Early seral plantation forests

biodiversity
and ecosystem services

Scott Harris
Graduate student (PhD) – Matt Betts advisor

Forest Health in Oregon: State of the State 2020
Corvallis Oregon
Studies

- Early Seral Habitat Longevity Study
  - 2017 – present

- Intensive Forest Management Study
  - 2011 – present

Landowners: Weyerhaeuser Co., Hancock Forest Management, Starker Forests, Oregon Dept. of Forestry
Take-home messages

For plantation forests in the Oregon Coast Range
1. Biodiversity values change over the life of the stand
2. Management activities can change biodiversity values
3. Ecosystem services (that we studied) are unaffected by management intensification

Caveats and limitations apply.......
Biodiversity and abundance

Ecosystem services of birds

The New York Times

MATTER

Birds Are Vanishing From North America

The number of birds in the United States and Canada has declined by 3 billion, or 29 percent, over the past half-century, scientists find.
“....the time between stand-replacing disturbance and the establishment of a closed canopy” (Swanson et al. 2012)

Where trees are not the dominant life form..... but eventually will be (Franklin et al. 2018)
The timing of canopy closure

When does canopy closure happen?
Is canopy closure an ecological threshold?
Early seral forest is not all the same!

Early seral forest conditions vary by:
- Disturbance (harvest or natural)
- Management objectives
- Policy
- Site conditions

Conditions:
- Large live trees
- Snags
- Down woody debris
- Conifer regeneration
- Non-conifer vegetation
- Length of early seral stage
Gradient of early seral forest

- IFM
- Variable retention
- IFM with retention
- Complex/Inverse
- Less herbicide

Plant diversity vs. Legacies

Credit: Nate Dogg
QUIZ

In the PNW, the ownership class with the largest share of diverse early-seral ecosystems is?

A. Federal forests

B. Private industrial forests

C. Private non-industrial forests

Phalan et al. 2019 PNAS
Regional declines in early-serial associated birds

Orange-crowned Warbler

Rufous Hummingbird

White-crowned Sparrow

Possible factors:
- Breeding season habitat
- Wintering habitat
- Migration
- Climate change
- Others...

USGS Breeding Bird Survey Data
Early Seral Habitat Study

Research Question
How long does early seral under IFM serve as habitat for birds?

- How does bird abundance change over time?
- What is the timing of canopy closure?
- Is canopy closure a threshold for birds?
- Can we manipulate stand conditions to improve biodiversity?
Data Collection

Study area
- 132,000 ha

2018
- 158 sites

2019
- 151 sites
Data Collection

Avian Point Counts
- 3 visits during breeding season (different observers)

Stand conditions
- Structure (density, live crown ratio)
- Composition (cover by vegetation class)
- Age

Stand age 3 years

Stand age 20 years
Stand conditions

Overhead canopy cover
2018-2019 raw data, n = 302

Live Crown Ratio
raw data, loess-smoothed curve

70% canopy cover at approx. 13 years

Age12, 45% cover
Age12, 94% cover
Age28, 99% cover
## The timing of canopy closure

<table>
<thead>
<tr>
<th>Region</th>
<th>Disturbance</th>
<th>Management</th>
<th>Canopy Closure (years)</th>
<th>Criteria</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clearcut</td>
<td>HJ Andrews</td>
<td>22</td>
<td>70% cover</td>
<td>Halpern and Lutz 2013</td>
</tr>
<tr>
<td></td>
<td>Clearcut</td>
<td>USFS</td>
<td>42</td>
<td>70% cover</td>
<td>Yang et al. 2005</td>
</tr>
<tr>
<td>Coast Range</td>
<td>Clearcut</td>
<td>USFS</td>
<td>23</td>
<td>70% cover</td>
<td>Yang et al. 2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Private</td>
<td>13</td>
<td>70% cover</td>
<td>THIS STUDY</td>
</tr>
</tbody>
</table>
Results

Previous studies

Jones et al. 2011 *Ecology*

This study

70% cover
Species presence change over time

Early

Common Yellowthroat

Middle

Willow Flycatcher

Late

Hermit Warbler

* 70% canopy cover

Illustrations D. Sibley
Illustrations D. Sibley

American Goldfinch

Common Yellowthroat

House Wren

White-crowned sparrow

Probability of occupancy

Stand age (years)
“Middle Winners”

Illustrations D. Sibley
“Late Winners”

Illustrations D. Sibley
Species richness peaks near canopy closure

Average number of species per site

Caveat.....Lots of variation
Stand conditions that “modify” the curve

<table>
<thead>
<tr>
<th>Species</th>
<th>Structure</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Live crown ratio</td>
<td>Basal area</td>
</tr>
<tr>
<td>American Goldfinch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black-throated Gray Warbler</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Common Yellowthroat</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Hermit Warbler</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macgillivray's Warbler</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Orange-crowned Warbler</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pacific-slope Flycatcher</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Spotted Towhee</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Swainson's Thrush</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warbling Vireo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White-crowned Sparrow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Willow Flycatcher</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wilson’s Warbler</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Next steps: quantifying effects and determining direction

Wilson’s Warbler

- 86% Broadleaf cover
- 23% Broadleaf cover

Stand age (years)
IFM Study

8 study blocks

50 km

1 km

4 herbicide intensities per block
- Control
- Light
- Moderate
- Intensive

USA
Oregon
50 km
8 study blocks
1 km
4 herbicide intensities per block
Control
Light
Moderate
Intensive
Intensive forest management effects on biodiversity, after 7 years

**Woody plants**
(46 species)

**Herbs**
(180 species)

**Flowers**
(92483 flowers; 61 species)

Kormann et al. 2020 *in review*
Overall:
22% fewer species

Primarily:
plants
pollinators
leaf-gleaning birds

Kormann et al. 2020 *in review*
RESULTS
Effects on Total Avian Abundance

Herbicides alter bird abundance

Kroll et al. 2017 J. Appl. Ecol
Modified from J. Verschuyl slide
Habitat debt

Orange-crowned Warbler (n=459)

- = herbicide treatment
- = control (no herbicide)

Relative abundance compared to Control (90% CRI)

Treatment Light vs. Control Moderate vs. Control Intensive vs. Control

Habitat debt

Forest harvest rotation approx. 40 years
IFM Exclosure Studies

Fenced

Netted
Arthropod Collection

95,000
149 families

sweep net  pitfall trap  leaf inspection

adelgids

leafhoppers

aphids

© Robin Rosetta
Bird-induced pest control

16% fewer arthropods due to birds

Known pests (families) of Douglas-fir according to Goheen and Willhite 2006

How does herbicide use change this ecosystem service?

No change!
Do birds help conifers grow? NO detectable effect

Harris et al. 2020 Ecology
Again: Take-home messages

For plantation forests in the Oregon Coast Range

1. Biodiversity values change over time
   • Early, middle, and late “winners”
   • Species richness peaks near canopy closure

2. Management activities can affect biodiversity values
   • More intensive herbicide use creates a habitat debt, for some species, over the first ~ 5 years
   • Stand density and composition affect occupancy for some species
   • Thinning can delay canopy closure

3. Ecosystem services are unaffected by more intensive herbicide use
   • Bird-induced pest control is important but....
   • Birds don’t help conifers grow
Acknowledgements

Land Owners:
Weyerhaeuser Co., Hancock Forest Management,
Starker Forests, Oregon Department of Forestry

Funders:
USDA – Agriculture and Food Research Initiative
National Council of Air and Stream Improvement
Institute of Working Forest Landscapes (OSU)
National Science Foundation GRFP
Weyerhaeuser
Fish and Wildlife Habitat in Managed Forests (OSU)

Many field technicians!