Wildfires

Wildfires

- wildfire dates to the time when trees first evolved 350 million years ago
- many fires start naturally as a result of lightning or lava from volcanic eruptions
- after a fire, vegetation completes a cycle from early colonizing plants to mature ecosystem
- wildfire moves through ecosystem and cleanses it, and new ecosystem that moves through after fire is different b/c it's a diff climate
- the ecosystem that evolves adapts to the climate at that particular location and time
- the ecosystem responds, regenerates, and adapts to new climate whether it be warmer, drier, etc.

Adaptation to Wildfires

- many species have evolved to withstand fire or promote the life of the species after a fire event
- examples:
    - oak and redwood trees have bark that resists fire damage – how they get to be so old, b/c they're resistant
    - some pines trees (smaller coniferous trees) have seeds that only open after a fire, at a certain temp fire causes cone to spread open and seeds fall down so they can grow after the fire

Wildfires Through History

- the geologic record shows an increase in the amount of charcoal in sediment approximately 10,000 years ago
- this suggests high amounts of wildfire activity at the time
- why might there have been more fire activity?
- A warmer and/or drier climate (relationship btwn the two)
- Increased use of fire by humans for clearing land and for heat, cooking, etc.

Elements of Wildfires

- wildfire requires three elements: fuel, oxygen, and heat. If any of these are lost, the fire will dissipate
- plants accumulate carbon dioxide and store carbon in their tissues
- during a wildfire, this carbon dioxide is released back into the atmosphere
- wildfire in the grand scheme won't affect climate or lead to climate change
- there are 3 phases to a wildfire: pre-ignition, combustion, and extinction

Pre-Ignition Phase

- **pre-heating**

- during this phase, vegetation reaches a temperature at which it can ignite
- as vegetation is heated, it often loses water – almost completely devoid of water b/c very dry time

- **pyrolysis**
  - this is a chemical process describing the degradation of large hydrocarbon molecules into smaller ones
  - aids in the possibility of a wildfire starting after ignition
  - this process occurs in the presence of nearby het (ie. From heat radiating off of nearbly flames)
  - explains how fire is able to sustain itself simply from the heat of flames nearby, pre-heating vegetation which allows fire to spread to them

Combustion Phase

- the two processes of pre-heating and pyrolysis result in fuel that is prone to ignite
- the combustion phase begins with ignition
- ignition is not a single process, it can occur repeatedly as the fire moves
- not all ignitions will result in a wildfire (the vegetation must be really dry, usually a month of no precipitation)

Types of Combustion

- flaming combustion is the rapid, high temperature conversion of fuel into heat
- it is characterized by flames and large amounts of unburned material
- smoldering combustion
  - flames are preheating fuel which dries the vegetation out fast so fire will spread to that region
  - occurs in an area with burned material and ash that covers new fuel
  - on the left side, we've removed the fuel so fire eventually goes out so fire moves to right where vegetation has been preheated by nearby flames

Transfers of Heat

- as a wildfire moves across the land, three processes control the transfer of heat
  - conduction: transfer of heat by molecule to molecule contact
  - radiation: transfer of ehat in the form of invisible waves
  - convection: transfer of heat by movement of a liquid or a gas

Transfer of Heat by Wildfires

- in wildfires, heat transfer is mainly by radiation and convection
- heat from radiation increases the surface temperature of the fuel

- as air is heated, it becomes less dense and rises
- the rising air removes heat from the zone of flaming and it is replaced by fresh air
- rises – we have replacement air coming in which is bad because it's oxygen
- this fresh air (oxygen) comes in and sustains the combustion

Extinction Phase

- this is the time when combustion has ceased
- there is no longer sufficient heat or fuel to sustain fire (eg. Cold winter months)

Fuel

- types of fuel include leaves, woody debris, decaying organic material, grasses, shrubs, etc.
- if diseases or storms down large numbers of trees, the decaying material dries and burns easily
- the density of the forest plays a role:
- in western North America, dense boreal forests contain abundant fuel supply

Topography

- the fuel content can vary by slope orientation (direction you're facing.. N/E/S/W)
- In the Northern Hemospehre, south-facing slopes are facing the sun in the afternoon (sun is in the south sky in the aftn, never in the northern sky), so are realtively warm and dry
- Slopes exposed to/facing prevailing winds are often drier
- In north america, prevailing winds are from the west (jet stream goes W E)
- West-facing slopes are higher risk.
- SOUTHWEST SLOPES are highest risk
- wildfires burning on steep slopes preheat fuel upslope from the flames
- this results in the spreading of a fire upslope

Weather

- large wildfires are common following droughts
- 'dry thunderstorms' with lightning can produce wildfires but so dry that the rain evaporates before reaching the ground
- wind can help preheat unburned materials
- wild carries embers (like sparks in a campfire) that can ignite **spot fires** ahead of the fire front (boundary of a fire)

Types of Fires

- wildfires are classified according to the layer of fuel that is allowing the fire to spread: surface or crown
- **surface fires** travel close to the ground and burn shrubs, leaves, twigs, grass, etc.; stays on floor of forest

  - they vary in intensity but most move relatively slowly
  - so much fuel to burn through before they move along so they're slower
- **crown fires** move rapidly through the forest canopy by flaming combustion
  - they are driven by strong winds and common in boreal forests
  - they can be fed by surface fires that move up limbs or tree trunks, or they may spread independently of surface fires
  - they could spread without any relationship to surface fires b/c they can blow from one tree to another tree via tops of trees, winds can take care of that

Crown Fires

- intermittent crown fires consume the tops of some trees in an area
- continuous crown fires consume the tops of all trees
- wind plays a huge role here

Regions at Risk

- in Canada, the hazard is greatest in BC and in the boreal forests of the Canadian Shield covers norther part of almost every promise (except maritimes)
- the geographic region most at risk changes annually with the weather and corresponds to areas experiencing drought – might be in alberta one year, quebec another.. drought naturally moves around

Effects of Wildfires

- fires that burn soil may leave behind a hydrophobic layer at the surface
- water cannot get through hydrophobic layer of ash
- this layer is caused by the accumulation of chemical from burning vegetation
- this layer increase surface runoff and erosion
- it may persist for several years following a fire
- tiny particles, particulates, can persist for weeks in the atmosphere and can blow hundreds/thousands of km
- increases of airborne particles and haze can be observed thousands of km downwind of large fires
- wildfires increases the amount of particulates in the atmosphere and thes can persist for weeks

Linkages to Climate Change

- climate change may increase the intensity of wildfires
- climate change affects both temperature and precipitation, and can lead to severe droughts
- in some parts of the world, grasslands will replace forests. Current areas of forest will expand poleward
- insect infestations can cause disease throughout a forest making it more vulnerable to wildfire

Forest Fires in Canada

- all across Canadian shield we expect more in wildfires because in summer times those regions are drier with climate change

Mountain Pine Beetle

- the beetle has destroyed forests throughout western Canada
- currently, 80% of mature mountain pines are impacted
- the consequences will be felt for deacdes in BC
- the beetle is posing a threat to Alberta's pine forests and Jackpine stands of Canada's boreal forest lands
- with warmer temperatures, the beetle has been able to survive through the winter in BC
- this is spreading, crossed border of Rocky Mountains and affecting another species
- size of a grain of rice
- all attacking valleys and forestlands
- warmer temperaturs are not killing these off like they use to, temps are not dropping below zero at night to kill them off
- past two winters in BC have been very warm so it doesn't help kill them

Impacts of Wildfire

- fires can lead to evacuations of entire towns, road and airport closures, and severe property loss
- in North America, organized evacuations have minimized the amount of deaths
- exposure to smoke and haze can affect the ocular and respiratory systems

Impacts on Animals

- most animals are able to escape fires unharmed
- rodents can take refuge underground and larger animals can outrun the fire
- fires can produce open areas suited for grazing mammals thus acting as a natural service function
- aquatic species may be impacted by increased sedimentation from runoff and erosion

Natural Service Functions

- wildfire temporarily reduces competition for sunlight and moisture in a forest
- before the leaves were intercepting that but now they're not
- it allows both surviving and new species to thrive by allowing sunlight to reach the forest floor opened up floor to sunshine and moisture
- in some species, it triggers the release of seeds or stimulates flowering
- lodgepole pine, aspen, and fireweed are examples of **p**ioneer vegetation that grow quickly after a fire
- **pioneer vegetation**: the first plant species to appear after a wildfire

- fires can remove micro-organisms in the soil, some of which are parasites or carry diseases
- fires remove surface litter (leaves, etc) and allows more moisture to infiltrate the soil
- fires remove weak or diseased trees and can limit the spread of beetle infestations

Yellowstone National Park Wildfire

- a series of lightning strikes caused 50 fires in the park in 1988
- park officials have a policy that allows naturally caused fires to burn
- if fire was caused by smoking, careless burning, etc or something not natural they'll stop it
- this became controversial as hot, dry weather that summer allowed the fires to spread and merge
- officials responded to political pressure and eventually called in nearly 10,000 firefighters
- the fires were beyond control of the crews and burned for several months
- it is believed that the fire became uncontrollable because many years of fire-suppression policies in the past had allowed fuel amounts in the park to reach dangerous levels
- the fires of 1988 revitalized ecosystems in the park
- officials remain committed to the natural-burn policy today; this is a common policy in national parks

Fire Management

- the objective is to control wildfires for the benefit of ecosystems while preventing them from harming people and destroying property
- in Canada, the fire season is from April to Oct, and is managed by provincial and territorial governments (short season b/c of our climate)
- every region has an agency responsible for fire management
- good management requires research of the **fire regime** of an area
- fire regime: the potential for wildfire in an area (potential based on weather, slope, topography, wind, lightning, drought, fuel, etc.. everything)
- satellite imagery is providing insights on fire potential in remote areas

Fire Suppression

- a strategy in fire suppression is to steer the fire into an area with no fuel (called a **fire break**)
- examples of fire breaks include river, lakes, roads, etc.
- fire break: features where the fire can't spread across; it slows it down
- if a natural fire break does not exist, an artificial break can be created by bulldozers clearing land
- reliance on fire suppression has led to a build-up of fuel in forests and a potential for intense fires

Prescribed Burns

- one way to counter the build-up of fuel is through the use of prescribed burns

- these are controlled fires that are purposely ignited to reduce the amount of fuel in an area
- difficulties relate to predicting the amount of fuel and the weather conditions under which the fire can be safely controlled

Perception of the Wildfire Hazard

- population growth in areas that are prone to wildfires has increased the risk to public safety
- since 2000, over 50,000people have moved to locations in California considered high-risk areas due to wildfires and are willing to pay insurance just to live there