WILDLIFE ECOLOGY AND MANAGEMENT  
(Humboldt State Univ. WLDF 300)  

LECTURE – FOREST MANAGEMENT & WILDLIFE I

I. Diversity and succession  
   A. Basics -- Community Development. Biological communities, meaning collections of species, exist in a continual state of flux. When individuals are replaced by individuals of the same species, the flux is subtle, but when species replace other species, the change is dramatic. The process of habitat change over time is called succession, and it has profound impact on wildlife communities.  
   B. Succession. Orderly pattern of species replacements.  
      1. When a new habitat is created, usually as a result of disturbance (natural or human-caused), a new suite of species well-adapted as colonists (aka pioneers) invades. The series of communities resulting from the process of succession is called a sere. A single stage in this series is called a seral stage.  
      2. These pioneering species or “early successional species” tend to have high dispersal capabilities and reproduction rates, and relatively poor competitive abilities -- they are things like grasses and forbs.  
      3. Gradually, these species give way to better competing species, or late-successional species, characterized by poorer dispersal abilities, slower rates of reproduction, but strong competitive abilities – these are things like shrubs and (later) trees.  
      4. Thus, a typical successional sequence in lowland coastal NW forest might go something like this: OVERHEAD pg 83 Whitney  
         a. First comes weedy herbs such as bracken fern and fireweed.  
         b. Shortly following is a rapid dominance of shrubs such as salmonberry, thimbleberry, salal, coast red elderberry etc. (rhododendron and madrone further from the coast)  
         c. Red alders often are some of the first trees to invade disturbed habitats.  
         d. Sitka Spruce, Douglas Fir, and Western Larch are the first conifers to readily colonize a site.  
      5. Finally, later-successional tolerant trees invade when local conditions cool and shade becomes established, such as redwood, western hemlock, bigleaf maple, etc.  
   C. Which successional stage has the highest diversity?  
      1. In succession, two things are clear:  
         a. Some successional stages have more species than others.  
         b. Each stage has a different (but not completely unique) species composition.  
      2. Role of biodiversity flux as community matures is less clear.  
         a. Traditional view (by Odum) was that diversity increased thru succession and reached its highest state at the “climax”. This idea was based, in part, on the premise that forest biomass (wt of living material) reached its highest point at the end point of succession.
b. However, field research suggests that biomass reaches its highest point earlier in succession, and then drops at the final stages as the “old growth” forests begin to senesce and die.

c. Nonetheless, the gaps created by fallen trees create new niches, so even though biomass may not be highest at climax, diversity probably is. So Odum was probably right, but not for reasons he thought.

D. Relationship between diversity and a changing landscape.
   1. So, if climax habitats have the greatest diversity, does that mean habitat managers should strive to have as many climax stands of forest as possible? Nope.
   2. Again, we’ve got to think about spatial and temporal scales. Consider two periods of time, (a) from colonization to maturity, and (b) a long period of maturity. Which period has the highest diversity? Clearly, even though the climax forest has the highest “within stage diversity” (sort of like alpha diversity), the time from colonization to maturity will have the greatest overall diversity. In short, managers must manage for a “diversity of diversities.”
   3. This is convenient because it can be integrated well with resource extraction.
   4. Be careful though. Can’t simply say that disturbance sets clock back and reduces diversity…because in fact such a disturbance can enhance the diversity of the landscape. Likewise, can’t say that lots of disturbance is good because the wildlife typically responding well to disturbance are usually more common than those restricted to older forests…more later.

II. Balancing age classes in space
A. Basics.
   1. Although age does not equal successional stage…it is a close approximation and can be measured SO easily. Simply reconstruct history of disturbance on managed sites, and you have the ages of the forests. So, much of succession management comes down to balancing different block of habitat that are different ages.
   2. Succession/forest age is a circle that is mirrored by changes in animal communities.

III. Basics.
1. Although age does not equal successional stage…it is a close approximation and can be measured SO easily. Simply reconstruct history of disturbance on managed sites, and you have the ages of the forests. So, much of succession management comes down to balancing different block of habitat that are different ages.

3. Note that the age structure of a stand is not the same as the age structure of a landscape. The first is made up of the ages of the individual trees within a small group of trees (a “stand.”). The second is made up of the ages of various stands of trees that together comprise an entire landscape.
   a. Even vs. uneven aged stands.
   b. Basic silvicultural treatments that lead to each:
   c. Clear-cut, shelterwood, and seed-tree treatments create even aged stands
   d. Single tree selection and group selection create uneven aged stands.
   e. For diagrams and photos of these practices, see: http://www.humboldt.edu/~mdj6/431/forest/primer.html

4. Despite the compelling reasons to balance a variety of age classes of stands within a landscape….there are many forests that lack such a balance. For a variety of reasons. One thing that is easy to overlook when getting frustrated about current inadequacies in our forest management is that forest grow very slowly…..and in the 20s, 30s and 40s….ecology was not even a word people (including many scientists) knew. Much of what we see NOW as poor age distributions is a result of ignorance over half a century ago.
III. Old forests
   A. Basics.
      1. This idea of maximizing forest diversity as being fairly consistent with resource 
         extraction is encouraging…except there is one major discrepancy: trees reach 
         traditional economic climax long before they reach their ecological climax.
   B. Defining “old”
      1. Where to start. Primeval, virgin, pristine, ancient, overmature, decadent, dingy. 
         Many loaded terms. “Old growth” is perhaps most free of bias.
      2. Obviously, what is old depends on the species of tree and the place it grows. For a 
         bristle-cone pine to get “old” it probably needs to be 1000+. An 80 yrs old Aspen is 
         down-right near death. Likewise, any 120 yr-old tree in a landscape that is typically 
         swept by fire every 100 yrs is old.
      3. In the pacific NW, the USFS originally used a minimum age of 200 years for old 
         growth Douglas-Fir, but more recent criteria include structural elements as well. 
         For example, there are particular dbh criteria depending on latitude, and there are 
         down log requirements: 10 tons per ha (Hunter says acre; it’s ha)
      4. Age criteria. Some ideas:
         a. Has the forest reached an age at which species composition is not changing (i.e., 
            climax)? Rarely met. Probably too restrictive, because forest develop old 
            growth ecologies before this point.
         b. Has average tree growth stabilized with death via senescence? Biomass 
            accumulation stable.
         c. Is the forest significantly older than the average interval of disturbance? But 
            what if that disturbance is 60 yr rotational cut. Is a 100 yr old forest then old? 
            Must be natural disturbance.
         d. Have the dominant trees reached their life expectancy?
      5. Disturbance criteria
         a. Has the forest been previously cut? Often people restrict use of the term virgin 
            for forests that have not been cut.
         b. Has the forest been converted by people to some other habitat types in the past? 
            “Primary” is often used for this criterion.
      6. Other ideas:
         a. In practice, age criterion b is probably good enough to distinguish most 
            ecologically “old” stands.
         b. However, the inclusion of disturbance criterion s should also be recognized, 
            with additional terminology. This is because if we leave forest alone, they will 
            become old and boast many of the advantages of old-growth forests…in fact in 
            many parks this is currently happening. At the same time however, we do not 
            know whether they will behave exactly as forests of similar age that have never 
            been cut. So the use of “old” or “late-successional forest” is good for the 
            former, while virgin is good for the latter.
   C. Importance of old forests for wildlife.
      1. General ideas. It is clear that there are number of wildlife species that reach their 
         highest densities and/or reproduce and survive at their highest rates in old forests. 
         So for that treason alone, they are very important for wildlife. Examples.
      2. Reliance of some wildlife on old forests? But are there any animals for which old 
         forests are critical habitat, without which they would go extinct. The answer here
is...probably. Difficult to tell. And the more we study the more we learn. Even NSO appear to do very well in some second-growth forests.

3. Emergent properties of old growth. Wildlife specie aside, old-growth forests are rare, especially virgin forests. So for no other reason—they are worth saving, they are endangered *habitat types*. They also serve as well-springs of human ideals: hope, wisdom, perseverance, peace.

4. Difference between old growth and wilderness. Wilderness areas are large block of land relatively free of human disturbance. It is true that some wilderness areas are old growth and some old-growth areas are wilderness; but many old growth areas are too small to be considered wilderness areas, and many wilderness areas are to young to be old-growth.

D. How much old forest?
1. Bottom line. Almost everyone likes old forests and think that some should be saved. The arguments are over how much.
2. Currently, about 14% of forests in the Pacific NW meet USFS criteria for old-growth.
3. History. Historically, probably about 50% of the forested area was old growth.
4. Recommendations. So how much should we keep? Harris, in his influential book “The Fragmented Forest” suggested maintaining 5% in the PNW.
5. One view may be to examine the most old-growth reliant critters, and meet their requirements, assuming the others will fall underneath them (umbrella species management...we’ll get to the pros and cons of this approach later).
6. Scientists doing just that for NSO suggested that 2 million ha of old-growth be retained in the PNW (about 10-20% total forested area).

E. Managing for old forest species.
1. General ideas. No big deal. Set aside old forests and leave them alone. But it’s not that easy. Ideally, these old-growth reserves would be allowed to undergo natural patterns of disturbance, but many of them are so small that a single disturbance event (e.g., a fire) would wipe them totally out...where as in a large old-growth landscape, it’s the very fact that disturbance is likely to only affect part of the area that makes it so valuable.
2. Rotations. An easy way, potentially, to create old forests is to lengthen the time between successive harvests of the same bit of land (called rotation time).
   a. Many forests are cut on 60-100 yr rotations.
   b. Lengthen that time for at least some of the stand, and viola...you have old forests.
3. Harris’ wheel. A classic example.
   a. Harris envisioned Douglas-fir forests being harvested on 2 rotational periods. One, the typical 80 yr cycle, but the other would be a longer, 120 yr cycle. OVERHEAD. In this way, as long as 20% of all stands were on the long rotation, 5% of the forest at any one time would be 240-320 yrs old.
   b. He further suggested that these longer rotations be arranged to encircle a core of old-growth permanently withdrawn from harvest, which would allow the core to remain buffered, which might increase its effective size for wildlife.

I. Sometimes foresters are tempted to conclude that they can create old growth characters for whichever species is endangered. Kill trees for snags, grow trees close together for a tight canopy. But that works only species by species. If all species are considered, than all
aspect of an old forest would be required… and that will only be found in an old forest proper.

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IV. General ideas.

A. Influence of home range.
   1. All animals require space…but some more than others; some have huge home ranges (e.g., the grizz), some have tiny home ranges (Ensatina).
   2. Clearly, there is a relatively close relationships between animal body mass and home range size.
   3. But there is more than this; lifestyle has an even greater impact on home range size. Herbivores typically have relatively small home ranges because their food is comparatively abundant. Carnivores have larger home ranges over which they need to search for herbivore prey. Top carnivores have the largest of all.
   4. Mobility also influences home range size. Birds (good dispersers) typically have the largest home ranges for their body sizes; herptiles the smallest.

B. When does black and white become gray? The importance of spatial heterogeneity may be best understood by asking the hypothetical question, “When does a landscape comprised of black and white blocks of habitat become gray to an animal?”
   1. Consider a landscape comprised of 1 ha blocks of 2 habitat types, 60 yr forest and 5 yr forest, arranged in a checkerboard.
   2. Consider two species, a warbler and a kestrel; they both select and require the open, 5 yr forest as suitable habitat. A breeding territory for the warbler is about 1 ha, for the kestrel it is 100 ha.
   3. The warbler is fine on the checkerboard, it simply selects suitable patches of habitat and avoids the 1 ha blocks of mature forest.
   4. For the kestrel however, a 1 ha block is much smaller than its territory size, and is thus not a usable patch of habitat. To the kestrel, the habitat is not made up of tiny blocks of suitable and unsuitable habitat….instead it sees a larger block of suboptimal habitat. In other words it doesn’t see black and white blocks….it sees the composite gray. OVERHEAD

C. Generalists and specialists.
   1. We’ve talked previously about habitat generalists vs. specialists, but now let’s think about them in the context of managing habitat heterogeneity.
   2. Habitat generalists, of course, are less sensitive to habitat heterogeneity than specialists because they’ll use a variety of habitat types. The examples with large home ranges are well-known: raccoon, coyote, etc. But animals with small home ranges apply as well: American toads, Peromyscus.
   3. But specialists can be further divided in this context into two groups: a. Those that need a uniform landscape comprised largely of a particular (or a couple) habitat types. Old growth-specialists (e.g., NSO?) are examples of this group.
b. Those that need a diverse landscape comprised of several habitat types. Ruffed grouse is this latter type of specialist. It needs mature forests in which to display and forage in winter, it needs younger tracts in which to forage in summer, and it needs brushy hollows in which to brood chicks.

4. In short, some animals need black, some need white, some need black and white, and some can use either.

D. Predictions.
1. From these two ideas, we can make 3 general predictions about how to manage habitat heterogeneity for wildlife.
   a. On a small scale, where a single tree could comprise a habitat (e.g., for insects), diversity is probably greatest in an old forest because it will have a mixture of old, young, and mature trees as well as downed material.
   b. At a slightly larger scale, one measured in hundreds of ha, a mosaic of stands of various ages and species compositions will harbor the highest wildlife diversity.
   c. At a large spatial scale still, one of thousands of ha, the most diverse landscapes will be those that have both uniform patches of habitat as well as highly diverse patches….in other words the landscape will have patches that are 0.1, 1, 10, and 100 ha in size.

V. Disturbance and Habitat Mosaics
1. Major forms of disturbance
2. Factors affecting how disturbance influences the landscape
3. Stable Habitat Mosaics

VI. Managing for spatial heterogeneity.
A. Basics of forest harvesting to create habitat heterogeneity.
   1. At a very small scale, selective logging creates habitat heterogeneity within a stand. But group selection, patch cuts, and clear cuts of various sizes can also enhance habitat heterogeneity.
   2. Using clearcuts for wildlife management is unpopular among the general public, but most people don’t recognize that many wildlife species either (a) require early successional habitats created only after a disturbance, or (b) require large stands of uniform (similar aged) forest, which only occur many years following some disturbance. Carefully planned timber harvests can meet these goals.
   3. You may be wondering something: Why should we cut at all?; presumably all the wildlife species did just fine in the habitat heterogeneity created naturally without timber harvests. There are two answers:
      a. First, because people now live within forested landscapes in much higher densities than they ever used to…we often need to manage fire simply from a safety perspective….so a “natural” (and presumably adequate) disturbance regime is simply not possible in many areas.
      b. Second, we can approach simulating natural disturbances with carefully managed harvesting, which not only can (potentially) reduce risks of catastrophic fires, it also permits timber extraction. That is the goal toward which we are working….managing ecosystem habitat heterogeneity and maintaining biological diversity while managing catastrophic fire and permitting sustainable resource extraction.
c. Better management, however, must be coupled with reduced rate of consumption. This is too-often de-emphasized. Rate of consumption and efficiency of use of resources work hand-in-hand.

d. These issues aren’t always easy to resolve. Consider the hypothetical of a 100 ha well-managed (but harvested) forest vs. a 90 ha untouched forest plus 10 ha of intensively managed hemp farm for paper. Which is better on the landscape? Clearly, that depends on the nature of the landscape.

4. With all of that said, it is important to note that logging is not the same as a natural disturbance. There are important differences between post-logging and post-fire habitats…which we’ll get to later.

B. A model for spatial habitat heterogeneity.
   1. Distribution of stand sizes. A big question in using logging to create habitat heterogeneity is, “how big should the cuts be?”
      a. Harris suggested a distribution of stand (and hence, cut) sizes with a strong skew towards many smaller stands. OVERHEAD
      b. He based this distribution on the correlates of home ranges: large animals need more space, but they are also very rare and there are few of them.

   2. Total area of stand sizes. His advocated distribution also resulted in a skewed total forest area in various stand sizes. OVERHEAD

VII. How big should clear-cuts be?
   A. Natural disturbances as models.
      1. Perhaps the most commonly invoked model for planning cut sizes is to “mimic patterns of natural disturbance.”
      2. Easier said than done though. First, it’s very difficult to reconstruct disturbance histories, and second, defining “natural” is often somewhat arbitrary in landscapes whose habitats were significantly altered by Native American practices.
      3. In general though, clearcuts should be no bigger than commonly occurring natural disturbances….which will clearly mean they should be avoided altogether in some forest types (e.g., tropical forests).
      4. On the flip side, in boreal forests where fire can cover 10,000 ha or more, clearcuts probably can be (should be?) rather large. With that said though, remember clearcuts are not the same as fires. In reality a large natural disturbance has many irregularities within it (e.g., cool spots), so in practice clearcuts should be much small to mimic this pattern, and/or large shelterwood cuts can create such irregularity.

   B. Compromises.
      1. As you can see, there are many influences on clear-cut size. Timber companies usually lobby for large cuts, as do those that emphasize managing habitat heterogeneity at large spatial scales.
      2. The public invariably lobbies for small to nonexistent clear-cuts.
      3. The result is often a compromise…medium sizes….all of them. This is perhaps the worst of both worlds because it does not provide heterogeneity in the sense that all clearcuts are almost the same size. Remember the graphs we went over to begin with? A balanced approach of some large and some small cuts, and some areas with no cuts at all, is clearly better and would probably result in similar amounts of extractable timber.