? It is a big area.

These hot spots tend to correspond with the locations of biological field stations in or other areas that have been surveyed. So there are some problems with this approach, and that is why we need to complement it with other approaches, as mentioned.

In the Klamath/Siskiyou Region in Northwestern California/Southwestern Oregon we have a large number of endemic plants in particular. There are 280 plant taxa at the subspecies level that are found nowhere else in the world. For the temperate zone, this is a very, very high level of endemism. So what we did is plotted out the locations of these endemic and other rare species based on Heritage Program records across the study area, and weighted those records depending on the level of imperilment, with those that are considered by the Nature Conservancy to be globally and critically imperiled weighted higher than those that are only imperiled at a state level and are more common globally.

A close up is shown here, we did this within a one kilometer by one kilometer grid and so the darker colors have more of these rare species including the endemics concentrated. As you can see here, this is shown in relation to some of the existing protected areas. We found that many of these rare species hot spots at this scale fall outside of existing protected areas. In fact, about 82% of them fall outside of the strictest category of protected areas. This tells us that we have not done too good a job in this region protecting rare species. However, because of the problem I mentioned earlier. not all possible locations of these rare species have been found because of incomplete survey; we might want to protect those habitats we know are associated with high numbers of rare species. In this region, they tend to be the serpentine habitats. The Klamath/Siskiyou Region has one of the highest concentrations in the world of a particular kind of rock, altermasic ultramaphic rock such as , serpentinite and (?) that tend to be associated with large numbers of rare species, and that is because they contain what are toxic levels to many species of certain minerals such as magnesium and nickel among others and they contain very low levels of calcium and some of the other essential nutrients. So only a very specialized species are able to persist here, in areas where they receive less competition from the dominant species. We mapped out for the area in the Klamath/Siskiyou Serpentine Habitats as valuable in their own right even if we have not found any rare species there yet.

For aquatic species this kind of mapping approach does not work too well because these species are distributed as stream organisms in a linear fashion. In this case, Salmon are connected to the ocean so you have to look at it real differently. You have to look at watersheds. It turns out in our region there are a number of species and runs of Salmon and Steelhead Trout that are imperiled to one degree or another. So we mapped out the watersheds where they occur and located those as shown in the dark blue. They have the highest number of these very endangered stocks. Here, we weighted those stocks and runs of Salmon depending on how critically imperiled they were and mapped out those watersheds.

Also it is good to look at, in this approach, rare habitat types or ecosystems. Such things as Oak Savannahs, for example, are endangered in this ecoregion. They have declined significantly since European settlement, but old growth forests of all types have shown major declines. So this maps shows the old growth forests presently existing in the region; according to the best available data.

As I mentioned, this special elements approach tends to focus on the very rare things. It does not necessarily assure that all species and habitats will be represented. The representation approach tries to assess how well species groups or particular habitat types are represented within existing protected areas. The Idaho Gap Analysis, for example, determined that alpine and sub-alpine communities are pretty well protected by wilderness, national parks and reserves, but if we go downhill just a little bit to the montane forests, there are some classes of montane forests like the Orange Cedar and Hemlock, the Olive, and the Ponderosa Pine Forests that are not very well protected and are being logged very heavily. This immediately tells us those are the areas where we might want to concentrate some future conservation activities of one sort or another.

In the Klamath/Siskiyou we actually combined a kind of vegetation Gap Analysis which is this here, which the federal program uses with a physical habitat and classification based on temperature, precipitation and soil sloe properties. Because the vegetation maps produced by the Gap Program are based on the dominant overstory vegetation, they do not tell you much about those taxa that are more closely tied to the substrate and, perhaps in many cases, very much affected by the variation in precipitation and other variables across the gradient over in which these vegetation types are distributed. So here is our physical habitat classification; a lot of work went into this-- it was a Master's Project and took about three years. These are the vegetation maps from the Federal Gap Analysis Program and when we combined them, we came up with 215 habitat types defined by this combination of vegetation and habitat gradients, which I will not show because it is a really scrambled. What I will show is this map that shows present condition. The white areas have less than 10% of those habitats found in that area which are not within protected areas currently. Going all the way up to the black where 50-100% of those kinds of habitat are currently found within reserves. This again shows us where some of the priorities are in terms of representation. Many kinds of habitats, especially low elevation areas with good soils, are unrepresented in protected areas.

Both of those two approaches I just briefly reviewed, special elements and representation, tell us a lot about the locations in the landscape where we might want to concentrate our conservation activities. They do not necessarily tell us about the configuration, the design, necessary to maintain species and ecological processes over a long period of time.

Here we have had to look in much greater detail at the needs of some particular species. We call these focal species. We could spend have an entire day or more spent just talking about focal species, so I am going to have to be very quick. A very interesting paper published in 1997 in Conservation Biology by Robert Lambeck of Australia defined four categories of focal species; these are species that are tied to certain characteristics of the landscape that you have to maintain. For example, area limited species are dependent on a particular area of habitat; you have to have a large enough block of habitat to maintain their populations. They are very sensitive to reductions in that amount of habitat available. Dispersal limited species are those that are very restricted in their mobility, they have a hard time getting across the landscape or else they might encounter mortality, say being struck by vehicles when they try to move across the landscape.

Resource limited species are dependent on particular habitat structures or resources that are at least sometimes, in critically short supply. An example would be secondary cavity nesters such as your Cactus Ferruginous Pygmy Owl which do not construct their own cavities so they depend on cavities constructed by other birds.

They also would include bats and fruit eating animals in this regions. Hummingbirds are also dependent upon particular resources that are, in some years, in very short supply.

Process limited species are sensitive to timing, intensity or frequency of some natural process such as disturbance regime like fire or flooding. If you try to determine the species that fall in these categories and try to select those species in each category that are the most sensitive, those combined might tell you suggest a way to keep all fauna in the landscape.

There are some other kinds of species that I think we also need to look at. Keystone species, for example. Probably some of you have heard of this term. These are basically species that have a very large impact on the overall diversity of the community, as such that if their populations are maintained, they help create conditions that provide for many other species. Cavity excavating birds, woodpeckers for example, are an example of one of these Keystone species. We might also include large carnivores that are as Keystone species because they regulate the populations and distributions of their prey, which in turn affect vegetation and the habitat for many other species. Therefore, identifying these Keystone species which have a disproportionately large effect on the community is important.

Now I mentioned that when I talk about special elements and this concept of endemic species, and species with very narrow distributions, most of them could probably be picked up by the special elements mapping kind of approach. Also, we need to consider some very rare species individually because their requirements are so narrow, and so restricted that we need consider them individually or that we are going to lose them soon unless we give them special attention. Then there are always special cases; for example a genetically unique population of a given species, or a species that is very popular with the public.

We are developing empirical models of habitat quality for focal species , which we then validate. In the case of the Pacific fisher, we validated models by going out and setting out sooted track plates. In this case, our preferred model was validated at a level of about 80%, which is very good. We were able to predict where the high quality habitat was for the Pacific Fisher in the Klamath/Siskiyou region. We found, as often is the case, that it was not very well represented in existing reserves. That is not a real good slide but the major point stands.

There is also talk of reintroducing some of the species that have been eliminated from the Klamath-Siskiyou region, such as the Gray Wolf. We are in the midst of a study there to look at habitat suitability for Gray Wolves across an expanded study region ranging from Sonoma County up to North Central Oregon and across the Sierra's, and where we are looking for those areas that offer in this slide, the greatest security to wolves, and those are the areas defined by green. These are areas with low road density, low human population density, and far from existing human settlements. We are also looking at prey populations and so on and we are identifying particular corridors that might link together our region with some other regions.

This is the kind of thing you can do knowing something about the habitat requirements of these animals. Then you can go out and verify it really works by setting up survey stations. Now for the wolf, we are validating these models actually up in the Rocky Mountains where there are existing wolf populations and assuming that they will transfer pretty well to the other study region.

These three approaches: special element mapping, representation, and focal species analysis ideally should be integrated when you get down to the stage of actually protecting certain areas of the landscape. We put together a proposed reserve design for the Klamath/Siskiyou Region based on a combination of these three approaches. In proposed GAP ones, this simply means the highest category of protection according to the Federal Gap Analysis Program capped to the moderate protection under those same criteria so this is what we are more or less suggesting.

Now finally, I wanted to address some issues about how we decide how much area is needed and in what kind of configuration. I am just going to basically review some of the empirical generalizations or principles of Conservation Biology. Generally, you cannot answer this question in an abstract way. These generalizations take us only so far. You have to do the necessary research. Every region is going to differ. Furthermore,protection does not necessarily mean hands off, in fact, it usually means restorative management, active management of various kinds to maintaining those necessary habitat conditions. Some of the principles of Conservation Biology and I mentioned earlier,--- the reserve design rules that Jared Diamond and others had proposed. Some of those have withstood the test of time while others have not.

What I am going to go through now are the empirical generalizations that have pretty much withstood the test of time. One is that it is good to keep species well distributed across their native range; do not let them shrink down to just a portion of their range. There are many reasons for this, some are genetic. Those populations that are towards the edge of the range may be genetically distinct. Also, we cannot ever count on the rest of the range being protected. The pygmy owl is an example of that. Certainly there are more pygmy owls-- we do not know how many and we cannot be assured they are going to persist there. It is possible that there are some unique adaptations of the Pygmy Owls in this area, on the edge of their range.

Probably the best accepted generalization, after the species area relationship which it corresponds to, is that large areas of habitat are better than small blocks because large blocks are going to have larger populations of your species of concern. We know through a number of studies that small populations are subject to a lot of different threats. Mike Gilpin is going to be talking more about this in his lecture so I am not going to cover this in any detail.

There is some data very similar to what I showed you earlier. In this case, the grassland bird is showing how the probability of protecting and finding those species increases as the size of the habitat increases.

Another related principle is that blocks of habitat close together are better than blocks far apart. The idea here is that if you have them close enough together they function as one single unit for the species concerned.

What we mean by close together has to be spelled out, because for some organisms, these two patches of forest are close together. Birds can easily fly over the highway. However, if you are a lungless salamander or , if you are a small forest rodent, those two patches of forest might as well be a thousand miles apart--- they are not going to cross it.

Another related idea is habitat in contiguous blocks is better than fragmented habitat. A lot of studies showing that fragmentation as shown here leads to impoverishment of the habitat. Where exactly the threshold is when a landscape becomes too fragmented is still something that remains to be worked out in many individual cases.

For example, is this too much fragmentation here? Or do we have to wait until they get down to here? That is something that has to be studied uniquely in every case.

Interconnected blocks of habitat are better than isolated blocks. There is a lot of discussion in Conservation Biology about corridors. Conservationists often include corridors in their designs, but it is possible that poorly designed corridor, for instance a very narrow one as shown here, could do more harm than good because it will favor species that thrive in disturbed habitats at the expense of those that are more sensitive to human disturbance.

What we are concerned about is not a corridor per se, but rather functional connectivity of the populations. This has to be defined pretty much species by species. Connectivity might be supplied by a corridor, or in some cases, it can be supplied in other ways. A recent review by Paul Byer Beier and myself of the corridor literature found that most of the properly designed studies of corridors found that they do, in fact, provide functional connectivity in to one degree or another. We have one of the fathers of metapopulation biology in the audience, Mike Gilpin, (and he even has "Metapop" for his license plate), so I will let him tell you more about this but this is one of the arguments for why we need connectivity--- to allow organisms to recolonize areas where we had populations go extinct. Mike will tell you more about that. I going to skip over these in the interest of time. Basically, we know enough now about connectivity in most cases to make a good start for maintaining a connected landscape. The details in many cases do need to be worked out through further research.

Another observation is that for species sensitive to human activities, blocks of habitat that are roadless or otherwise relatively inaccessible are preferred to those with a lot of access. There are many reasons for this; for example, roads are sources of mortality for a number of organisms, such as wolves in the Rocky Mountains. Y ou might expect the Canadian Rockies to be a pretty secure place for wolves. In fact, highway mortality is the largest known source of mortality for wolves in the Canadian Rockies, and it is even worse in the national parks because there are more vehicles traveling through them. Snakes are also very vulnerable to road kills.

Roads also provide access to poachers and collectors, and not just the wolves are threatened by this, but snakes for the pet trade, orchids and cacti for the horticultural trade and so on. That kind of poaching is enhanced by roads and other access.

Now I have been talking mostly about species specific rules, the last few were built from observations of species and how they respond to landscape configuration. We are beginning to see that maintaining viable ecosystems, however we might choose to define them, is in many cases going to be more efficient, economical and perhaps notably more effective in than a species by species approach. We need so in my view, to find a way to reconcile our rich knowledge based on observations of focal species with the knowledge that we have to start managing for entire ecosystems.

I am going to skip over a couple of these because I am about out of time. Some zoning rules. I am going to leave you with one point:

Again, how much is enough? That question not only applies to how much of the land you need to have in a conservation system, it also applies to how much research, how much study is necessary before you finalize the Conservation Plan. One rule that our Scientific Review Panel from the Coastal Scrub Plan, which included myself and Mike Gilpin, agreed on is that data collection is going to take awhile but in the meantime, the less data or the more uncertainly you will have, the more conservative your plan has to be. The margin for error is reduced, so it is in everybody's best interest to get a lot of information. At some point you have to act, but in the absence of complete information you have to err on the side of protecting more than enough rather than protecting too little if you want to meet the biological goals of your plan. With that I will close. Thank you.

I have a brief advertisement. I brought along three copies of my book on Science and Conservation Planning, I sold one already and I am selling them for a discount price of $20.00 so if you would like one I have two.

QUESTIONS AND ANSWERS:

Dr. William Shaw: We are going to take a few minutes for questions now and then we will take a break. We are going to set up some additional chairs for those of you that ran out of space. There will be additional time at the end of the whole session to have questions as well.

Question:Do we have some kind of interim guidelines during the phase of research and data collection before the final plan is approved?

Answer:In the example of the Southern California Sage Scrub, what we did is come up with some interim guidelines and they were to lose not more than 5% of the Coastal Sage Scrub habitat during the planning process. But it was not just a simplified 5% cap, what we produced is a decision tree where you go through and you compare pieces of habitat in terms of their known biological values, their size, their isolation and other factors to channel development away from those patches that are likely to have more biological value and channel development into those areas that are very small, very isolated, that are degraded by other activities so that we kind of maintain our options during that interim period. That is a very difficult thing to do. I think our approach worked pretty well in the case of the Coastal Sage Scrub, I have heard of some abuses where our decision tree was not really followed but I think in most cases, the jurisdictions show goodwill and try to follow the interim guidelines.

Question:How long was that period?

Answer:Well, it kind of lingered on. Mike, you might know more than I do how long that research period lasted.

About five years.

We originally were hoping it would be two three years but it turned out to be about five years.

Question:How does sustainable cattle ranching conform to the presentation today about a landscape management through biodiversity?

Answer:I think it is a landscape specific kind of issue and I would not pretend to be familiar enough with your local situation to give you a definitive answer to that. The kind of approach that I worked on elsewhere has established different zones basically where those areas of highest biological value are usually recommended for the strictest protection which in the case of a desert or grassland ecosystem would usually be, not always, no grazing by domestic livestock. For other zones where grazing by livestock, where sustainable forestry where a number of other extractive kinds of uses would be perfectly appropriate so you really have to look at the site and you have to look at how the livestock are being grazed. We know some examples, and this is sometimes a misused notion, but where livestock can be a management tool. Examples include areas that were adapted to grazing by native large herbivores, those native large herbivores were extirpated, you cannot get them back at least in the short term and so livestock, if managed correctly can fulfill those roles. However, we know of many other cases where livestock are definitely causing problems so it really has to be, I am sorry to have to put it off on you, but it has to be a case specific kind of issue. In a particular area, particular grazing regime, is it or is it not compatible? We have to ask that question case by case.

Q:Why should we try to preserve the status quo when nature always changes?

A:That is one that we hear often, it is one that is often brought up and it has never had a completely satisfactory answer, but it really has to do with rate and scale. The rate of which we are losing species worldwide today has exceeded all rates we know of for the last sixty-five to six-seven million years.

Q:What is that based on?

A:It is based on pretty damn hard data. We have good fossil data of the cretaceous extinction of man, for example, and we have some pretty good extrapolations on current rates of species loss. We know that it surpasses anything we've seen since civilization, since the agricultural revolution or the industrial revolution. We have hundreds of species documented that have gone extinct, even on this continent and they seem to be going extinct of course, more rapidly in the highly species rich tropics. S so it is something that 99.99% of biologists would agree that we are in another mass extinction event and the question is whether we are going to allow that to happen, whether that is something we are going to live with. In the past, recovery did occur, recovering species numbers (, you can never get those same species back given current technology) but recovery of species numbers did occur after these great mass extinctions of the past, but they took between ten and twenty million years. so Ddo we want to wait ten or twenty million years for our descendants to have a complete bountiful world again? and I think Mmy personal philosophical response is that I think we have a need for a stewardship ethic, we have an obligation to try to maintain species that we see here today that would be around without our harmful activities. There are some species that are on the way out naturally but that rate might be one or two per year compared to what is now on the order of 20,000 or 30,000 species per year ,so it is just a difference in the scale.