Fire Risk and Northern Spotted Owl Recovery in Dry Forests

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- Question 1: How do we quantify the risk of severe fire?

Fire-Severity Definitions

Low severity

0-20% of basal area removed by fire

Kaibab NF, AZ 2008

Mixed severity

20-70% of basal area removed by fire

High severity

>70% of basal area removed by fire

Hayman Fire Area, CO 2008

Measures for Quantifying Risk of High-Severity Fire to NSO

- **Direct Measures of Rate of High-Severity Fire**

  Fire rotation = expected time for high-severity fires to burn an area equal to a study area of interest

  - Usually is one to many centuries in western forests
  - If short, land area is likely mostly young forest

  Fraction of total burned area that is high severity

- **Measure of High-Severity Fire Risk to NSO**

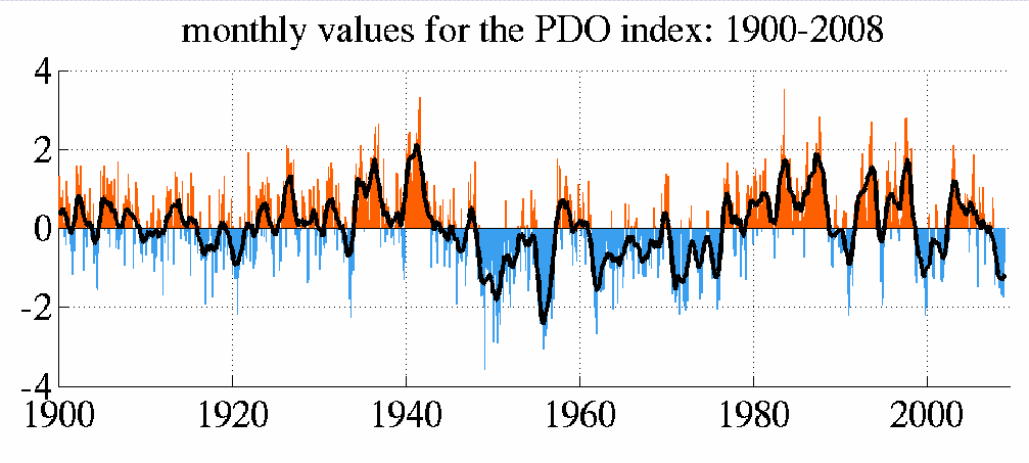
  Ratio of old-forest recruitment area to high-severity burned area in old forests over some period of time

  - If large, lots of old forest is being recruited relative to the amount being burned at high severity

High-Severity Burned Area Can be *Preferred* by Spotted Owls--*Not* Correct to Equate High-Severity Fire with Habitat Loss for NSO

- For the foraging component of habitat, in California spotted owls, there is *habitat preference*:
  - "…spotted owls selected burned areas for foraging over unburned forest, with the greatest selection for high-severity burned areas" (Bond et al. 2009)
- Some similarity with A.B. Franklin et al. (2000) NSO study:
  - "Northern Spotted Owls in California first selected dusky-footed woodrats over other species, and then selected foraging areas near ecotones between late- and early-seral forests where woodrats were both abundant and accessible"

- **Indirect Measures of Factors that Contribute to the Rate of High-Severity Fire—Competing Ideas**
  - Are changes in fuel loads and forest structure key?
    - e.g., logging, grazing, fire exclusion thought to increase high-severity fire
      - Increased ladder fuels, such as small trees
      - Increased fire-intolerant trees, particularly firs
      - Increased tree density
  - Or are changes in weather and climate (e.g., Pacific-Decadal Oscillation, global warming) the primary drivers of recent fire rates? (e.g., Westerling et al. 2006)



From: Univ. of Washington, Joint Institute for the Study of the Atmosphere and Ocean

Context—Transition in Evidence of Historical Fire Regimes/Forest Structure in Dry Forests

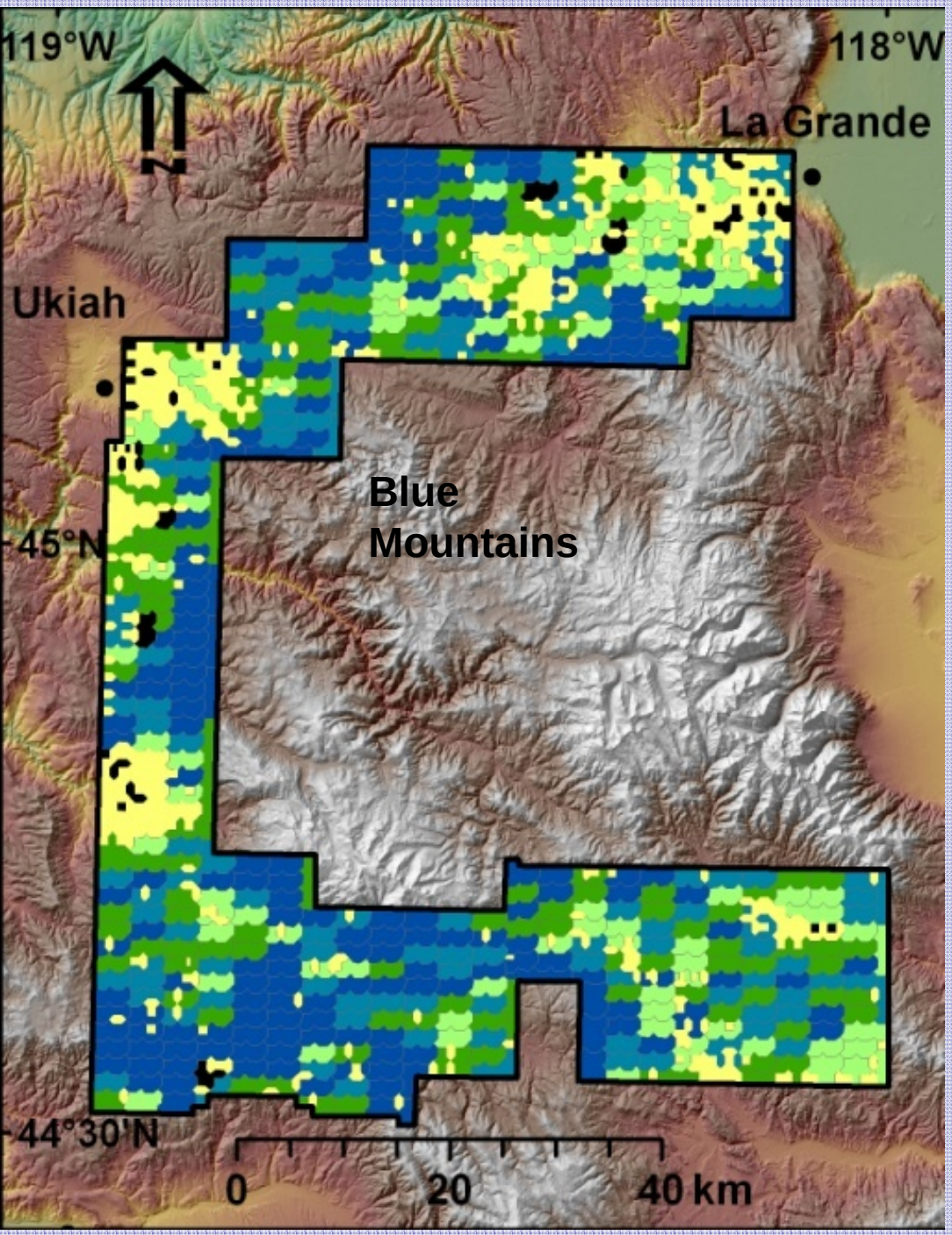
- Spies et al. (2006) Conserving old-growth forest diversity in disturbance-prone landscapes. Conservation Biology 20:351-362.
  - "Frequent low-mixed severity fires are generally thought to be characteristic" and "the structure … would have been characterized by an open, park-like appearance with large live and dead trees…" (p. 354)
- This is a logical summary, based on the available evidence, but available evidence was limited:
  - Scattered anecdotal historical accounts
  - A few tree-ring reconstructions of forest structure
  - Some early stand exams and reports
  - Many fire-history studies, but did *not* study fire severity
  - Mostly extrapolating to large areas from small studies

- 2007 study of extensive landscapes led to a substantial change:
  - Hessburg et al. (2007) – earliest aerial photos
    - 303,156 ha of mixed conifer forests in E WA (& OR)

"The structure of mixed conifer patches…was formed by a mix of disturbance severities…However, evidence for low severity fires as the primary influence, or of abundant park-like patches, was lacking in both the dry and moist mixed conifer forests…Across the study area, 22% of the area in dry forest was affected by low severity, 59% by mixed severity, and 20% by high severity fire…"

- New reconstructions from Blue Mountains, OR, using GLO surveys support Hessburg et al. (2007)
    - Reconstructed 552,953 ha of ponderosa pine and dry mixed-conifer forests - median survey in A.D. 1877
      - Williams & Baker (2010) Journal of Biogeography 37:707-721.
      - Williams & Baker, In press, Ecological Monographs

Historical Tree Density



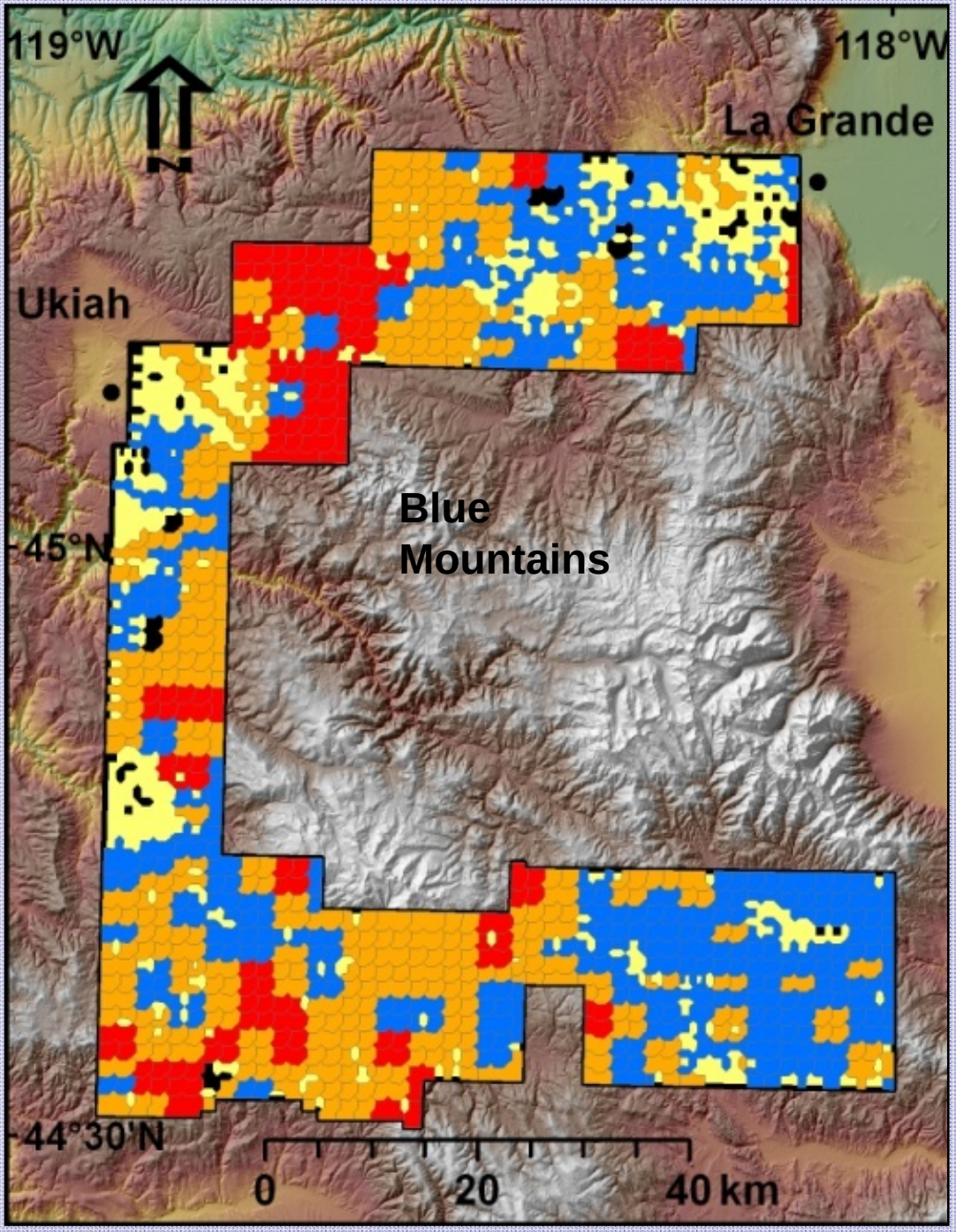
Trees/ha

- 20-89
- 89-134
- 134-178
- > 178
- Park
- No data

- Heterogeneity in tree density
- Large areas of high tree density

Area = 552,953 ha

Historical Fire Severity



Fire Severity

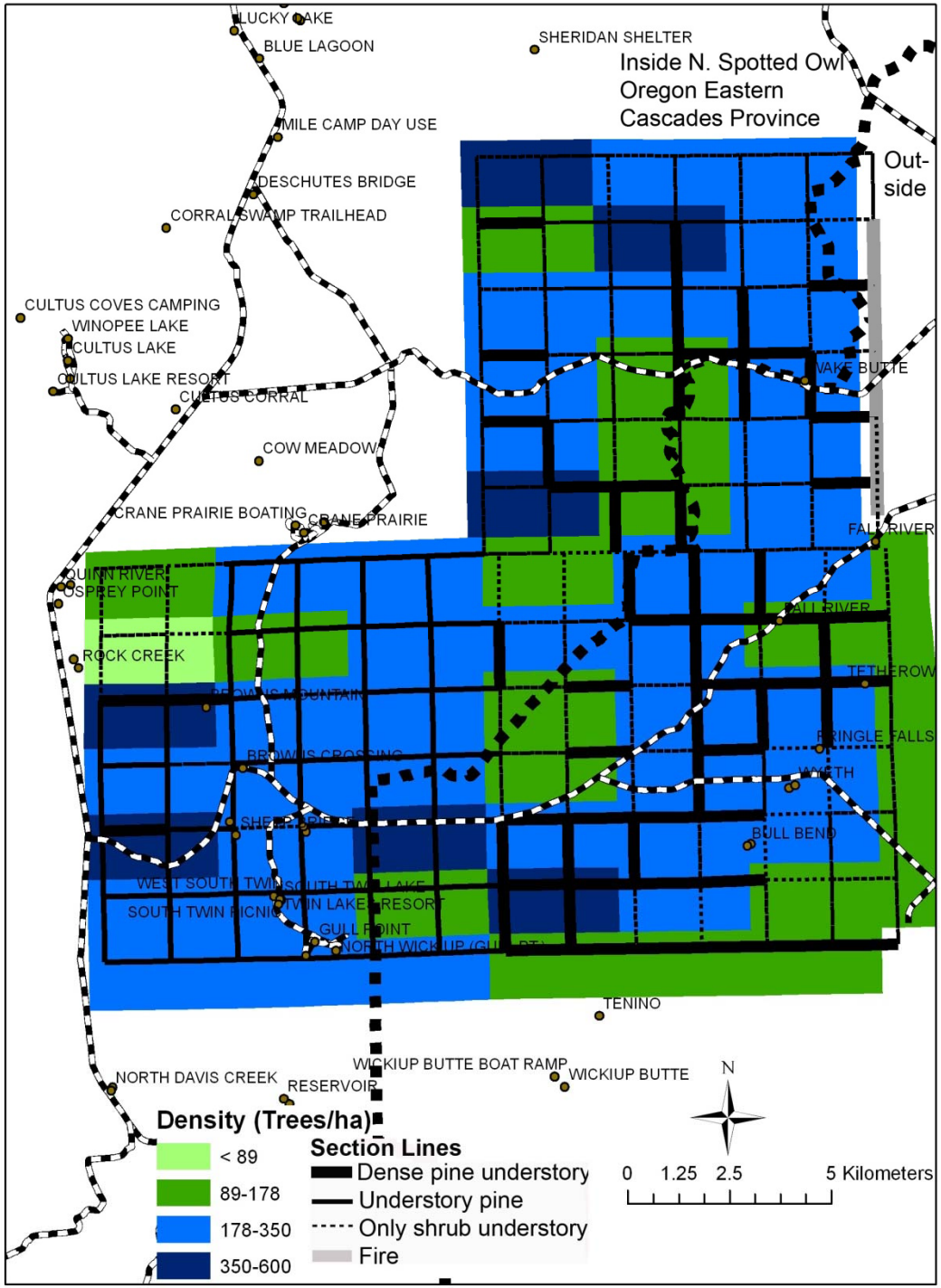
- Low
- Mixed
- High
- Park
- No Data

FRACTION OF 552,953 HA AREA

Low severity = 40.3%
Mixed severity = 44.2%
High severity = 16.5%

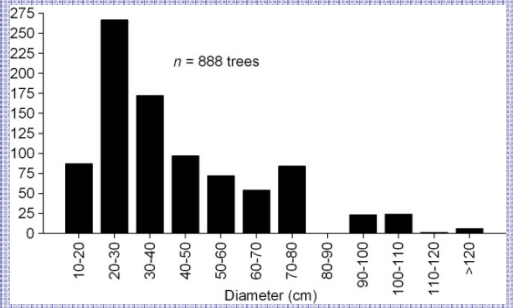
HIGH-SEVERITY FIRE ROTATION

506 years if only mixed- and high-severity areas could burn at high severity



E. Cascades GLO Reconstruction Project

- Pringle Falls area SW of Bend, OR (28,000 ha) in A.D. 1880
- Tree density generally high, but mosaic of varying density
- Large trees common, but small trees predominant



- Understory commonly “dense pine,” “understory pine” and shrubs “dense”, so fire not likely as frequent as prev. thought
- Likely mixed- to high-severity dominant; some low severity
- Similar to Hessburg et al. 2007

Context—A Transition in Evidence of Recent Fire Severity in Dry Western Forests

- Common recent conclusions:
  - Annual burned area or fire-severity is increasing because of climatic change and fuel buildup due to fire exclusion, grazing, logging etc. (e.g., Spies et al. 2006)
  - Risk of high-severity fire is uncharacteristically high today in dry western forests

2008 Recovery Plan Also Identified High Fire Risk

Based on estimates of fire rotation for high-severity fire:

1. Oregon Eastern Cascades Province: 69-yr high-severity fire rotation, based on preliminary data on the 2003 B&B fire
2. Oregon Klamath Province: 105-year high-severity fire rotation

Extrapolated from these Province estimates to Cascades/Klamath scale

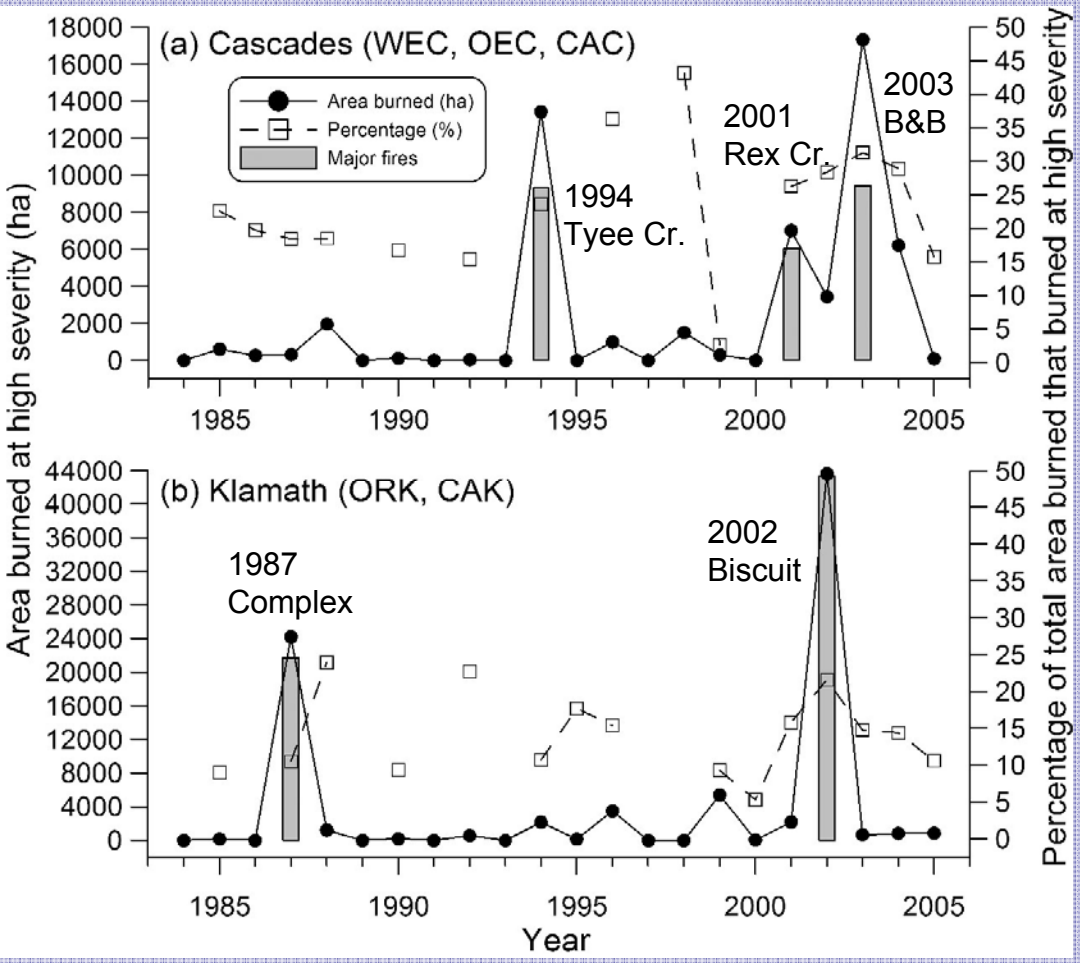
"…the rate of loss of older forests to stand-replacement wildfire has been relatively high…there is evidence that wildfire activity will continue or increase…thus, it is unlikely that designating Spotted Owl habitat reserves within fire-prone landscapes will be effective"

(Recovery Plan, p. 20)

Reassess High-Severity Fire Risk Using More Complete Data

- Data Sources:
  - High-severity fire (1984-2005): Monitoring Trends in Burn-Severity (www.mtbs.gov) data
    - Our RdNBR threshold represents about 60% mean percent basal area mortality of trees ≥ 50 cm dbh
  - Old forests: 1996 (Moeur et al. 2005)
  - Northwest Forest Plan federal lands
  - Dry forest provinces (www.reo.gov)
- Estimate high-severity fire rotation
  - period/fraction of area burned
  - 5, 10, 20-year periods to study effect of period
- Old-forest recruitment (Moeur et al. 2005)

Area burned at high severity on federal land in dry forests



Not old forest, just any dry forest

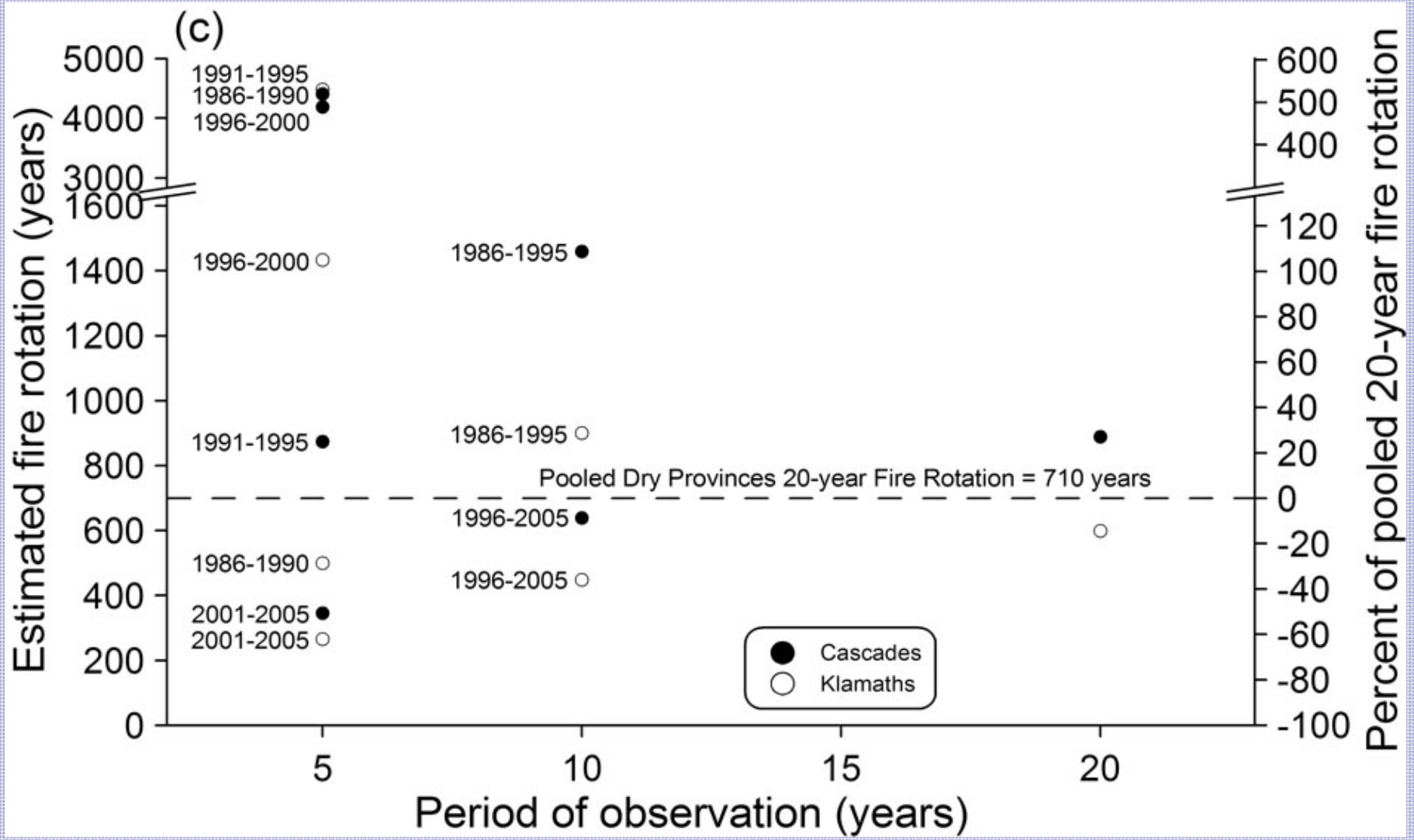
PROVINCES:
WEC = Washington Eastern Cascades
OEC = Oregon Eastern Cascades
CAC = California Cascades
ORK = Oregon Klamath
CAK = California Klamath

No significant trend (p = 0.346) in percent high severity in Cascades/Klamath
- Percent high severity of 20-25% similar to historical (Hessburg et al. 2007)

Significant (p = 0.045) trend in rank-order area burned at high severity in Klamath
- Not much can be made of trend analysis—only 5 fires

Looks like lots of fire but fire rotations long; what is effect of period of observation?

High-Severity Fire Rotation Versus Period of Observation



Note: Area burned in dry forests on federal lands, **not** area burned in old forest

Previous Planwide Estimates of Fire Risk Using High-Severity Fire Rotation

- Rangewide: 1.3% per 9 years (Davis and Lint 2005—In Northwest Forest Plan—the First 10 Years)
  - Fire rotation = 692 years
- "Older forest losses to wildfire Planwide were about 1.3 percent (102,500 ac for the 'medium and large older forest' definition) (Table 15)" (Status and Trend of Late-Successional and Old-Growth Forest, In: Northwest Forest Plan—the First 10 years, Moeur et al. 2005)
  - Fire rotation = 769 years

Old-Forest Recruitment Versus High-Severity Fire Rotation in Old Forests (1996-2005) in Dry-Forest Provinces

Province	High-severity fire rotation (years)	Ratio of old-forest recruitment area to high-severity burned area: Using average recruitment estimate[a]	Ratio of old-forest recruitment area to high-severity burned area: Using low recruitment estimate[a]
Washington Eastern Cascades	372	7.06	3.53
Oregon Eastern Cascades	469	8.92	4.46
California Cascades	4,545	86.36	43.18
CASCADES	746	14.18	7.09
Oregon Klamath	233	4.42	2.21
California Klamath	1,351	25.68	12.84
KLAMATH	575	10.92	5.46

[a] Old-forest recruitment data from Moeur et al. (2005)

Summary—Main Findings About Fire Risk & NSO

- Fire regimes historically dominated mixed-, & high-severity fire
  - Landscapes a mosaic of patches varying substantially in tree density, composition, basal area, and diameter distributions often with understory shrubs & small trees
- Recent decadal estimates of high-severity fire rotations are long
  - Revised high-severity fire rotation estimates in old forest are long:
    - Cascades = 746 years, not 69 years as in RP
    - Klamath = 575 years, not 105 years as in RP
  - These recent rates are similar to previous estimates planwide: 692, 769 years
  - These recent rates are longer than historical estimates for Blue Mts.: 506 years
- Ratios of old-forest recruitment to high-severity area are currently high:
    - Cascades: 7.1 times (low est.) to 14.2 times (avg. est.)
    - Klamath: 5.5 times (low est.) to 10.9 times (avg. est.)
  - Thus, dramatic increase in high-severity fire (e.g., 5-10 times as many huge fires per decade) would need to occur for net declines in old forest to begin
  - High-severity rate, if anything, is not currently a risk to NSO
- Fire-risk estimates inherently unreliable over short periods (e.g., 10, 20 yrs) and small areas (province scale). Need long periods, large areas
  - Fire rotations are several centuries--10- or 20-year data far too short, as short-term trends shaped by only a few large fires and particular climatic (e.g., PDO) periods

- Question 2: What does the current fire risk mean in the context of spotted owl recovery and dry forest ecosystem restoration?

Implications of Fire Risk for NSO Habitat Restoration

- *Abandoning reserves/extensive fuel treatments not needed:*
  - *If anything is shown by decadal data, current fire risk is low*
    - *Allows us to focus on owl habitat needs and other threats, not so much risk of fire*
  - *Extensive treatments inconsistent with adaptive-management*
  - *New landscape-scale reconstructions (Hessburg et al., Williams) suggest less thinning, more attention to landscape heterogeneity*
- *Using a precautionary approach: small-scale research & adaptive management to first understand NSO response to:*
  - Natural processes (wildfire, insect outbreaks, climatic events)
  - Global warming
  - Stand-level actions aiming to enhance/restore NSO habitat
    - e.g., <u>No</u> empirical studies of NSO response to thinning in dry forests
- *After findings at small scale are available, can scale up:*
  - Manage natural processes in ways found to benefit NSO
  - Implement enhancement/restoration actions found to benefit NSO

How Does Geographic Scale Affect Implications?

- Fire regime operates at scales larger than provinces
  - A large percentage of burned area comes from a few percent of fires that are large and infrequent
    - Property of virtually all fire regimes that have been studied
  - Infrequent regional episodes of drought-linked large fires are normal in fire regimes
    - Large fires have a tendency to be synchronized by regional drought having teleconnections to the oceans (e.g., PDO)
  - These fires are inherently locally surprising, even if regionally normal and characteristic of fire regimes
    - Short-term dramatic transformations in particular areas normal
    - Need to plan for periodic local disruptions
- Minimum scales for management, planning, monitoring:
  - Spatial extents many times the largest fires, so > province scale
  - Temporal period exceeding periods for known climatic drivers (e.g., 20-30 year Pacific Decadal Oscillation); even longer is better

Other threats: Insect Outbreaks & Climatic Change

- **Insects**
  - The insects
    - Major bark beetles: Douglas-fir beetle, Mt. pine beetle, W. pine beetle, Fir engraver
    - Defoliators: W. spruce budworm, Douglas-fir tussock moth, pandora moth, pine butterfly
    - Branch/terminal: Non-native balsam wooly adelgid
  - Currently affecting 8% of Washington forests and 3% of Oregon forests (USDA and States in 2008 & 2009)
  - What to do?
    - Usual perspective: keep tree density low, tree growth vigorous; thin smaller trees to retain larger trees
    - Instead: small trees are the ones likely to survive insect outbreaks; thus, *maintain diversity of tree species & sizes*
    - Suggest a focused assessment of insect risks and responses

- **Climatic Change**
  - Some expected climate trends (Washington Climate Change Impacts Assessment—Littell et al. 2009)
    - Added annual T increase of 3.2° F by 2040s
    - Little expected change in tot. precip., but reduced snowpack
    - *But PDO not well simulated*; entered a cold phase in 2007
  - Some expected ecological impacts relevant to NSO
    - EWC: Mean annual burned area increases
      - 63,000 acres/year now; 90,000 acres/yr by 2040s (1.43 times as much)
      - Could lower high-severity fire rotation in old forest, but currently 372 yrs
    - EWC: Decline in climate suitability for certain trees by 2060s
      - Douglas-fir and pines
    - EWC: Increase in insect outbreaks; decreases possible too
  - What to do?
    - *Maintain diversity of tree species & sizes*
    - Focused assessment of climatic risks to NSO habitat

Summary—Primary Implications of Fire-Risk Assessment

Likely there is ample time for adaptive management, small-scale experiments, and planning NSO habitat improvement and ecological restoration at the landscape scale

- Low current risk likely provides a 10-year (or more) window
  - Fire risk, if anything, is currently low
  - Insects are not currently at exceptional levels
  - Negative PDO beginning in 2007 could increase the window of opportunity for 20-30 years?

Likely there is ample time to create intentional landscape designs for NSO habitat in relation to fire, insects, and climatic change

- New landscape-scale understanding and data (e.g., Hessburg et al.)

But, ecological surprises are always possible! Plan for them.

- *e.g.*, 5 consecutive years of drought could rapidly change the situation

- Question 3: Two proposed approaches for ensuring spotted owl recovery include the Northwest Forest Plan and the current Recovery Plan. What are the consequences of using either of these approaches in light of the different measures of fire risk previously discussed?

Limitations of NWFP and 2008 RP for Eastside NSO Recovery and Ecosystem Restoration

- NWFP: Could be improved
  - Could remedy mismatch between owl habitat and reserves
  - Could expand protection (e.g., replacement habitat)
  - Could explicitly plan for dynamism from fire, insects, disease, climate
- 2008 Recovery Plan-Reserveless: Unnecessary idea
  - Need for dynamism/no reserves based on incorrect fire-risk estimates
    - Fire risk, if anything, is currently low, and dynamism rather slow
  - Fuel treatments on up to 65-70% of dry forests premature and incompatible with recent science
    - No study of effects of treatments on owls in dry forests
    - Widespread fuel treatments based on incorrect notion that forests were generally open and park-like because of low-severity fires (see Hessburg et al. 2007, Williams and Baker, for evidence that this is incorrect)

Potential Approaches to Eastside NSO Recovery and Ecosystem Restoration Given Fire, Insects, Climate

IMMEDIATE

- Refine/expand landscape protection system to aid recovery
  - Refine NSO protection using MaxEnt, Zonation, HexSim results
  - Expand NSO protection (e.g., more area, > 30% old growth, replacement habitat etc.)
  - End post-fire logging in NSO habitat, so owls do not avoid logged areas they could use (Clark 2007)
  - Implement dynamism in the protection system (e.g., designate replacement habitat, systematize periodic revision of boundaries)
- Refocus on *ecological restoration* rather than fuel treatments
  - Designate ecological restoration areas
  - Refocus on maintaining/restoring habitat features for owls and other species at stand- and landscape-scales
  - Implement adaptive management system for monitoring owls and learning from significant restoration actions (e.g., thinning)

Refocus on Maintaining/Restoring Known Stand-Level Habitat Features for NSO in Dry Forests

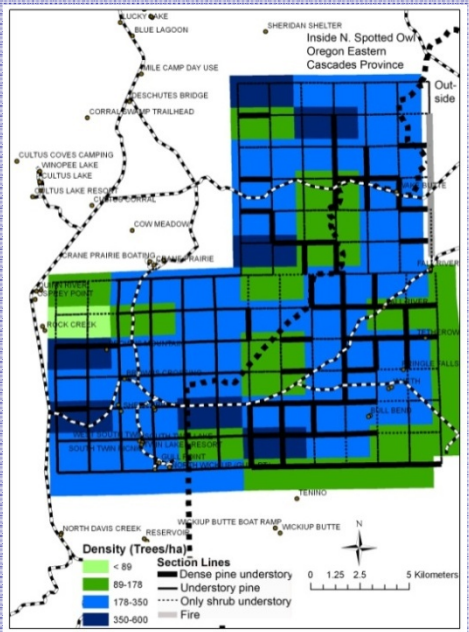
- High number/density of large (> 60 cm dbh) Douglas-firs or grand/white firs (King 1993, Buchanan et al. 1995, Everett et al. 1997)
- Large basal area, especially Douglas-fir (Buchanan et al. 1995, Pidgeon 1995)
- Large quadratic mean diameter of dominant trees (Lint 2005)
- High canopy cover (King 1993, Pidgeon 1995, Lint 2005)
- Multiple tree layers, including abundant medium & small grand/white fir or Douglas-fir (King 1993, Pidgeon 1995, Everett et al. 1997)
- High density of large pine snags in lowest decay class (Pidgeon 1995)
- Large volume of mature-sized down logs (Pidgeon 1995)
- High understory litter, ferns, and tall shrubs (King 1993, Pidgeon 1995)

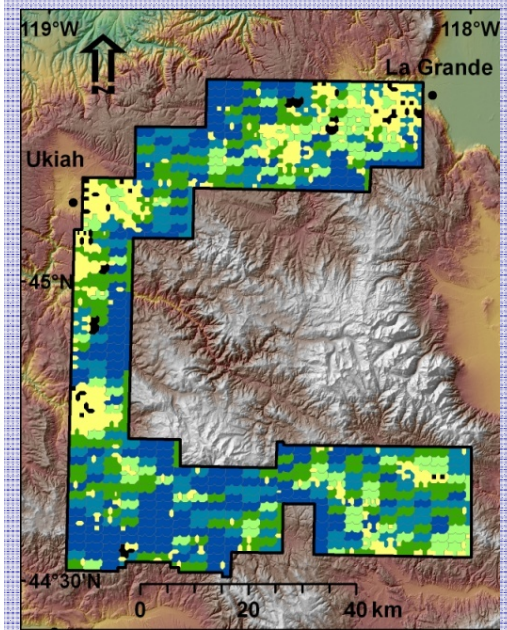
U.S. Fish & Wildlife Service photo

Refocus on Maintaining/Restoring Known Landscape Heterogeneity in Dry Forests

- Scientific basis:
  - Hessburg et al. 2007 – E WA and E OR
  - Williams and Baker (Blue Mts.) – for comparison
  - Savoie and Baker E. Cascades reconstructions, in prep.
- Heterogeneity in tree density, tree sizes, tree species diversity at both stand- and landscape-scales provides some insurance against fire, insect, disease threats

"Restoring resilient forest ecosystems will necessitate managing for more natural patterns and patch size distributions of forest structure, composition, fuels, and fire regime area, not simply a reduction of fuels and thinning of trees to favor low severity fires" (Hessburg et al. 2007 p. 21)





NEXT 5 YEARS

- Reduce fire risk by reducing human-associated fires
  - Reduce excessive human-caused fires in and near NSO habitat
  - Reduce human-caused high-contrast edges that favor ignition/spread
  - Limit invasion/expansion of fire-cycle invasive species (cheatgrass)
  - Carefully manage slash from restoration treatments/other activities
- Refine methods to monitor fire, insect, climate effects on owls
  - Change monitoring to owls & actual owl habitat, rather than old forest
  - Complete statistical analysis of sample size for change detection
- Complete needed adaptive management/scientific research:
  - Owl response to fire, insects, climate, & various types of restoration
  - Reconstruct historical owl habitat and fire across landscapes
- Complete focused landscape designs: Blowout preventers?
  - All potential insect/disease threats
  - Fire
  - Climatic change

NEXT 10 YEARS

- Scale-up ecological restoration actions that were found through adaptive management to benefit owls and other species, using reconstructions as a guide
- Implement plans to manage natural disturbances that were found through adaptive management to benefit owls and other species
  - e.g., in designated areas, manage wildfires to provide foraging habitat and future NSO habitat and restore ecosystems
- Implement intentional landscape designs for insects, fire, climatic change
- Expect some surprises from a warming climate and expanding human populations (e.g., Rodeo-Chediski, a 467,066 acre AZ fire set by an arsonist and a lost hiker)

Thanks!