COURSE OBJECTIVES:

1. Students will demonstrate an understanding of fire as an ecological process using the concepts of fire regimes and first order fire effects at multiple scales.
2. Given an altered fire regime and a variety of socio-political issues and resource concerns, the student will be able to identify realistic management solutions in an adaptive management framework.
3. Students will be able to communicate effectively with fire and resource professionals based on a common understanding of first order fire effects.
4. Students will be able to demonstrate an understanding of how fire management related resource issues interact.
5. Discuss how to manipulate fire treatments to achieve desired first order fire effects.

UNIT LESSON PLAN

RX-310, INTRODUCTION TO FIRE EFFECTS

INSTRUCTOR: Dr. Lauren F. Howard

LESSON: Fire Ecology Overview

UNIT: Unit 1

OBJECTIVES:

Upon completion of this lesson, participants will be able to:

1. **Describe Basic Ecological Concepts**
2. **Identify how fire and other disturbances function within and across ecosystems**
3. **Describe how historical fire practices have influenced fire regimes**
4. **Describe the classification of fire regimes in North America**

NARRATIVE:

I. INTRODUCTION

A. Welcome, Introduce Myself
B. Learning Goals for the Unit
C. Outline of the Unit

II. ECOLOGICAL CONCEPTS

A. Key Definitions
   1. Community - a group of populations of species living together in the same place at the same time
   2. Biological Diversity - the variety of living things in the community. Can be measured in different ways: richness, evenness, combined
   3. Ecosystem - the biological community plus its abiotic environment, including soils, sunlight, etc.

B. Niche & Life History Theory for plants
   1. Niche idea - range of resources and conditions that a species can persist in indefinitely
   2. Life History traits - features of organisms that help them live in their environments and reproduce successfully. Examples: reproductive rate, shade tolerance, predator resistance, dispersal ability, fire resistance
   3. Trade-Offs - idea that no species can be a jack of all trades and master of all of them. Life energy must be divided among traits and activities, just like money in a budget. Thus, a specialist in one area has weaknesses in others.

C. Succession
   1. Definition: a directional replacement process of species (change in species composition) over time.
   2. Time Scale - hundreds of years for forests, just a few years with algae colonizing rocks or fungi breaking down logs
   3. Climax Community idea - that the strongest competitors (the most shade tolerant) will eventually dominate and create a self-replacing community
   4. Factors that affect succession: competition, predation, species available, resource levels, abiotic conditions, historical events, disturbances
   5. In forests, what are some key trade-offs in the life history traits of early-successional vs. late-successional trees?
      A. Discussion

D. Disturbance
   1. Definition - events that cause mortality to individuals or parts of individuals (like trees)
   2. Frequency vs. Intensity and Size - inverse relationship where intense or large events occur less frequently than mild, small events.
      A. Frequency - how often a disturbance returns to the same place (For example, Cutting Cycle or Mean Fire Interval)
      B. Intensity - how destructive the disturbance is, often measured in % of biomass killed
      C. Size - amount of landscape affected (for example, acres burned)

3. Heterogeneity & Landscape - Disturbances (especially fire) are rarely uniform in intensity and frequency across the landscape, creating a disturbance patchwork over time and space.
4. Human vs. “Natural” disturbance regimes - what are some key differences?
   D. Discussion
5. How can a disturbance affect plant succession?
   E. Discussion

III. FIRE IN ECOSYSTEMS

A. Types of fires
   1. Surface - moves along the ground surface, consumes leaf litter, some duff, understory vegetation. Kills seedlings and above-ground portions of saplings but may not kill adult trees.
   2. Canopy - above-ground, stand-replacing fire. Kills all trees, consumes more leaf litter and duff than a surface fire, but does not kill all dormant seeds in the soil or resprouting species with deep roots.
   3. Ground - below-ground fire that consumes all leaf litter and duff, sterilizing the soil. It will kill all trees and seeds in the soil seed bank, as well as beneficial mycorrhizal fungi. Most intense form of fire.

B. Characteristics of Fire
   1. Frequency - Fire Return Interval (or Mean Fire Interval): number of years between fires. Depends on habitat type. Community type with high MFI? What kind of vegetation? Low MFI? Corresponding vegetation?
   2. Intensity/Severity - Canopy and Ground fires cause the highest % mortality, so they are the most intense. Some folks equate heat with intensity and mortality with severity, and others use the terms interchangeably.
   3. Size - acres burned. Large fires are often more intense but not necessarily so.
   4. Seasonality - when during the year a fire occurs
      a. Dormant season (leaves of deciduous species off) - driest conditions, fairly hot fires
      b. Spring fires (new leaves just out) - wetter conditions and new succulent vegetation reduces flammability and heat, but fires in spring can be fairly intense because they eliminate the investment the plants just put towards new leaves
      c. Fall and summer fires - hotter, drier conditions during drought years lead to hotter fires that can be fairly intense.

C. Factors that influence fire
   1. Fuel Load - amount of dry, dead material that can burn - increases intensity
   2. Moisture - the wetness locked up in living leaves and leaf litter - decreases heat
   3. Wind - increases flame lengths, fire spread, heat
   4. Topography - may increase or decrease spread of fires and intensity in certain locations.
   5. Ignition Source - how the fire got started (lightning, drip torch, etc.)
   6. Stand Architecture - Out west, "ladder trees" may facilitate transfer of a surface fire to the canopy. Overmature mountain laurel might do the same in PA. Very dense laurel may actually retard fire (lack of oxygen).

7. Flammability of Vegetation - some species are more flammable than others. Examples?

D. Effects of Fire
   1. Short Term
      a. Mortality - may not be immediate, but may occur within a few years.
      b. Changes in Stand Structure - gap formation, coarse woody debris, snags.
      c. Changes in Stand Composition - Certain species are more likely to survive and benefit from a fire. Examples?
   2. Successional Time Scale
      a. Species Composition - more early-successional (shade-intolerant, good dispersers) and fire-tolerant species (resistant to fire, or resprouters). More animals dependent on these habitat types will be present.
      b. Diversity - Increases in landscape heterogeneity often correlate with higher biodiversity (plant and animal).
      c. Landscape dynamics - stand-replacing events can reset plant succession to an earlier stage. Dispersal and colonization is Important.
   3. Evolutionary Time Scale
      a. Adaptations to fire can occur (example: cone serotiny in the central NJ pine plains)

IV. HISTORICAL FIRE REGIMES

A. Why is it important to understand historic fire regimes if you are a fire manager?
   1. Discussion

B. How do we study and characterize historic fire regimes?
   1. Written records of fire
      a. Literary sources such as journals & newspapers
      b. Colonial Land Surveys
      c. Pros/Cons?
   2. Pollen and Charcoal in Lakes & Bogs
      a. Methodology
      b. Pros/Cons?
   3. Dendrochronology
      a. Fire Scars & Tree Ring Analysis
      b. Pros/Cons?

C. Pre-European Settlement (<1620's)
   1. Native Americans
      a. N.A. uses of fire - hunting tool, clearing farmland, facilitate travel, encourage blueberries, discourage snakes, communication over long distances, heating homes in winter, cooking food
      b. geographic locations - coastal & river valley had the highest populations
      c. seasonality, frequency, intensity - most pre-European settlement fires in the Appalachians were dormant season burns
      d. MFI of less than 15 years in oak and pine dominated forests
      e. effects on vegetation - encourage fire-adapted oaks and pines, as well as grasslands and savannahs were fire was frequent enough

f. genocide of N.A.’s - through disease (>90% mortality) and war with Europeans altered fire regimes that N.A.'s had practiced for 1000's of years.

2. Other Ignition Sources
   a. lightning (not as common in the Appalachians as other places (like out west or down south), but still an important source of ignition.

D. Post-European Settlement (1620’s-1920’s)
   1. Agricultural Clearance - fire was used to clear farmland and maintain pastures, and often burned into adjacent forests - MFI similar compared to pre-settlement
   2. Charcoal Iron Industry - major source of fire in the late 1700's to early 1800's before anthracite coal was used widely - decreased MFI in areas near iron furnaces
   3. Railroads & Clearcut Logging - logging slash and sparks from steam engines burned over 90% of the Appalachian wilderness between 1880 and 1920 - decreased MFI, also increased number of large fires
   4. Extinction of Passenger Pigeon - a species that created coarse woody debris in large flocks, as well as selectively favored white oak reproduction - probably lengthened MFI

E. Fire Suppression Era (1920’s-2000’s)
   1. Firefighting Technology - trucks, air power, system of fire towers to spot and triangulate ignitions so that fires could be extinguised - lengthened MFI
   2. Social Awareness - Smokey the Bear and Bambi - fire is bad and destructive
   3. Effects on seasonality, frequency, intensity - eliminated majority of fire except in the most dry years
   4. Effects on succession, mesophication - replacement of fire adapted species with shade tolerant species, increase in leaf litter and moisture content in some forests. Increases in fuels and fire potential in others (especially out west).

F. Introduction of Controlled Burning (present-day)
   1. Silvicultural objectives - favor regeneration of commercially valuable, fire-adapted species (especially oak)
   2. Game and nongame management - increase in oak mast (acorns) as food sources for wildlife, increases in early successional thicket habitat for rare species that require it
   3. Seasonality, frequency, intensity - many controlled burns are spring burns (as opposed to dormant season burns historically). Easier to control. Frequency and usage is still longer MFI than historical levels due to limitations in people power, resources, and political capital
   4. Social challenges - many people still remember Smokey, Bambi, oppose fire
   5. Deer herbivory challenges - hard to regenerate oaks if too many deer eat seedlings and acorns
   6. Invasive species challenges - potential competition for seedlings and saplings of desirable native species.
   7. Changing Climate challenges - increased temperature, increased precipitation in our area (but with majority of precipitation in large events) may mean more droughts and potentially more fires.

8. Adaptive management, science, and monitoring - always trying to learn more and do better, using the scientific method and the practical experience of boots-on-the-ground managers.

V. CLASSIFICATION OF FIRE REGIMES

A. Fire Regime Definition: A generalized description of fire's role in an ecosystem, characterized by fire frequency, seasonality, intensity, duration and scale (patch size), as well as regularity or variability.

B. Groups I-V (Fire Regime Condition Class)
   1. Summary Table

Fire Regime Group	Fire Frequency	Fire Severity	Percent of (Conterminous) Federal Lands
I	0-35 years	Low severity	31%
II	0-35 years	Stand destroying	13%
III	35-100+ years	Mixed severity	36%
IV	35-100+ years	Stand destroying	14%
V	> 200 years	Stand destroying	6%

Fire Regime Groups; All generally <40 ha (100 ac) in size
(Adapted from Dana Cohen's descriptions as applied to western forests)
http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5435658.pdf

2. Group I
   - 0-35 Years, Low Severity
   - Open forest or savannah structures maintained by frequent fire
   - Also includes frequent mixed severity fires that create a mosaic of different age post-fire open forest, early to mid-successional forest structural stages, and shrub or herb dominated patches
   - Large stand-destroying fire can occur but are rare events (i.e. every 200+ years)
   - Pitch pine-scrub oak barrens

3. Group II
   - 0-35 Years, Stand-Destroying, Non-Forest
   - Shrub or grasslands maintained by frequent fire (typical return intervals of 10-25 years)
   - Fires kill non-sprouting shrubs such as sagebrush which tend to regenerate & dominate within 10-15 yrs
   - Fires top-kill sprouting shrubs, which tend to resprout & dominate
   - Prairie / Grassland

4. Group III
   - 35-100+ Years, Mixed Severity
   - Heterogeneous landscapes maintained or cycled by infrequent fire

- Mosaic of different age post-fire open forest, early to mid-successional forest structural stages, and shrub or herb dominated patches
- Large, stand-destroying fires may occur, usually rare events
- Pine-Oak forest

5. Group IV
   - 35-100+ Years, Stand-Destroying
   - Large patches of similar age post-fire shrub or herb dominated structures, or early to mid-successional forest cycled by infrequent fire
   - Some pine forests

6. Group V
   - >100 years, Stand-Destroying
   - Large patches of similar age post-fire shrub or herb dominated structures, or early to mid to late successional forest cycled by infrequent fire
   - Occurs at environmental extremes where natural ignitions are rare or environmental conditions rarely result in large fires
   - Northern Hardwoods, Hemlock
   - Sites tend to be very cold, very hot, very wet, very dry or some combination of these conditions

C. Fire Regime Caution: The Natural Fire Regimes of the past are not the regimes of the present, nor will they be the regimes of the future. (Agee 1998)

Fire Regimes of the Coterminous United States / Northeast
http://www.fs.fed.us/database/feis/fire_regime_table/PNVG_fire_regime_table.html
Based on LANDFIRE rapid vegetation assessment models
Compiled by Janet L. Fryer and Peggy S. Luensmann in February 2012

*Fire Severities—
Replacement: Any fire that causes greater than 75% top removal of a vegetation-fuel type, resulting in general replacement of existing vegetation; may or may not cause a lethal effect on the plants.
Mixed: Any fire burning more than 5% of an area that does not qualify as a replacement, surface, or low-severity fire; includes mosaic and other fires that are intermediate in effects.
Surface or low: Any fire that causes less than 25% upper layer replacement and/or removal in a vegetation-fuel class but burns 5% or more of the area

		Fire Regime Characteristics		
Community Type	**Fire Severity***	**Percent of Fires**	**MFI**	**Min-Max FI**
Pine Barrens	Replacement	10%	78	
	Mixed	25%	32	
	Surface or Low	65%	12	
Oak-Pine Woodland	Replacement	4%	185	
	Mixed	7%	110	

	Surface or Low	90%	8	
Appalachian Oak Forest	Replacement	2%	625	500-1000+
	Mixed	6%	250	200-500
	Surface or Low	92%	15	7-26
Northern Hardwood Forest	Replacement	39%	1000+	
	Mixed	61%	650	
	Surface or Low	0%		

(Selected community types… more are available online)