Welcome to next lecture in the class. During this week we will introduce the concepts of risk and hazard analysis and go over the processes that these analysts use and how this can relate to fire and fuels management. Before I begin I want to propose the idea that fires are naturally-occurring phenomena which benefit the ecosystem if they are similar to the historical fire regimes. Following this idea it is apparent that fires outside this historical range pose negative values to ecological resources.
So let's talk more about this idea. Risk is the chance that a fire might start, as affected by the nature and incidence of a causative agent. In other words, risk is referring to the ignition potential, which is the probability that a fire will start. The NFDRS classifies two types of fire risk: lightning-caused fires and man-caused fires. The total risk is calculated by adding together the risk of these two factors. With this definition the fire itself is the risk, and it is defined by a probability of ignition.
Fire hazard is the fuels complex, as defined by the volume, type, condition, arrangement and location, all of which determines the ease of ignition and the resistance to control. It is important to realize that this term is independent of weather. So the hazard is simply based on the fuels complex.

**More Terminology**

- Fire hazard – a fuel complex, defined by volume, type, condition, arrangement and location that determines the degree of ease of ignition and the resistance to control (NWCG 2003)
  - NOTE: this term is independent of weather conditions.
The fire severity on the other hand is the magnitude of significant negative impacts on wildland systems. This definition has nothing to do directly with the fire itself, only with the effects of the fire. Flame length, fire line intensity, etc. are properties of the risk (fire); they do not measure the severity of the risk. However, loss of soil material, mortality, etc. are indicators of the severity. These will be related to the risk and the hazard.
Earlier this semester we talked about the need to evaluate models in terms of the prediction process and use the term validation as this has a particular connotation associated with it. We now have reached the second terminology dispute of this class, which we should all be familiar with: characteristic vs. uncharacteristic wildfires. These terms are now being used instead of the typical catastrophic, large uncontrollable, or any other term you may have used or heard over the last 80 years. The basis for these terms comes from the concept of the historical natural fire regime. In your reading this week, Hardy stated that the term “fire regime” in this case is not an exact recreation of pre-settlement conditions, but rather it reflects the general fire frequencies and effects of an area in the absence of fire exclusion. With this in mind it is easy to see how describing fires as either characteristic or uncharacteristic removes the negative connotation and allows us to only view the fire in terms of the fire effects and not within the context of the social, economic and cultural values that often distort our opinion of fires.

<table>
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<th>A thought about characteristic and uncharacteristic wildfires</th>
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<td>• The need for new terms is due to the negative connotations of our current and past terminology which implied all fires were bad!</td>
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<tr>
<td>• Characteristic fires are fires which are similar to the historical fire regime for the area</td>
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<td>• Uncharacteristic fires are those which deviate significantly from the historical fire regime for the area</td>
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Now that we have covered several definitions let's define what risk analysis is. Risk analysis is a large field of study which includes risk assessment, risk management, and risk communication.
Risk assessment involves identifying the sources of risk, assessing the likelihood that the risk will occur and the consequences if it does occur.

- There are three steps in the risk assessment:
  - Hazard Identification
  - Determining the relationship between the risk and the hazard
  - Risk quantification
As we mentioned earlier in this class fire is the risk we are concerned with. I would like to further state that uncharacteristic fires are our primary concern. A side note is that in our definitions we purposely left out the social and political context of fire and only discussed the ecological risks. However, in many cases this is not possible, so the risk may simply be stated in terms of being able to control the fire. In these terms, the risk may become a crown fire or a fast-spreading surface fire in heavy fuels. It is important, however, that while we state what the risk is, we also need to be able to communicate why it is a risk.

So with either one of these definitions the next step is to identify the conditions which will allow an uncharacteristic fire to occur.
At this point many of you are probably asking yourself about this idea of ignition probability. I would like to make a quick note that this probability will change depending upon your time scale. That is, if we set our time scale at a long-enough time frame, then the ignition probability will be 100%. However, this is just the probability of ignition this does not take into account the probability of an uncharacteristic wildfire. To get this probability we need to assess the physical conditions which lead to this event such as fuels, weather, and topography, and develop a probability that this event will occur.
As I just mentioned one of the key steps to this process is to define the physical properties which will allow our risk to become a hazard. In many cases we can use fire behavior models such as NEXUS to help complete this portion of the analysis. For example, we could conduct a field inventory, input the data into NEXUS (or whatever model you like) and compute the set of conditions which will gives us uncharacteristic fire behavior. Note that in this process the only variable which changes is the weather (assuming we do not alter the fuels). So we hold fuels and topography constant and identify the weather which will allow for a uncharacteristic fire to occur.
The use of such models will help us quantify the risk. In this part of the process, we can generate probabilities for the uncharacteristic event occurring. Let’s go over an example.

If we set our time frame to a long period, then we know the probability of ignition is 100%. We then run some fire behavior models and calculate the weather conditions that allow for an uncharacteristic wildfire. We now can use long-term weather data to estimate the number of days on average per year that the weather conditions exceed this amount. In our example, we find that throughout the year there are typically only 20% of the days which will allow a fire to become uncharacteristic. Therefore, we can say there is a 20% chance that a hazard will occur in this stand for a given year. This probability is constrained by the fuels in the stand as well as the weather conditions, our understanding of the system, etc. We could do this for many stands to help identify those stands which need treatment, or we could do this for a pre- and post-treatment to quantify the effect of the treatment on fire hazard within the stand (note that so far we have only talked about stand level concepts).
Now that we have quantified the risk, we can begin to manage for it. In fire management, the goal then becomes to reduce hazardous fuels so that an uncharacteristic event will not occur. A quick note is that all wildland systems share risk: that is they can be the source of risk, they can transmit risk or they can accept risk. That is fire can start in our stand (source of risk), it can spread from our stand (transmit risk), or fire can spread into our stand (accept the risk).
Due to this idea we ultimately have two goals; prevent uncharacteristic fire from starting in a stand and prevent it from spreading into and from a stand. To truly reduce the risk we must apply these two goals to the area of concern as well as to the neighbors.
The next step in risk management is identifying the values at risk. Not only do we need to identify what these values are, but we also need to evaluate the effects of an uncharacteristic fire on these values. Examples of values at risk might be wildlife habitat, soil integrity, water quality, timber resources, etc. Identifying these values and understanding the effects that an uncharacteristic event might have on these values will aid in the development of alternatives as well as in selecting the best locations for implementation of treatments. For example, a stand might have a high risk of experiencing an uncharacteristic wildfire, but it might not pose any risk to the values we are concerned with.
One of the things in the readings that I wanted to discuss was developing the project size. Based on the fire history of the area you could develop estimates of the size of uncharacteristic fires and then use this in designing treatments which will indeed affect this fire. Your readings suggest that a fuels treatment project should encompass an area 2 to 4 times larger than the expected fire area. However, this can be managed as a set of small treatment areas instead of one big treatment area (see work by Mark Finney).
Locating Your Projects

- Projects are generally recommended in areas where:
  - The risk to resources and hazardous fuels are both high
  - Important values will be protected from long-term harm
  - Available management options are well known and proven to be affective
  - Altering an area of high hazard decouples two or more larger areas
  - The area is large enough or in an arrangement such that a high opportunity exists to affect an uncharacteristic wildfire

Despite some research suggesting that treatments can be placed randomly if enough are done, it is also noted that targeting specific areas can greatly reduce the amount of acreage that needs to be treated. Specifically, treatments should be placed where the risk to resources is high and hazardous conditions exist, in areas where important values will be protected from long term harm, in areas where available management options are well known and proven to be affective, in areas large enough or in an arrangement such that a high opportunity exists to affect an uncharacteristic wildfire and in areas where altering the fuels will decouple two or more areas with a high hazard.
Let’s go over a quick example of how to estimate the effectiveness of a treatment. In this example we will look at how the treatment will affect fire transition. First we will develop a graph which show the percentage of days in our time frame where the wind speed is slower than any given wind speed (example is on the next slide). Then we will estimate the required wind speed for fire initiation, and the required wind speed for crown fire spread. From where this line intersects with our curve, we will draw a line down to the x axis to identify the % of days that have a wind speed below that of our initiation wind speed. Using this same approach, we will find the % of days that have a wind speed below that required for crown fire spread. If we subtract these two percentages, we would have the relative effect of the treatment on these stands.
Here is an example of the graph I just described. This graph can be used to answer both questions we are looking at: that is, what is the probability of crown fire starting? (based on torching index) and what is the probability of crown fire spread? (based on crowning index).
For this last part I will summarize a paper by Fischhoff (1995). This paper discusses the stages of risk communication (it is a good read and I recommend it). In this paper it is suggested that we basically go through 7 progressions of communicating risk.

**Risk Communication**

- Developmental stages in risk communication (Fischhoff 1995):
  - “All we have to do is...”
    - get the numbers right
    - tell them the numbers
    - explain what we mean by the numbers
    - show them that they have accepted something similar in the past
    - treat them nicely
    - make them partners
    - All of the above!
The first step in the communication process is typically figuring out that all we have to do is get the numbers right. This step basically revolves around all the analysis that we have been talking about and assumes that there is no need to involve the public if we get the numbers right. In other words, we do our analysis in private and have no intention of involving others. This approach can often get communications off on the wrong foot very quickly and could severely hinder the process.
Typically we evolve from the first step fairly quickly and realize that we are not trusted enough to do our work in private, so we respond by simply handing over our numbers. In this step, we are hoping that the numbers tell a good story which is based in part on how well we did step one (getting the numbers right). Unfortunately, rarely do our numbers paint a clear and decisive picture on their own. Although there is something forthright about sharing our numbers, it is likely to be seen as a reflection of the distance between the analysts and the audience. This leads the audience to assume we are out of touch and can undermine the credibility of the process and of the analysts. Not only can this be an issue, but further credibility issues can occur if the numbers just do not make sense. Part of the issue here is that the assumptions must be stated and clearly reported so that the audience does not make their own assumptions about the numbers.
Due to the fact that the numbers rarely speak for themselves, we often decide we need to explain the numbers. This relates to the full disclosure tip we have read and talked about in this class. Now that I have emphasized being open and honest about the prediction process, I want to take a few minutes to talk about how this can go bad.

Attempting full disclosure can lead to technical difficulties, the least of which is a large unprepared audience. For example, people who have only previously heard confident-sounding experts could misinterpret an explicit expression of uncertainty as an admission that we are completely confused. As a result, those of us who do come clean may get a mixed reception as a transition period takes place. In such cases, we should focus on only the numbers which really matter and not discuss numbers that people do not need to know. One approach to help facilitate this transition period is to use mental models.
Here is an example of a mental model I use in several classes where I need to talk about fire behavior. In this case I ask the students to list the variables they think may effect fire transition and crown fire spread. We begin with an open discussion about how these variables affect the predicted variable, and end with a talk about how we can measure these variables. This helps me quickly inform the students about how the model is working without going over complicated mathematics, showing equations, etc.

This approach can be used in many situations and I oftentimes find it valuable to explain complex interactions or math.
After we explain the numbers we tend to show the audience that they have accepted similar risks in the past. Although this can be very useful, it can backfire, especially when our comparisons are chosen for rhetoric purposes. For example a common statement might be that the risk of x is no greater than the risk of y, where we want them to do x and they already are doing y.

Mentally we often assume people want no risk involved at this stage of development, since they will not accept some small amount of risk we are proposing. For example, since group A is opposing our treatment, they must be against any treatment. However many times we are misperceiving this action, and instead the audience is not against taking a risk - they just do not want to accept this risk. Although, this is not true in every case, as there are people out there who do make a living in this arena.
One of the next stages is to feel that if we just treat them nice they will listen. Although most people do want to be treated nice, we must do this long before this stage of development. The first impression we make will often make or break the communication process. One of the primary responses to this stage is to provide training in communications, typically in written and oral communication.
Here are just a few blunders I often see which may help out. A lack of an overview and summary section, no obvious logical order, for example a 14-page paper with no headings is not fun to read through. The use of technical or condescending language can limit the communication process. A poor display of information is another blunder. With oral communication we have other difficulties to deal with such as nonverbal cues (body language) and nervousness. Both of these can limit effective communication.
Now to quickly go through the last communication development stage. In this stage we feel like if we make them partners this will help. Oftentimes just asking them will establish a healthy communication process. We should consider this as soon as possible, as it shows that we have an interest in what they think without them causing trouble. One effective way to do this is provide outreach to the public. For example, you could have field trips, provide educational classes or materials, etc.

The point is, for effective communication, we need to do all these steps.
As we end this lecture I want to leave with two quick summary statements. First, the field of risk analysis is a viable way for us to account for uncertainties and provide some openness to what we have done and what our results mean.

- Although, it does lead to several other issues.
- The risk communication stages can provide guidance on effectively communicating which is one of the six tips we talked about earlier in the class.

I also want to leave you with thinking about communications and how we can communicate more effectively.