FOR 433

Fire Ecology and Wildlife

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Direct Effects of Fire on Wildlife

- only a small proportion of wildlife are killed or injured during forest fires
  - Ambient temperatures of over 145 f are reported to be lethal for small animals and often assumed to be similar for larger animals and birds (Howard et al 1959, Brown et al 2000)

The first question I typically get from people when I tell them I study forest fires is what effect does it have on wildlife species. Most of the general public often times assumes that wild fires are devastating to wildlife. The short answer to this question is that in general only a small proportion of wildlife are killed or injured during forest fires.

Ambient temperatures of over 145 f are reported to be lethal for small animals and often assumed to be similar for larger animals and birds (Howard et al 1959, Brown et al 2000). With this in mind most fires therefore have the potential to do harm to wildlife.

Dealing with fire

- Resistance
  - The insulating capacity
  - The size of the organism
  - The duration of heat exposure
- Avoidance

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There are two types of ways wildlife deal with fire, they can be resistant to the heat of a fire or they can avoid fire. In the case of resistance to heating will be dependent upon the insulating capacity, the size of the organism and the duration of exposure. The other strategy of animals to deal with fire is to simply avoid the fire.

A note on the Howard study: This study would attract a lot more attention today than it did back in 1959, during this study they placed live animals in cages spread throughout various locations in grass and shrublands and than lit fires to look at survivability.

Resistance to Wildfire

- Fur is a good insulator
  - Therefore given two animals one with and one without fir the one with fir will heat up more slowly (Whelan 2002)
  - Smaller body sizes will heat up quicker
  - As duration of heat increases probability of survival decreases

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One of the key issues with resistance to fire is how quickly an animal will heat up. As an example of this lets imagine we took two animals a mammal and a reptile, one with fir and one with out fur. Lets also assume that all other things are equal. Due to the thermal conductive heating properties of fir the mammal will heat up at a slower rate than the reptile. Furthermore there is an indication that body size will effect fur thickness, which will add another disadvantage to small animals. The next key property we need to investigate is body size. Smaller body sizes will heat up quicker simply because there is less material to heat up. For example think of it this way if you put two pieces of ice outside one that is 1 foot by 1 foot and another that is a small ice cube even though the receive the same amount of heating the smaller ice cube will melt first. This leads us to the next concept of fire resistance and that is that as the duration of heat increases the probability of survival decreases. Think of the ice cubes again, in this case even though the small ice cube melted first eventually the larger one will also melt away.

Avoidance of Wildfire

- Animals can get out of the way, burrow into the ground or find areas that will not burn in a wildfire.
  - Some animals will double back through the flames (relates to heat resistance characteristics)
  - Seek wet areas or areas that will not burn
  - Simply move out of the way of the fire front

Much like humans many wildlife species will try to avoid the fire front. Examples of these behavioral strategies include simply moving out of the way. For example a bird can just fly away, or other mobile wildlife species will simply move. Other animals will double back through the fire front. This will dependent partially on their ability to resist the heat of the flaming front. But there are reports of animals escaping the flaming front using this method. The other method is to seek areas that will not burn or heat up to a lethal temperature. This has been captured in the photo that many or all have now seen of the ungulate standing in the stream with the hill side burning behind. However other animals especially those that are not as mobile can use this strategy by burrowing into the ground or seeking refuge in a wet habitat type near by or in a hollow log.

Some notes on thermoregulation and smoke

- Even if temperatures are not lethal smoke can still kill an animal
  - Rodents who burrow typically survive the fire if the burrow has two openings

Another important consideration when investigating the effects of wildlife mortality and survival is smoke and thermoregulation. Just like human fatalities in fire smoke can be a major contributor in wildlife mortality. As an example of this one study found that rodents who used burrows to survive wildfire typically survived if the burrow had two openings which allowed adequate ventilation for survival as well as protection from the heat source.

Another factor affecting wildlife survival is thermoregulation of body temperature. Essentially thermoregulation is sweating to help keep the body cool. In the case of an animal hiding in a shelter the ability of thermoregulation may be a critical factor in survival. The ability of an animal to survive is tied to thermoregulation through vapor pressure at different relative humidity. In short as relative humidity decreases animals are much more tolerant to increased temperatures.

Some notes on thermoregulation and smoke

- Thermoregulation is the use of evaporative cooling as a means of survival
  - Dependent upon relative humidity
    - Lethal temperature decreases as relative humidity increases
      - low humidity permits animals to tolerate much higher temperatures than if humidity is high

Life History as a Defense

- Life History is another important factor in assisting wildlife surviving fire
  - Examples
    - Grasshoppers may survive fire since they are adults during the fire season and can flee the area (Gander 1982)
    - The geometric tortoise lays eggs under the ground where the incubation period lasts through out the fire season, then the animals avoid dense stands which are likely to burn (Kruger and Bigalke 1984)

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Another important consideration in animal survival is life history. The stage of the life form can influence many factors we have already talked about. However some species appear to have specific life history traits which make them less susceptible to fire. For example grasshoppers are matured and mobile during the fire season thus they maybe less resistant to fire mortality. Another common example used to show how life history maybe a good defense from fire injury or mortality is the geometric tortoise. This animal lays its eggs underground where the incubation period lasts throughout the fire season, acting as a duel defense. Than the animal avoids areas with closed canopies and lots of fuels throughout its life. Thus it avoids areas which are likely to burn.

Effects of a post fire conditions on wildlife

- Removal of plant biomass
  - Vegetation either directly or indirectly provides a host of environmental conditions which determine a suitable habituate for an animal
- Changes in soil chemistry
  - Can increase forage production after fire

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The fire survival methods we have been discussing so far allow an animal to survive the fire front only, these creatures are no faced with the task of living in a altered environment. The removal of plant biomass either directly or indirectly influences the ability of an animal to survive in a given area. For example the loss of hiding cover, nesting sites, and food are direct effects, where as changes in temperature and wind or changes in soil properties are examples of indirect effects. As you might guess being able to predict

Fire effects on Animal Populations
Birds

- Populations change in response to changes in food cover and nesting habitat
  - Fires indifferent seasons will have different effects on populations
  - Reduction in plant cover can increase prey for several species of raptors
  - Creation of snags can increase nesting habitat for many species.

So far we have focused on the behavioral responses of animals to fire, these responses are limited to short term survival techniques. To investigate longterm changes it is much more helpful to look at animal populations and communities. We will no discuss fire effects on animal populations. Population changes are the end result of the behavioral short term responses and longer term responses. I will now provide a brief overview of the effects of wildfire on wildlife. In no means are the examples or text I present here a conclusive review of these effects, but they should provide some insight into how wildfire interacts with wildlife populations.

Fires during the nesting season tend to reduce population size more than fires during other times of the year, and it follows that fires which occur before the arrival of migratory birds will only have indirect effects on the population or not at all. Most raptor populations respond favorably or are unaffected by burned habitat. The favorable response is due to a reduction in hiding cover for prey species.

In addition to increased prey the creation of snags may provide increased nesting sites for many species. Many species of wood peckers have shown substantial population increases following stand replacement fire (Sabb and Dudley 1998). Reports of wood peckers in areas with underburns tend to suggest little effect on populations.

Fire effects on Animal Populations
Small Mammals

- Respond directly to changes in cover and food
  - Ream (1981) concluded that populations of several small mammal populations generally increase after wildfire, however other studies have found decreases in populations after fire.

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Like birds, mammals respond directly to fire caused changes in cover and food. Spring fires may impact mammal populations more than fires in other seasons because of the limited mobility of young. The species with the most vulnerable young are small mammals. However small mammals tend to also have high reproduction rates, which allows there populations to recover quickly if the post fire environment is suitable. In a literature review of 237 references looking at he effects of fire on animal populations ream (1981) concluded that there are a host of small mammal populations which respond favorably to fire. Included in this list were ground squirrels, pocket gophers, and deer mice. However other studies have found that several animal populations tend to avoid recent burned areas. This list includes rabbits, snow show hares, red squirrels, and northern flying squirrels.

Fire effects on Animal Populations
Large Mammals

- Large mammal species tend to be most sensitive to changes in vegetation structure
  - Ungulates tend to show no population changes or respond positively to fire
  - Large carnivores and omnivores generally do not change in response to fire

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Large mammal species, particularly ungulates, tend to be sensitive to changes in vegetation structure which is related to fire severity and uniformity across an area. In several studies mule deer populations have increased in burned areas in northern California and in a variety of chaparral ecosystems. However one study found that mule deer tend to prefer pinion juniper stands that have not burned. Most other large ungulates tend to respond positively or show no change in response to fire. Other large ungulates such as elk and moose rely on a combination of pole sized forests and shrub fields throughout the year. Other large ungulates such as bison, may avoid burned areas for several years until regrowth begins again.

Large carnivores and omnivores tend to be more opportunistic species with large home ranges. Due to the large home ranges and opportunistic nature of these populations they tend to change little in response to fire, although they due to tend to increase in areas where their prey thrives after burning.

Fire effects on Animal Populations
Reptiles and Amphibians

- Fire caused changes in plant species composition can have an influence on reptile and amphibian populations.
  - Amphibians in forested areas are closely tied to debris quantities which can take years to centuries to accumulate after sever fires
  - In other ecosystems changes in populations was highly dependent upon the needs of the individual species

Just like the other wildlife groups we have discussed changes in plant specie composition and density can have an influence on reptiles and amphibians. For forested lands there tends to be a link between debris quantities and amphibians, so post fire populations will be tied to the loss and subsequent accumulation of woody debris and litter. However in other ecosystems changes in population shave been found to be dependent upon the needs of the individual species. As an example reptiles that favored closed canopy chaparral sites tended to have a decrease in population size following fire, while species that preferred open stands tended to increase (Simovich, 1979). It should be noted that in either case the species were nto entirly eliminated from the site however.

Fire Effects on Wildlife Communities

- Community responses to fire:
  - Increasers pre-dominate
  - Decreasers predominate
  - Most populations change
  - Few populations change
  - Intermediate change

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Based on Rowes (1983) classification of plant responses to fire, Huff and Smith (2000) developed the following guidelines for the effects of fire on animal communities. Mean changes in abundance before and the first few years following a fire or in unburned versus burned areas can be classified into one of these six categories. Possible community response patterns using the six categories based on abundance.

Fire Effects on Wildlife Communities

- Response categories
  - Invader:
    - typically invaders are not detected before the fire and can be detected after the fire
  - Exploiter:
    - Typically detected before the fire and have an increase of 50% or more after the fire
  - Resister:
    - Detected before the fire and have a decrease of less than 50% after the fire
  - Endurer:
    - Detected before the fire and a greater than 50% decrease after the fire
  - Avoider:
    - Detected before the fire and not detected or has low population numbers after the fire
  - Vacillator
    - Shows wide fluctuations both before and after the fire (inconsistent)

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Fire Effects on Wildlife Communities

- Increasers predominate
  - Invaders and exploiters
- Decreasers predominate
  - Avoiders and endurers
- Most populations change
  - Proportion of invader and or exploiter responses and of avoider and or endurer responses
- Few populations change
  - High proportion of resister responses and a low proportion of other responses
- Intermediate change
  - A high proportion of resisters, endurer and exploiter responses with a low proportion on invader and avoider responses

Lets now return to look at the different community responses that were presented by Rome (1983) and modified by Huff and Smith (2000). The first class of community responses is when the increasers predominate. In this setting we will typically see an increase in the invader population and or exploiter populations.

The next community response we could see is the decreasers predominate. With this type of community response we will see an increase in the avoiders and endurers with in the area. The 3rd type of community response is that most populations will change. This type of community response consists of a proportion of invaders and exploiters as well as of avoiders and endurers. In other words it is a combination of the first two community responses. The forth type of community response is that few of the individual populations change. In this response type we see a high proportion of resisters and a low proportion of other responses. Last we can get a intermediate change within the community. In this response type we tend to see a high proportion of resisters, endurers and exploiters and a low proportion of invaders and avoiders.

Summary

- Most wildlife species present some strategy for survival of the fire front.
- Wildfire wildlife populations mostly through changes in food, and plant composition.
- Wildlife communities can respond in several ways depending upon the life traits of the individuals within the community and the changes in post fire plant structure and composition.