Disturbance Ecology
Objectives

• 1. Describe the major types of ecological disturbances and how they influence site potential, productivity, and sustainability.

• 2. Describe the role of disturbance in ecosystem structure and function.

• 3. Discuss disturbance theories and concepts.

• 4. Describe disturbance regimes that influence Utah and Great Basin ecosystems.
What is Disturbance?

• Definition

• Types

• Spatial and temporal considerations

• Ecosystem wide effects
Disturbance regimes

• Fire
• Flood
• Avalanche
• Slash and burn agriculture
• Timber harvest
• Ranching and Agriculture
• Development
• results - biodiversity crisis
<table>
<thead>
<tr>
<th>Factor</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of Disturbance:</strong></td>
<td></td>
</tr>
<tr>
<td>Physical factor</td>
<td>Drought impact on distribution of birds in forest</td>
</tr>
<tr>
<td>Biological factor</td>
<td>Mountain pine beetle</td>
</tr>
<tr>
<td>Interaction of physical</td>
<td>Rain and bird distribution affect of fish population</td>
</tr>
<tr>
<td>Anthropogenic disturbance</td>
<td></td>
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</tbody>
</table>
# Regime of Disturbance:

<table>
<thead>
<tr>
<th>Spatial dimension</th>
<th>Frequency</th>
<th>Time of occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial</td>
<td>Annual vs. irregular</td>
<td>Food during spawning period of fish</td>
</tr>
</tbody>
</table>
Concepts
Equilibrium vs. Non-equilibrium forces influencing community structure

**Equilibrium:**
- stability, climax community
  - Competition
  - Predation
  - Other species interactions

**Non-equilibrium:**
- communities constantly changing
  - Disturbances
  - Recruitment
The **Intermediate Disturbance Hypothesis (IDH)** states that local species diversity is maximized when ecological disturbance is neither too rare nor too frequent.

![Graph showing the intermediate disturbance hypothesis. The greatest biological diversity is expected to occur at intermediate levels of disturbance. Modified from Connell 1978.](image-url)
• Disturbance and land management

• Consequences of altered disturbance regimes

• Ecological restoration
Forest Disturbance
Characteristics of Disturbance Regimes

- Type
- Frequency
- Magnitude
- Predictability
- Extent
- Timing
- Synergism
- Severity
Disturbance Regimes

- Agent (fire, insects, disease, climate change, invasive species)
- Scale (tree, stand, landscape)
- Severity
- Pattern
- Seasonality
- Frequency
- Interactions of multiple agents
What is Ecological Succession?

- Typically refers to vegetation... (but fauna changes in response to succession)
- A process of more-or-less predictable and orderly changes in composition or structure of an ecological community
Secondary succession takes place following a major disturbance (e.g. fire, flood, landslide, agriculture).
Succession after fire

Why wouldn’t this lead to a climax community? (where plant community is stable and unchanging)

Is constant change natural?
Pattern on landscape

- Fires
- Beetle outbreaks
- Timber harvest
- Avalanche
Management Issues
Fire Behavior in Bark Beetle-Affected Fuels
Shifting Ecotones

Images courtesy C. Stockdale
ASPEN DIEBACK...
Change Detection on Mountain meadows -- Oregon

Fig. 5. Example of Landsat composites, forest cover mapping and change detection results (Arkhangelskaya Obl, 63°40’N, 42°30’E).
A—Circa 2000 Landsat composite (band 5-4-3 combination); B—Circa 2005 Landsat composite; C—Classification results: forest cover for year 2000 (green), gross forest cover loss (red), non forest areas (yellow).
MOUNTAIN PINE BEETLE LIFE CYCLE

- **attacking adult**
- **egg**
- **larva**
- **larva**
- **pupa**
- **brood adult**

**Seasons:**
- **summer**
- **fall**
- **over winter**
- **spring**
- **summer**

**Color Changes:**
- **Green Infested**
- **Yellow**
- **Red**
FIRE SUPPRESSION CONSIDERATIONS IN BARK BEETLE-AFFECTED FUELS (CONT.)

- Increased fireline construction time
  - Snag mitigation
  - Downed wood fuel
  - Increased burnout times increase threat to firelines
  - Increased retardant for adequate coverage
  - Increased time for mop up
Ecosystem Dynamics & Disturbance: Above- & Below- Ground Linkages

Overstory

Understory

Below-ground
Figure 1. Recent mortality of major western conifer biomes to bark beetles. (a) Map of western North America showing regions of major eruptions by three species. (b) Sizes of conifer biome area affected by these three species over time. Data are from the Canadian Forest Service, the British Columbia Ministry of Forests and Range, and the US Forest Service.
Mountain Pine Beetle (MPB)  
*Dendroctonus ponderosae*

- Native bark beetle
- Mutualism with ophiostomoid “blue stain” fungi
- Kills trees by girdling them – mass attack
- 97.5% mortality to maintain static population
- “Most damaging biotic disturbance agent in mature lodgepole pine in western Canada” (Kurz 2008)
- Climate change: Forests changing from sinks → large net C sources
MPB’s Moving Target: Alberta

- Not endemic to most of Alberta
- Former climatically-hostile environments => not so hostile!
- Lots of habitat suitability (41% forest = pine)
- => huge ecological (and social and economic) impacts

Pine beetles continue to devastate boreal forest

By Aaron Hinks, Grande Prairie Daily Herald Tribune
Sunday, September 9, 2012 7:22:42 MDT PM
MPB - 2007
*huge influx from BC - 2006
OUTSIDE HISTORICAL RANGE:
HOW WILL PINE STANDS RESPOND TO CHANGING DISTURBANCE REGIME?
Long-term Repeated Measures Study

- Clearcut
- Control 50% Kill
- Control 100% Kill
- x 3 Replicate Blocks

Timeline:
- 2008
- 2009
- 2010
- 2011
- 2012
- 2014
- 2016/17
- 2019
- 2024
- 2029
- 2039
- 2049
- ....

Blocks:
- Block 1
- Block 2
- Block 3
Successional Trajectory?

1. What regeneration will occur and when?
2. How will regeneration differ across the range of MPB (& serotiny)?
3. How may it differ among different tree species?
4. How should we manage these forests:
   • Silvicultural intervention?
   • Plant different species?
5. What about other changing disturbance agents (e.g., aspen decline, invasive species)?
6. How do we manage future forests for climate change and adaptational lag?