Riparian Forests and Silvicultural Strategies

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Objective:

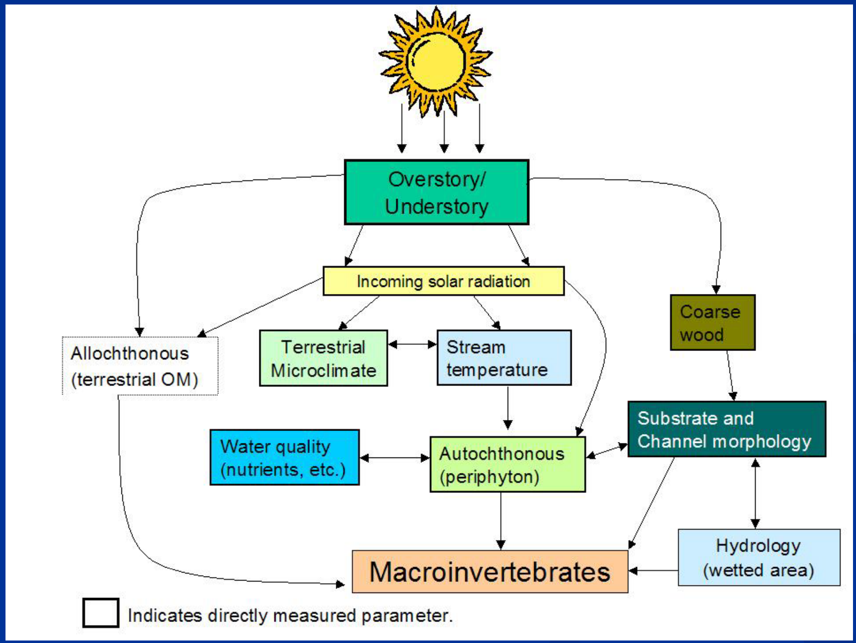
- Review key concepts of riparian forest structure and composition, and highlight the silvicultural issues specific to management of riparian areas
  - Ecosystem functions provided by riparian stands
  - Structural and compositional characteristics
  - Measures to mitigate potential effects of stand management on riparian functions
  - Strategies to produce desired future stand structures

What are Riparian Zones?

- Three dimensional zones of interaction between terrestrial and aquatic ecosystems extending outward from the channel to the limit of flooding and upward into the canopy of streamside vegetation – (Swanson et. al. 1982)

Riparian Stand Functions:

- Interface between aquatic and upland ecosystems
- Riparian vegetation provides:
  - Wildlife habitat
  - Stream bank stability
  - Nutrient assimilation
  - Influence on microclimate
  - Filtration of sediment and debris transported by runoff
  - Large wood
- Complex, dynamic environment serving as hotspot of biological diversity



Management Objectives for Riparian Forests:

- To provide structural diversity in streams and floodplains
- To provide wildlife habitat
- To maintain stream productivity
- To produce wood

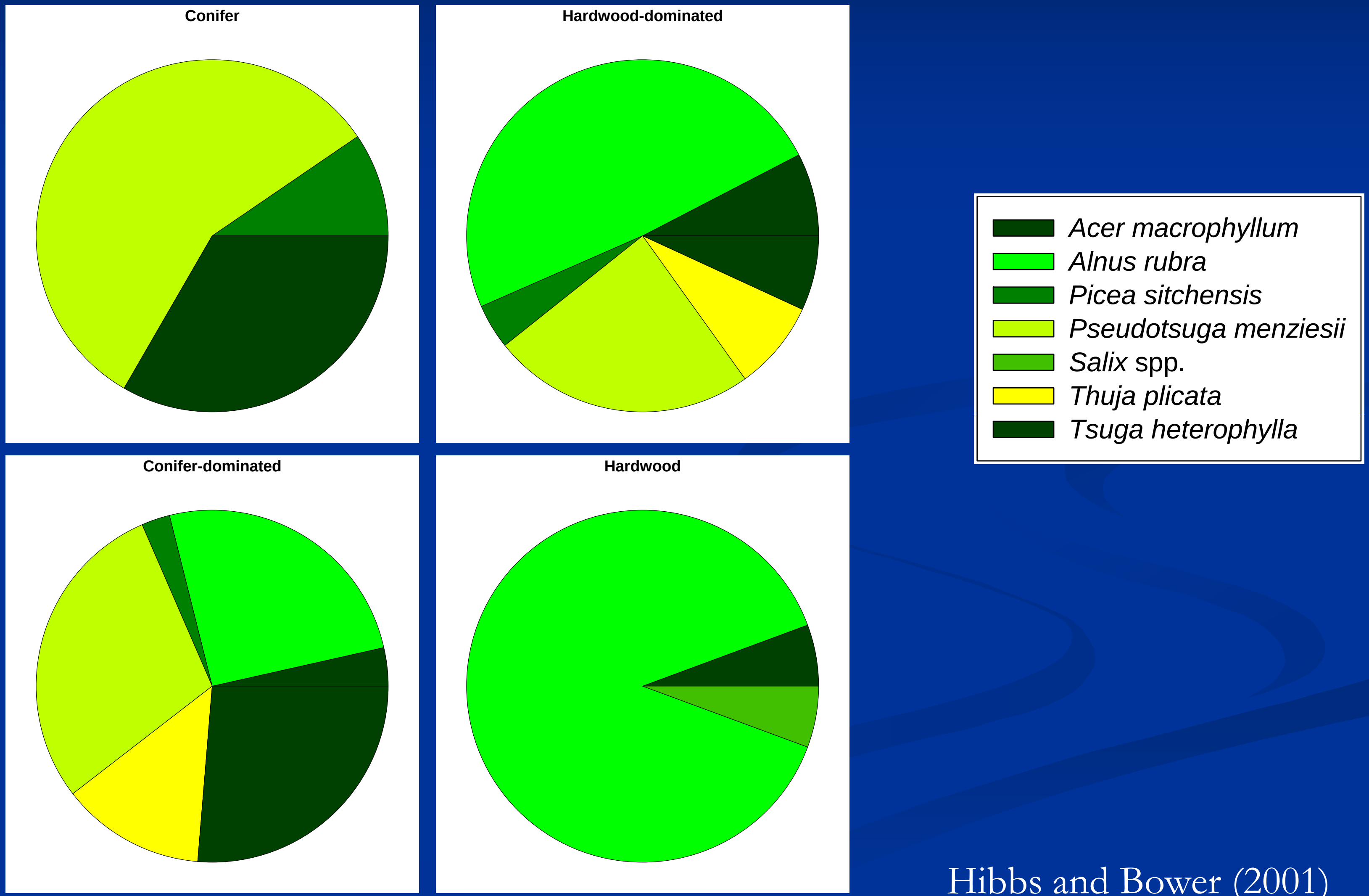
Silvicultural Practices for Riparian-area Management

- Buffers
- Thinning
- Regeneration
- Release

Riparian Forest Structure and Composition:

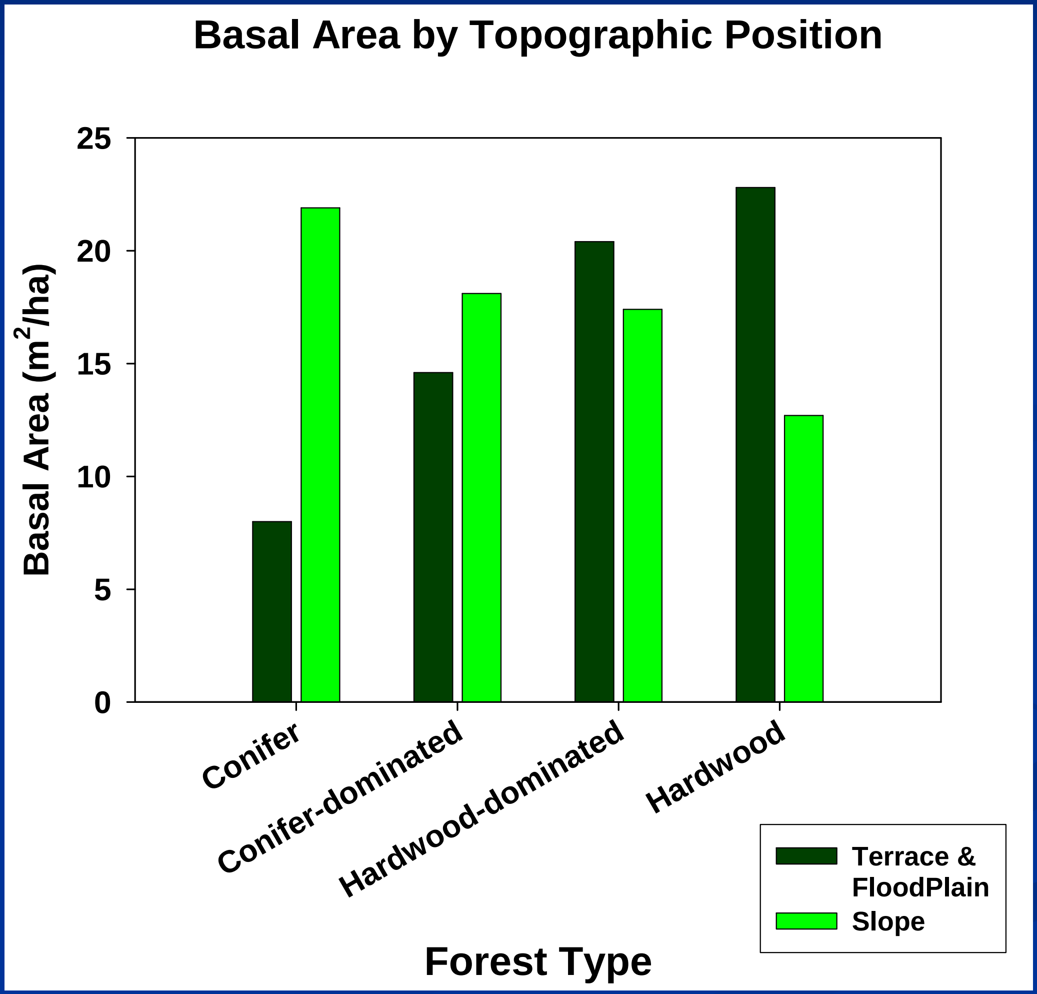
Comparisons Among Conifer and Hardwood Types

Overstory Species Composition: Percent Stem Count



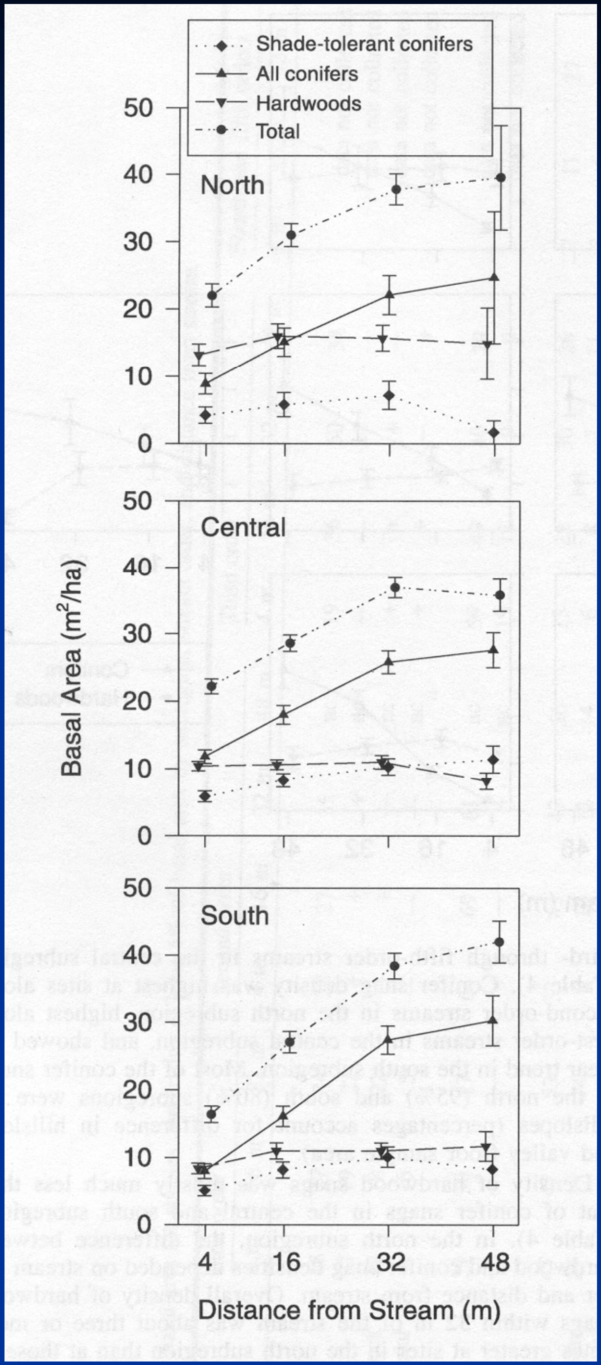
Hibbs and Bower (2001)

Forest Type Distribution: Topographic Position



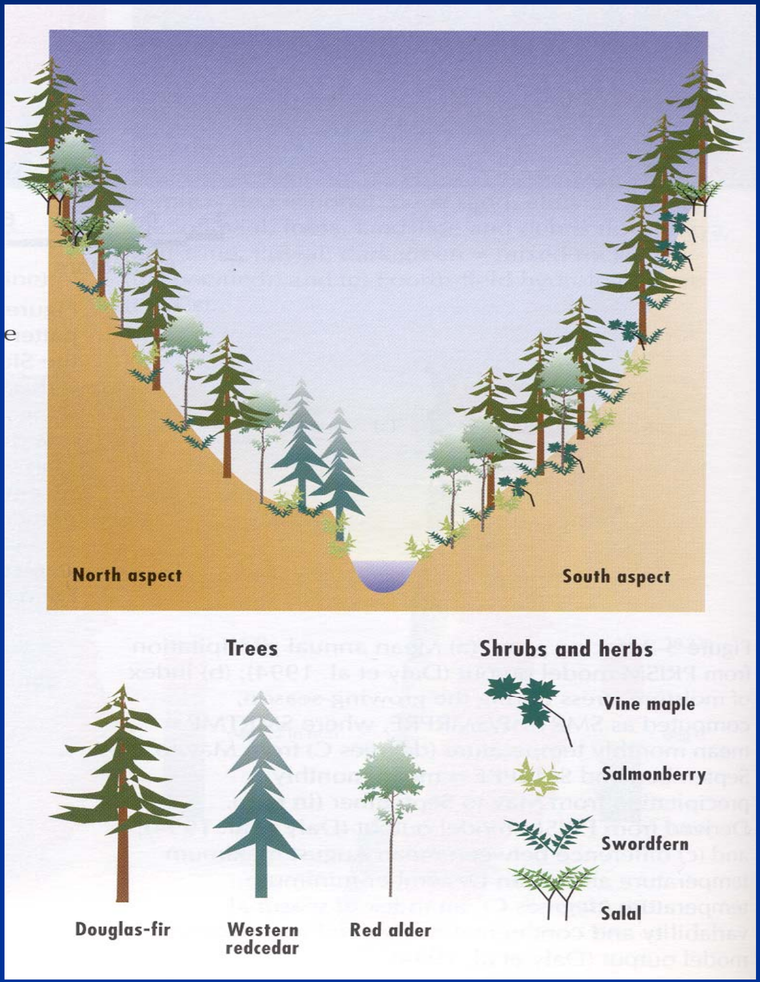
Hibbs and Bower (2001)

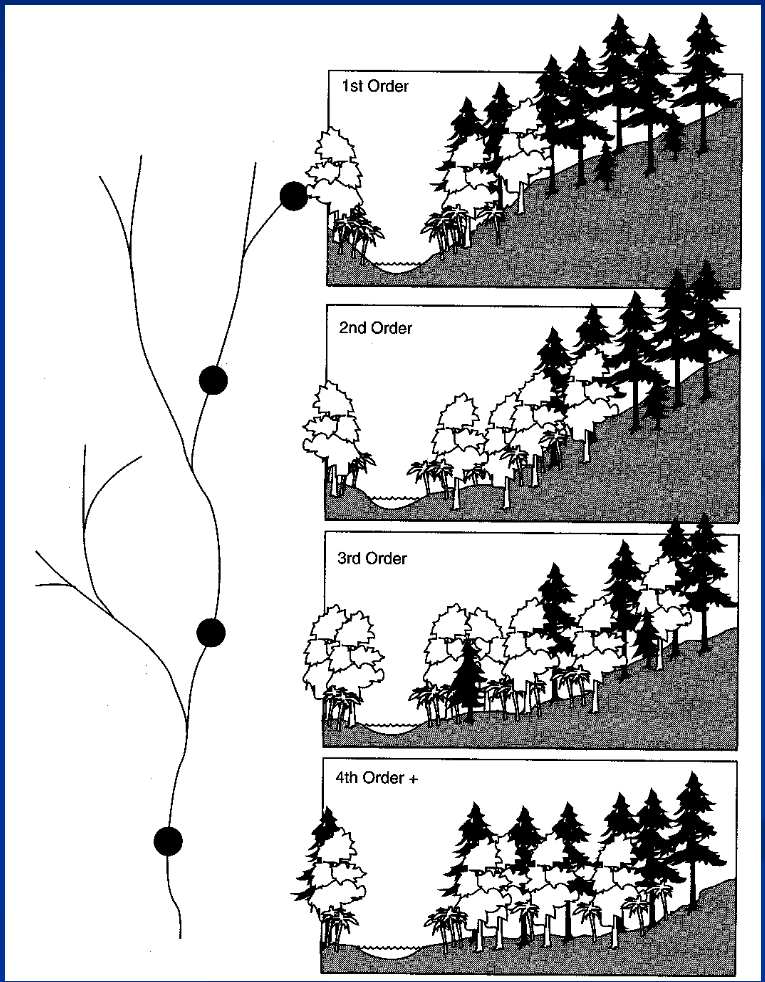
Basal Area Distribution: Distance from Stream



Pabst and Spies (1999)

Aspect and Stream Cross-section Influence on Composition



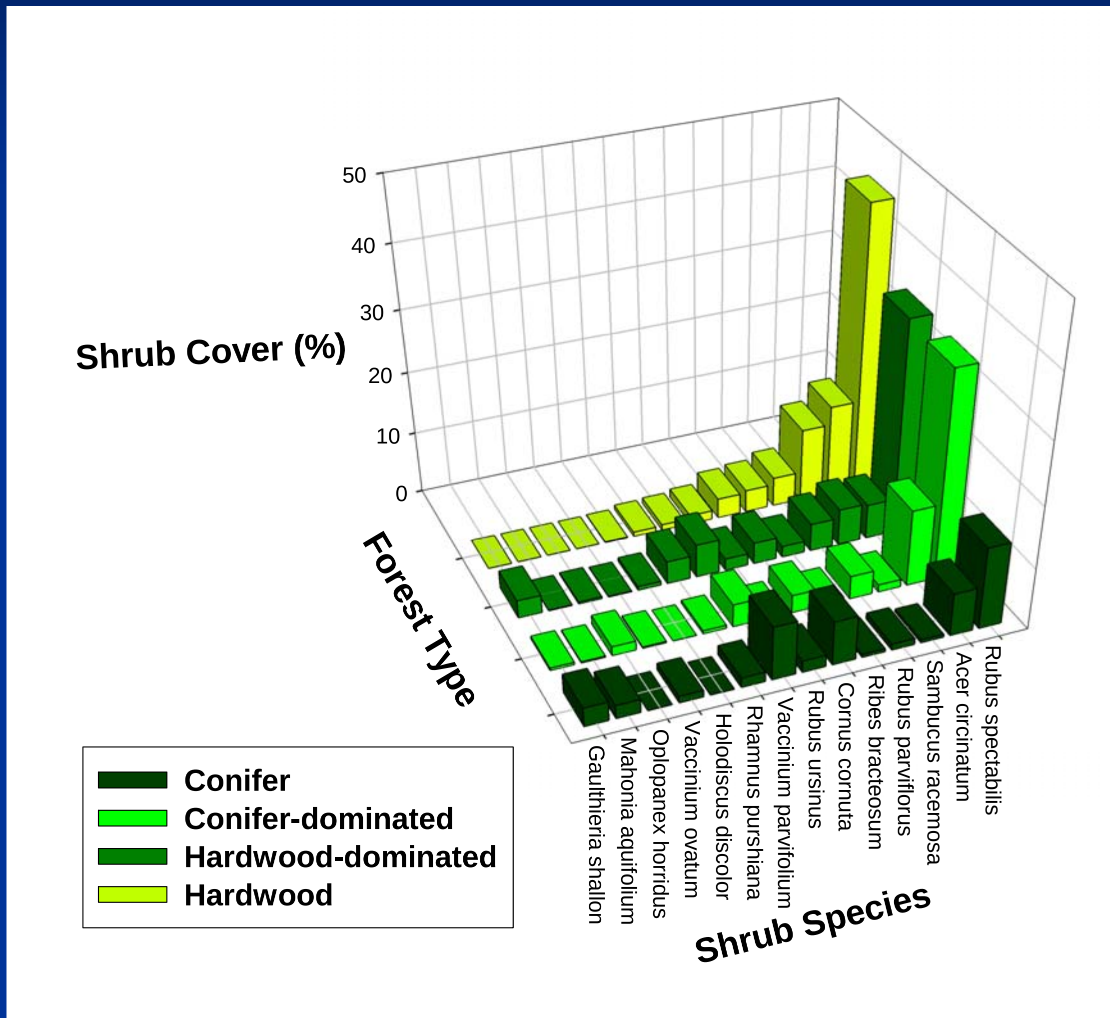


Hobbs et al. (2002)

Species Tolerances to Flooding and Shade

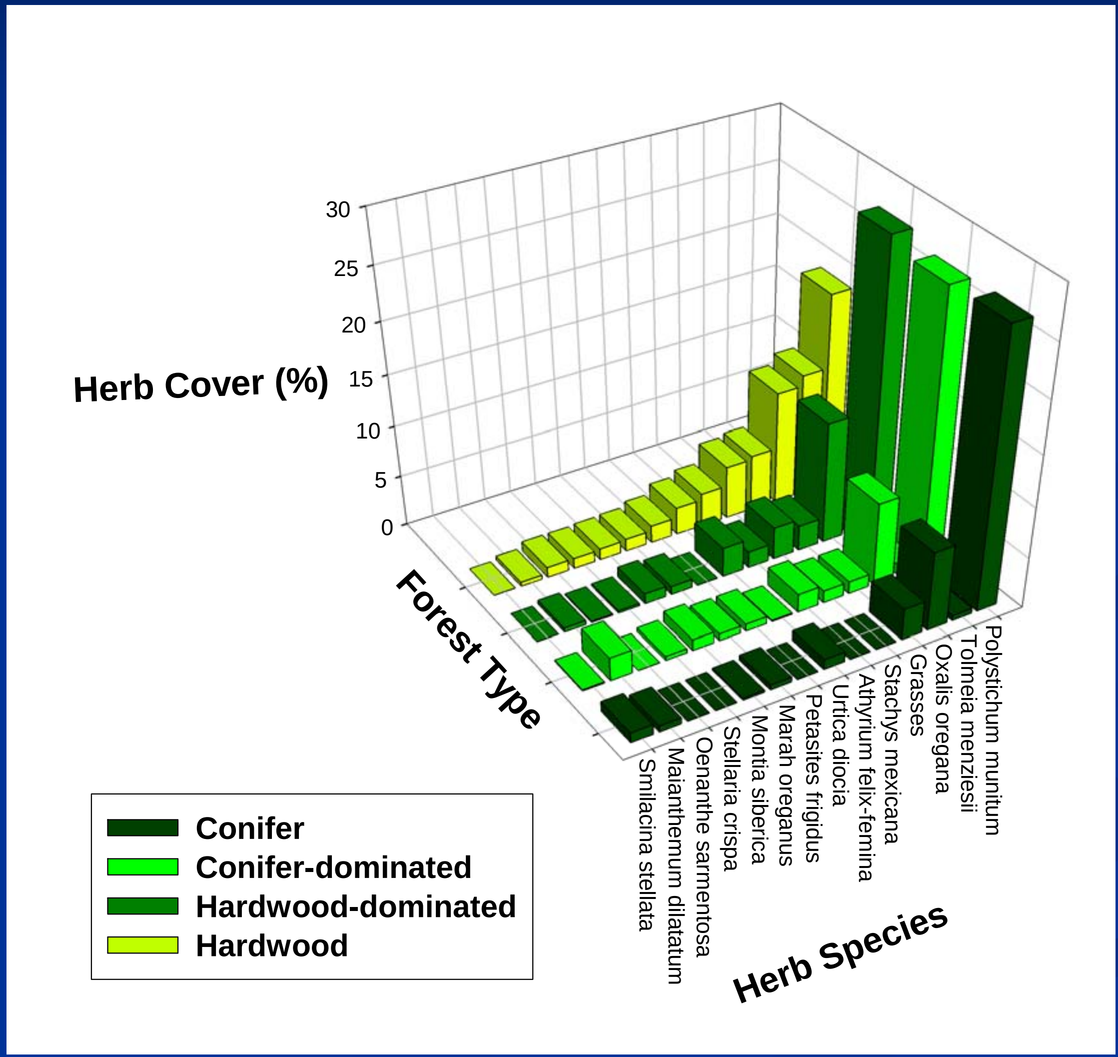
Tree Species	Tolerance to flooding	Tolerance to shade
Douglas-fir	Low	Low
Redcedar	Medium	Medium
Redwood	High	High
Spruce	Medium	Medium
Shore pine	Medium	Low
Hemlock	Low	High
Grand fir	Medium	Medium
Alder	Medium	Low
Bigleaf maple	Medium	Medium
Vine maple	Medium	Medium
Dogwood	Low	Medium
Poplars	Medium	Low
Ash	High	Medium
Willows	High	Low

Understory Shrub Composition:



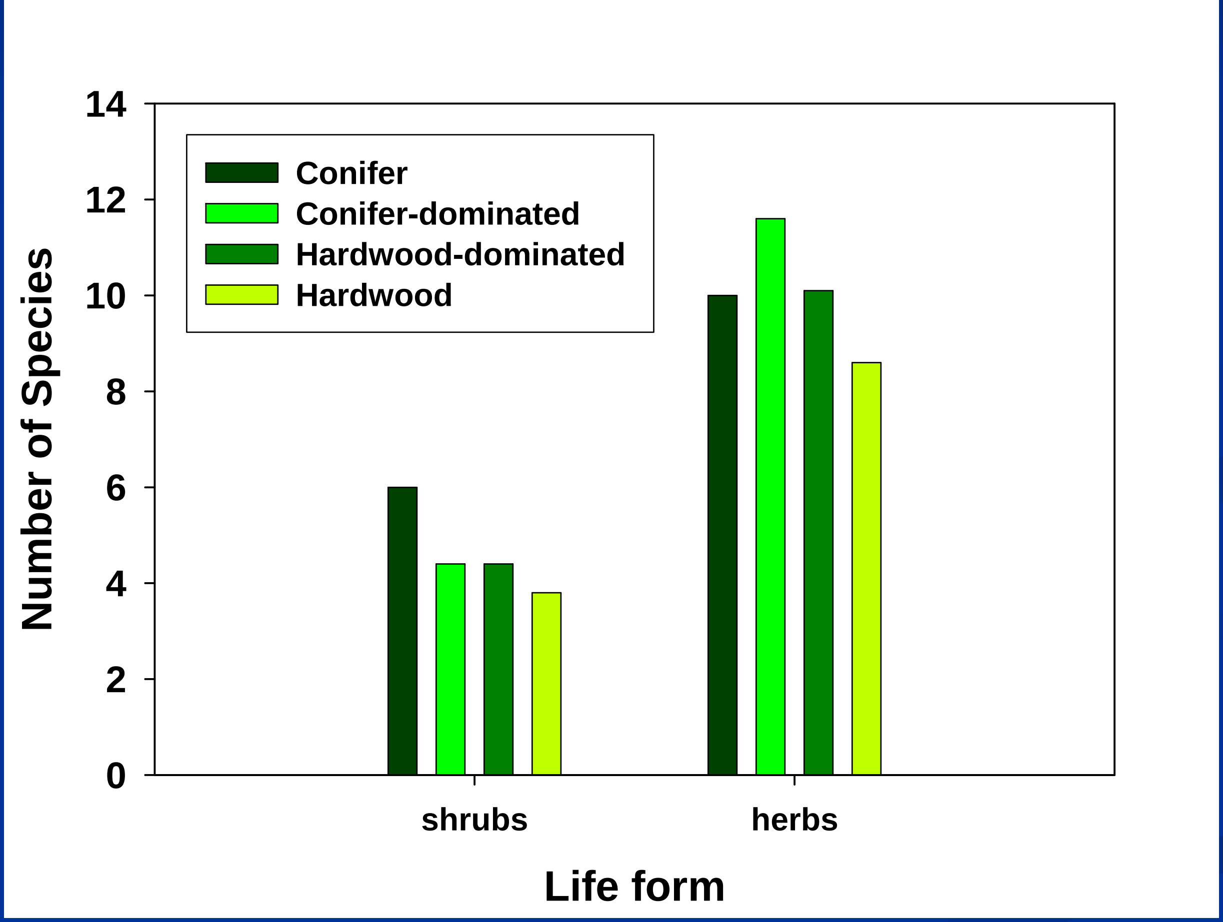
Hibbs and Bower (2001)

Understory Herb Composition:



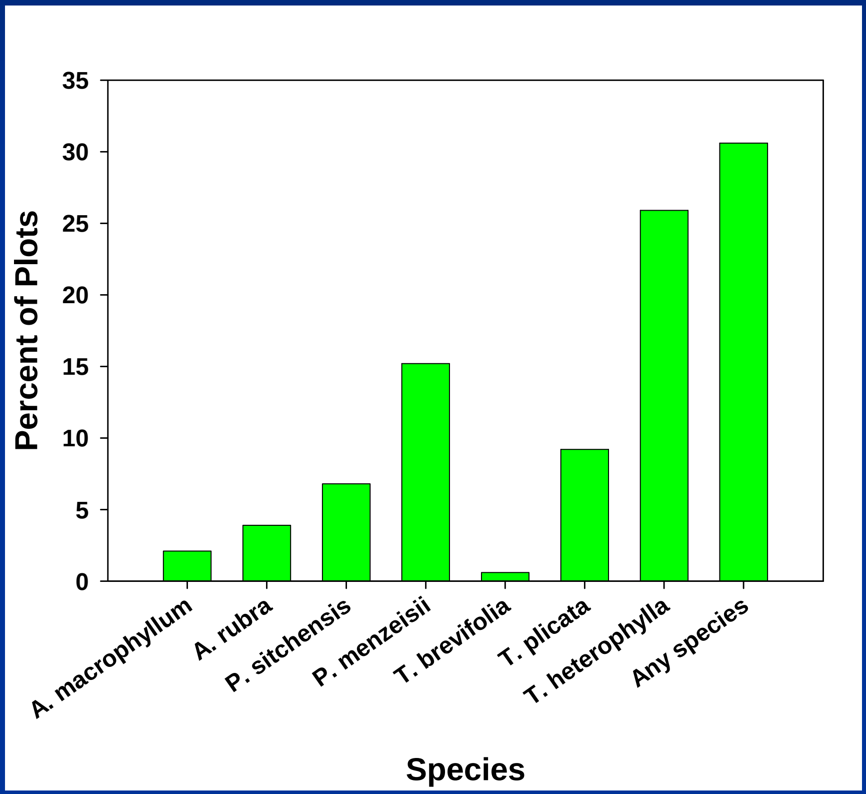
Hibbs and Bower (2001)

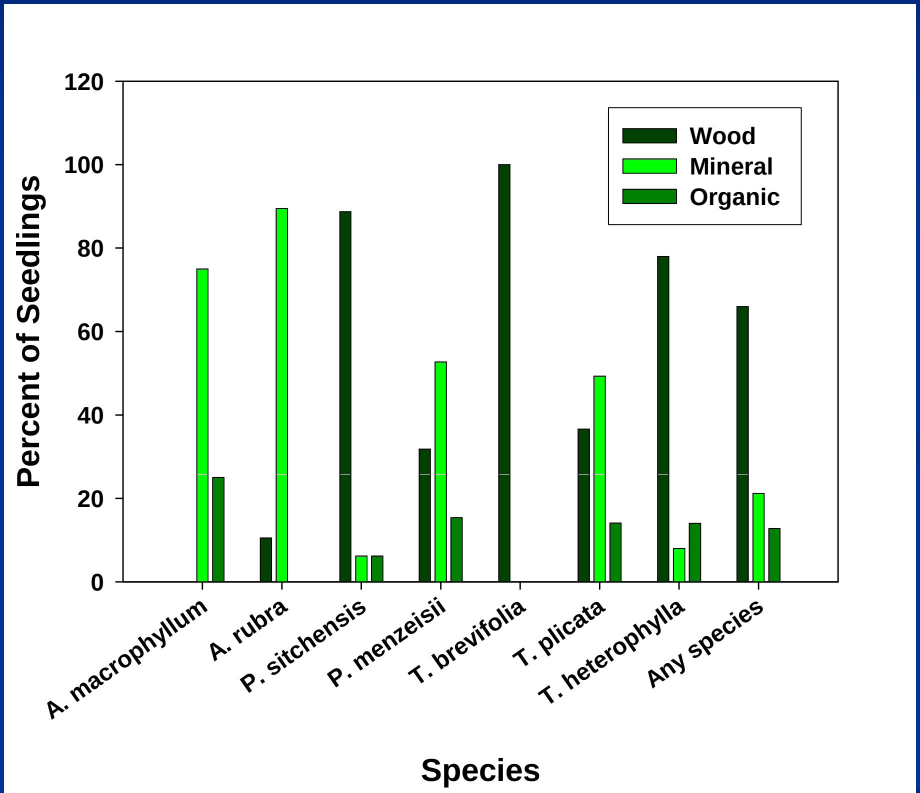
Understory Species Richness:



Hibbs and Bower (2001)

Regeneration: Frequency of Occurrence and Substrate Affinity





Density Management and Buffer Width Influences on Riparian Microclimate and Microsite

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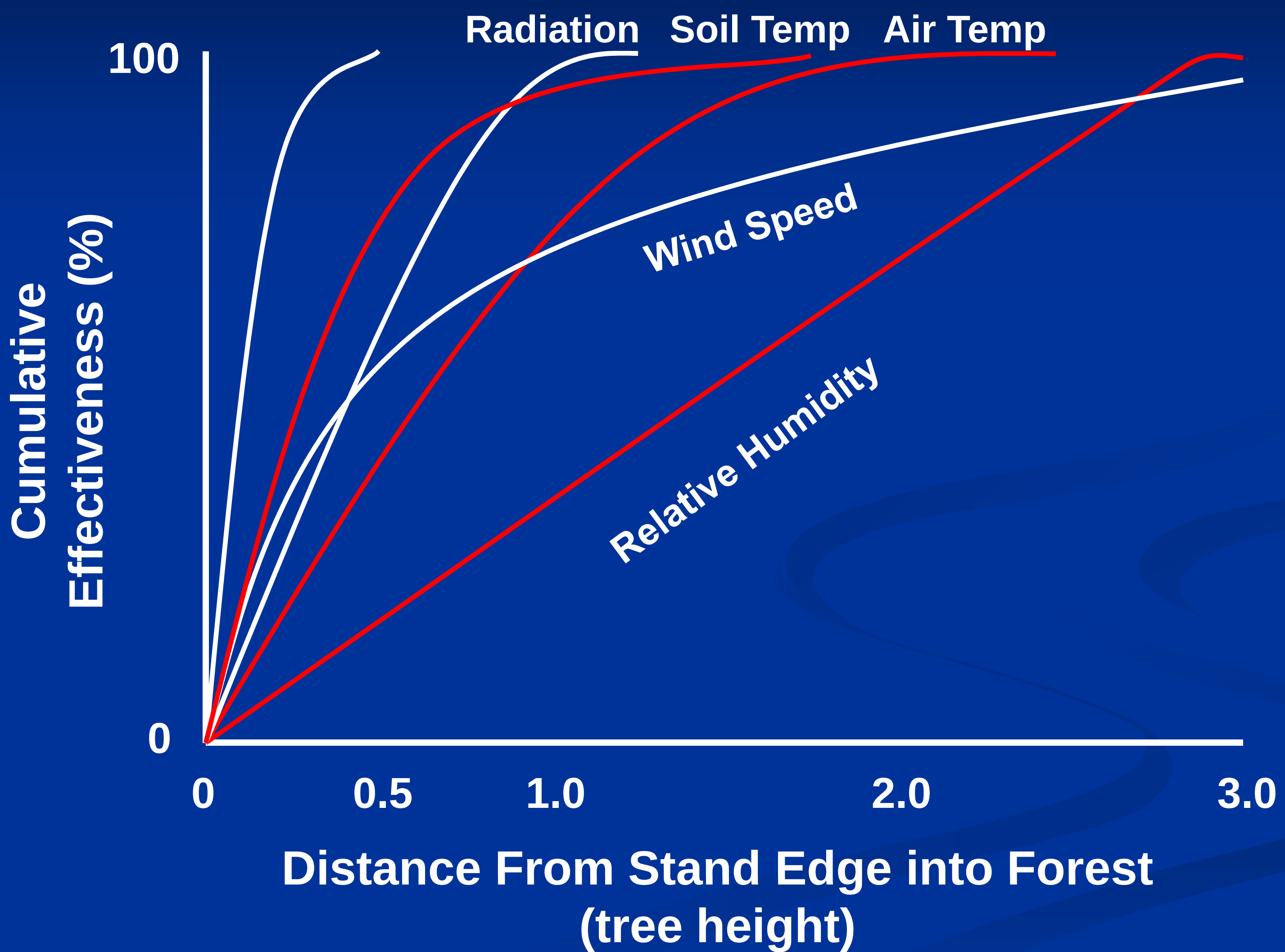
Pacific Northwest Research Station
USDA Forest Service

Riparian Buffers: Microclimate Moderation

- Buffers influence microclimate in several ways
  - Decreased insolation
  - Decreased airflow
  - Increased insulation
  - Increased humidity

How Wide Should Buffers Be? Microclimatic Edge Effects

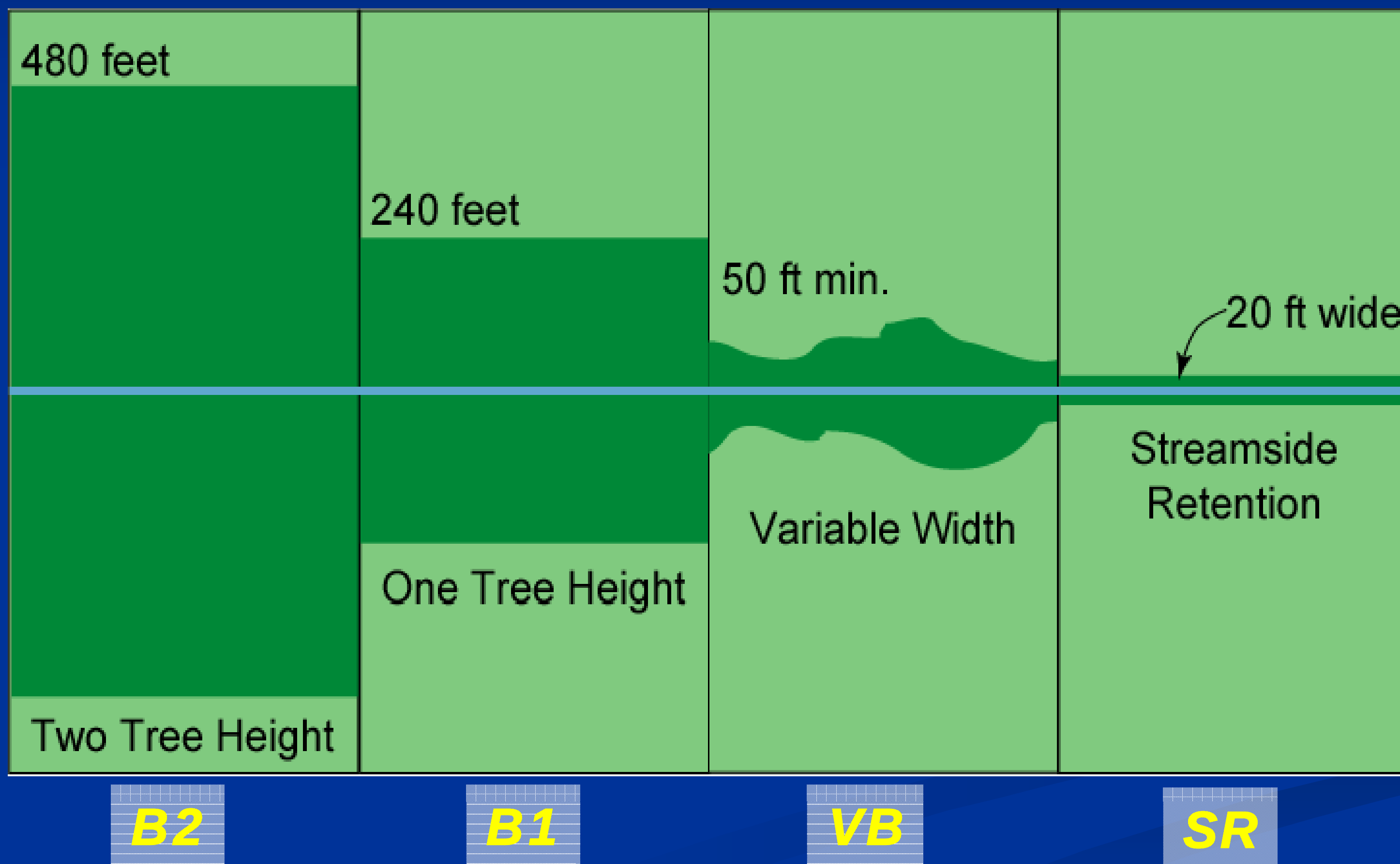


Redrawn From FEMAT (1994)

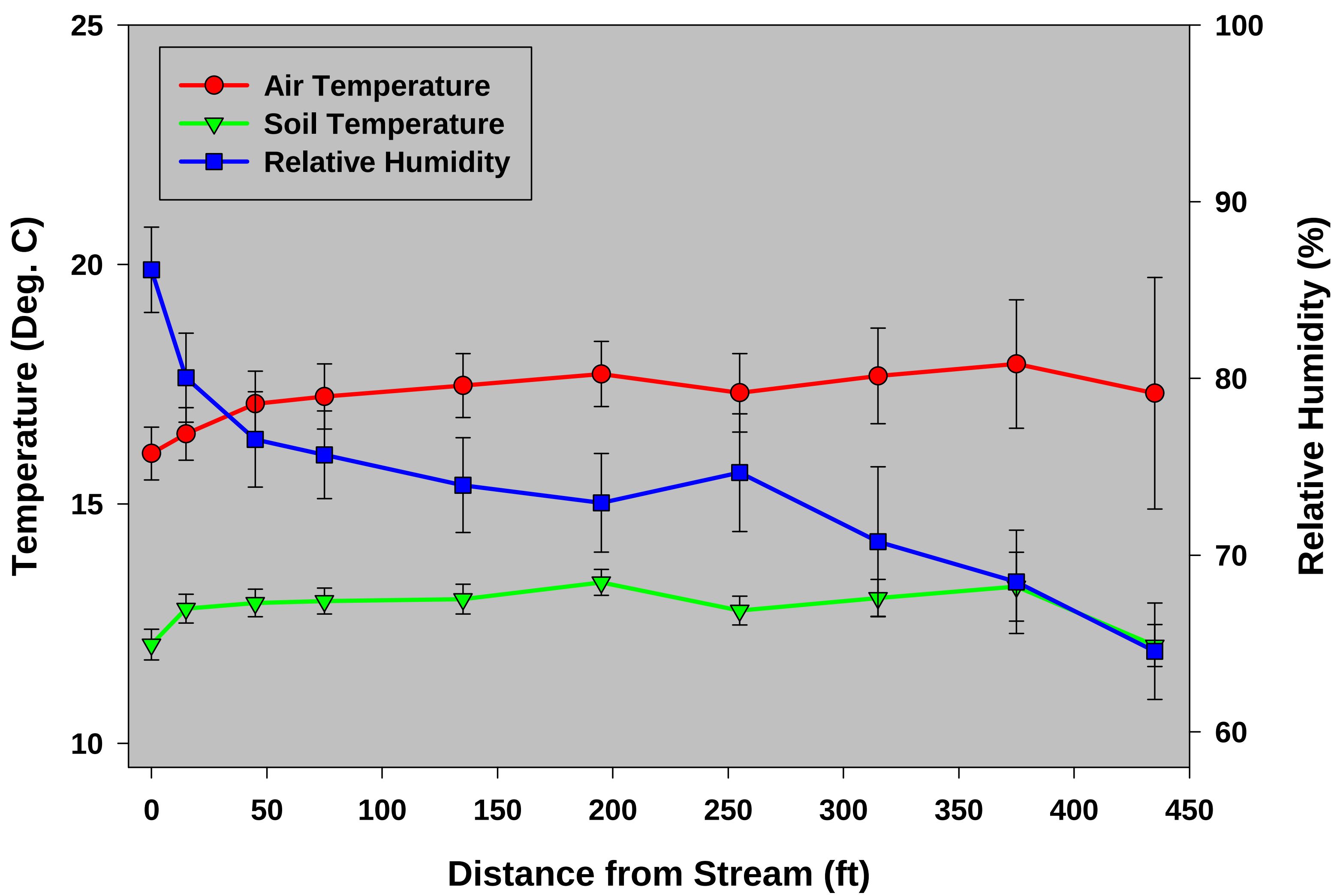
Factors influencing the effectiveness of buffers as a source of shade

- Stand Structure
  - Stand density
  - Stand height
  - Live crown length
  - Foliage density
  - Species composition
  - Understory
  - Down wood
- Hydrophysiography
  - Channel width
  - Channel profile
  - Stream orientation
  - Stream depth
  - Stream flow

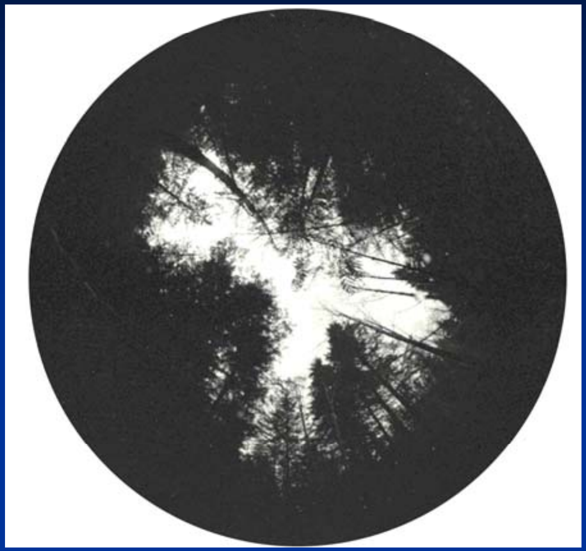
Riparian Buffer Alternatives



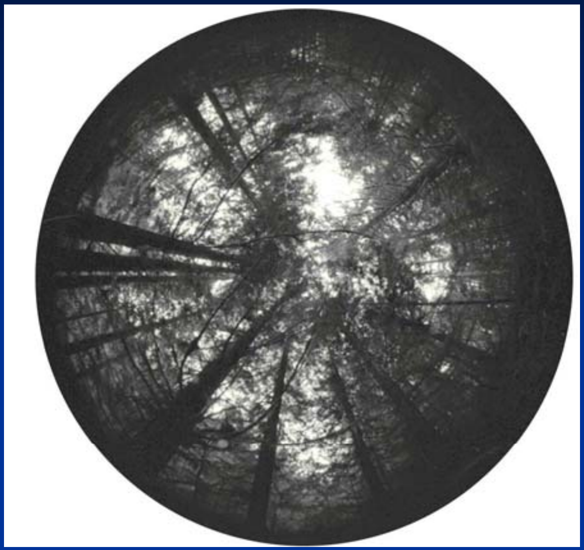
Microclimate Gradients – Unthinned Stands
Summer 4 PM



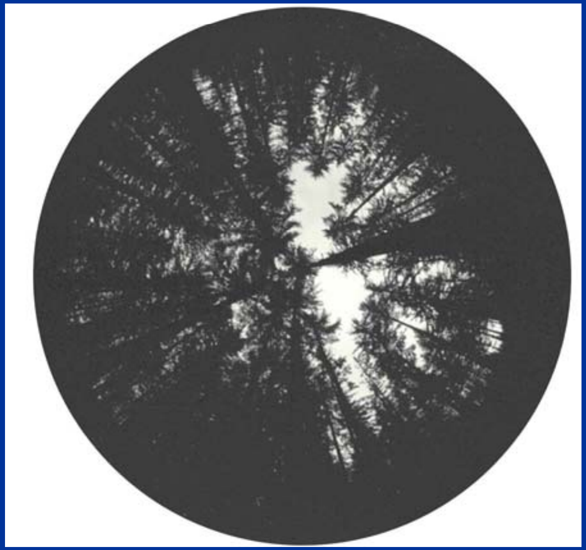
Canopy Transmittance Along "Typical" Transect: A one-tree–height buffer into a moderate (80 tpa) thinning



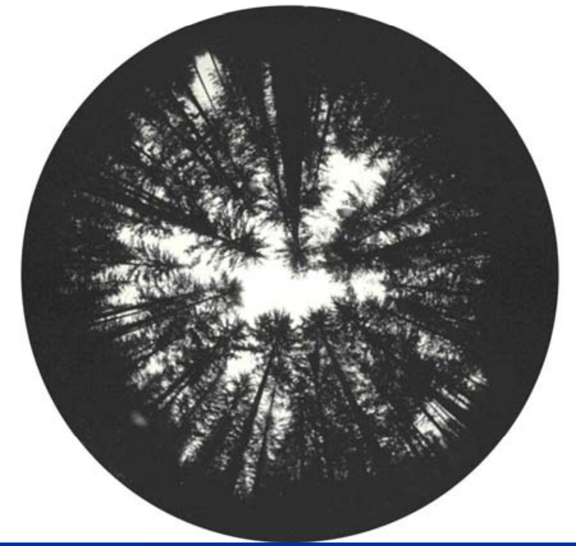
Stream Center (0 ft) - 13%



Buffer (75 ft) - 5%



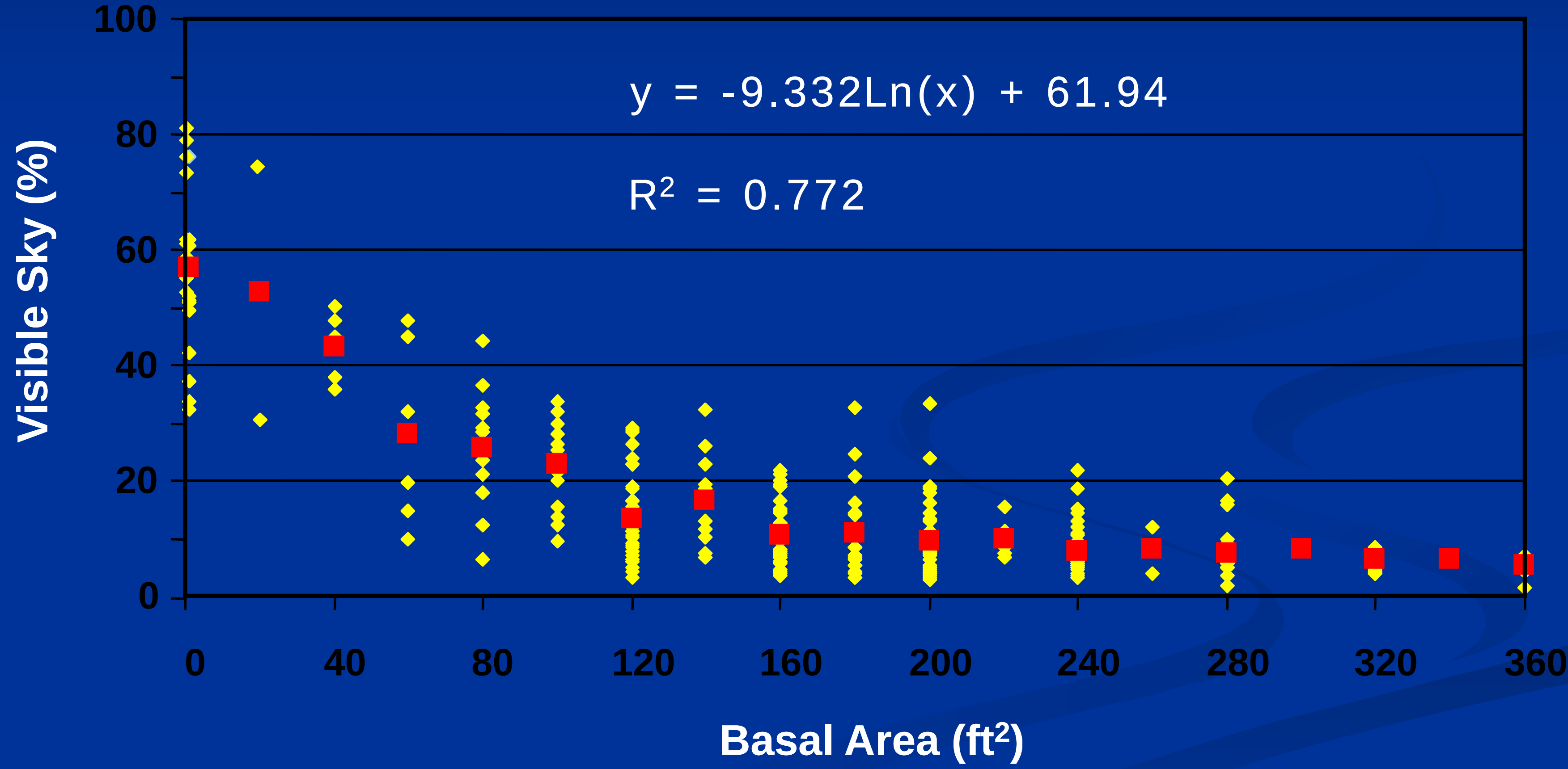
Buffer Edge / 80 TPA (255 ft) - 8%



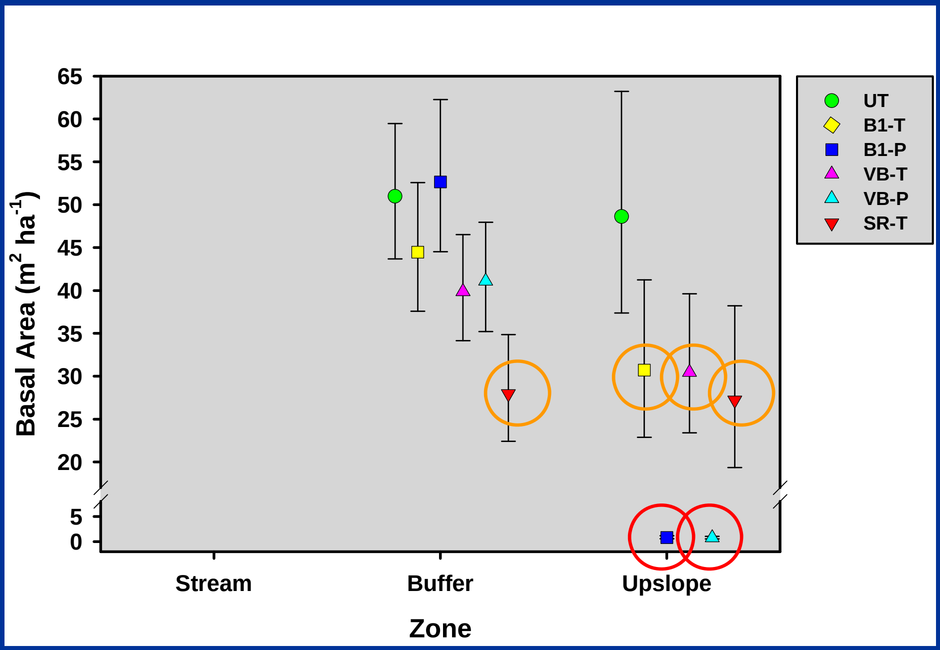
80 TPA Thinning (375 ft) - 12%

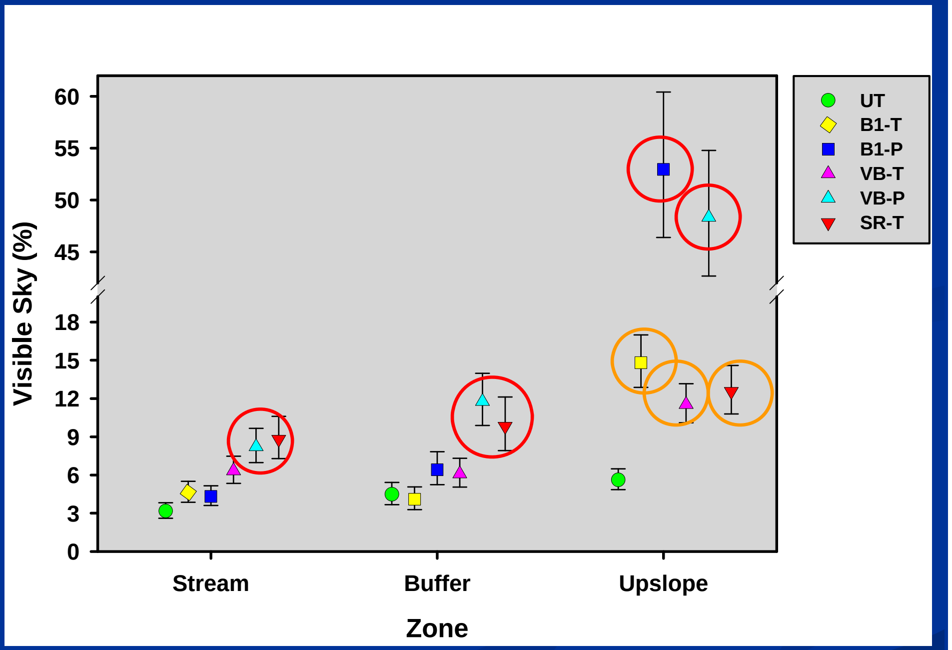
Light Transmittance in Relation to Basal Area:

Observations Across Six DMS Sites



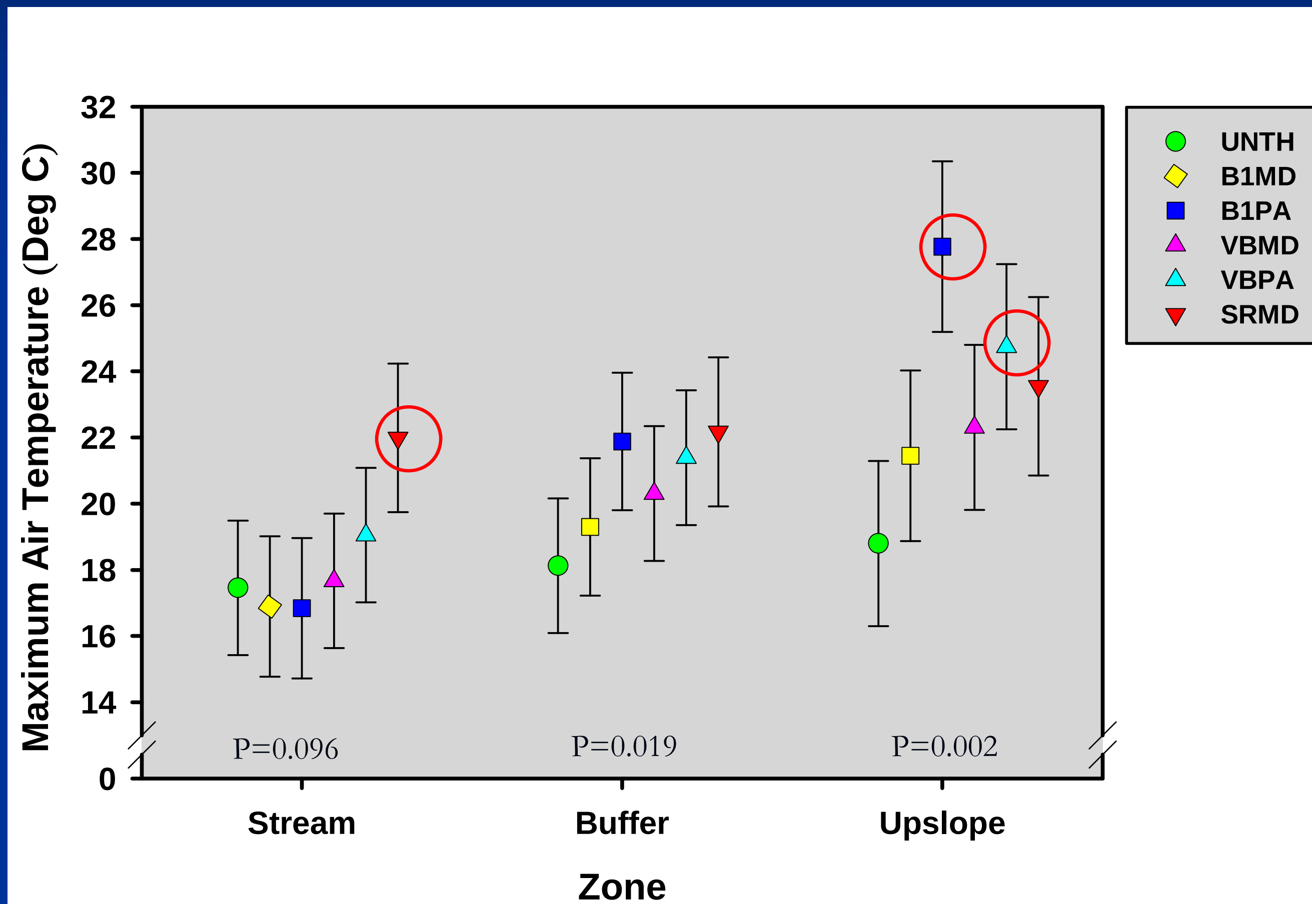
Basal Area – Light Relationships: 30-60 yr-old Douglas Fir





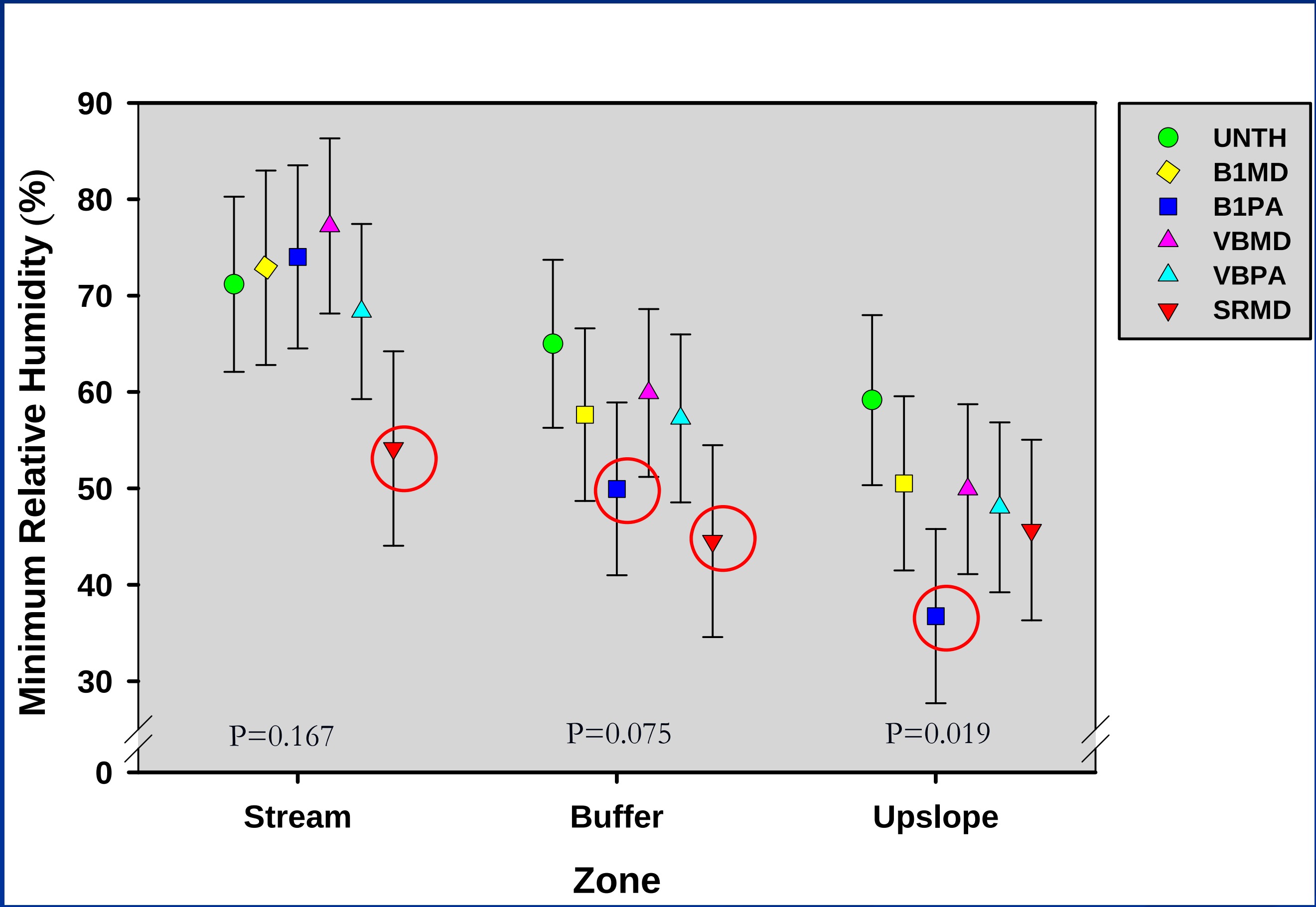
For each zone, circled means statistically differ from that of the unthinned control

Mean Daily Maximum Air Temperature by Zone



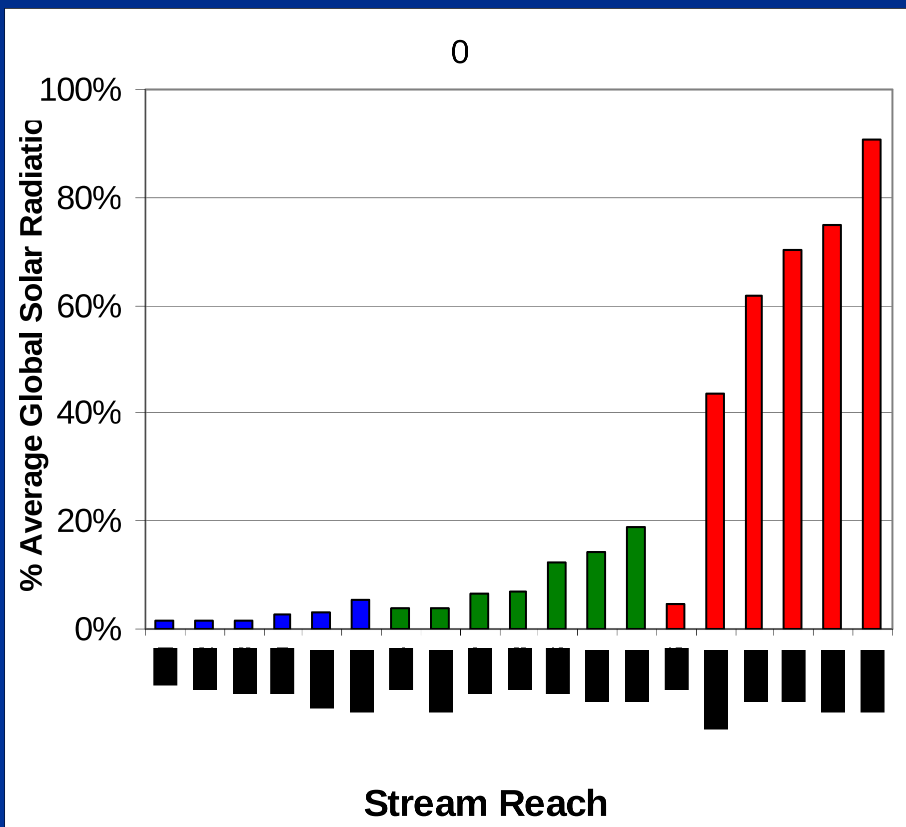
For each zone, circled means statistically differ from that of the unthinned control

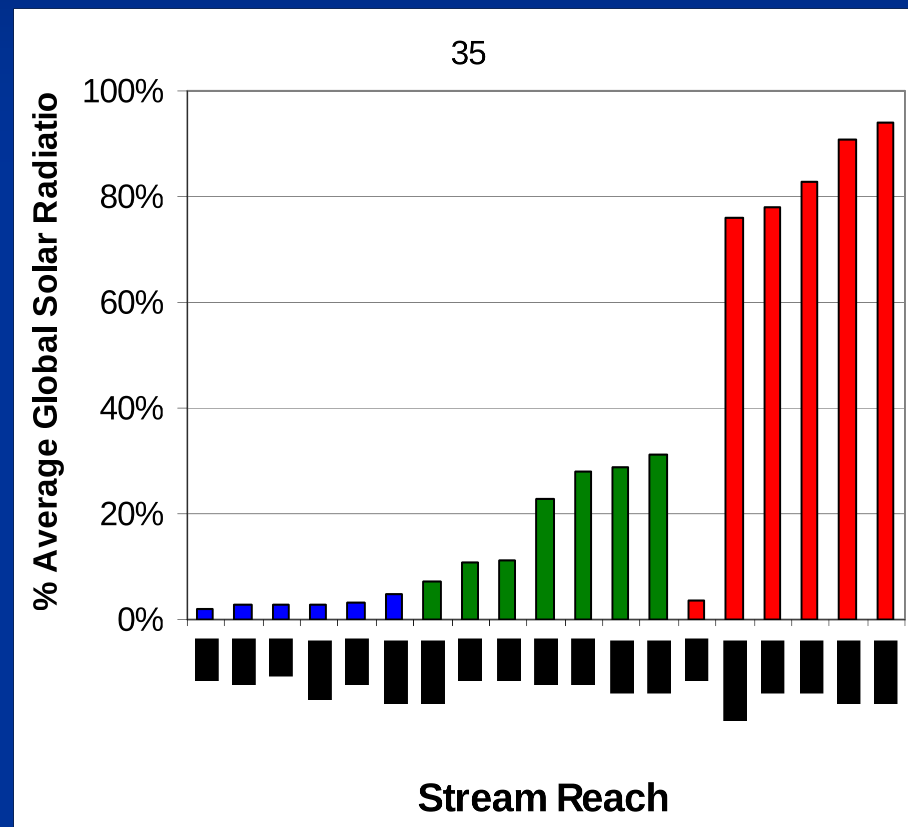
Mean Daily Minimum Relative Humidity by Zone



For each zone, circled means statistically differ from that of the unthinned control

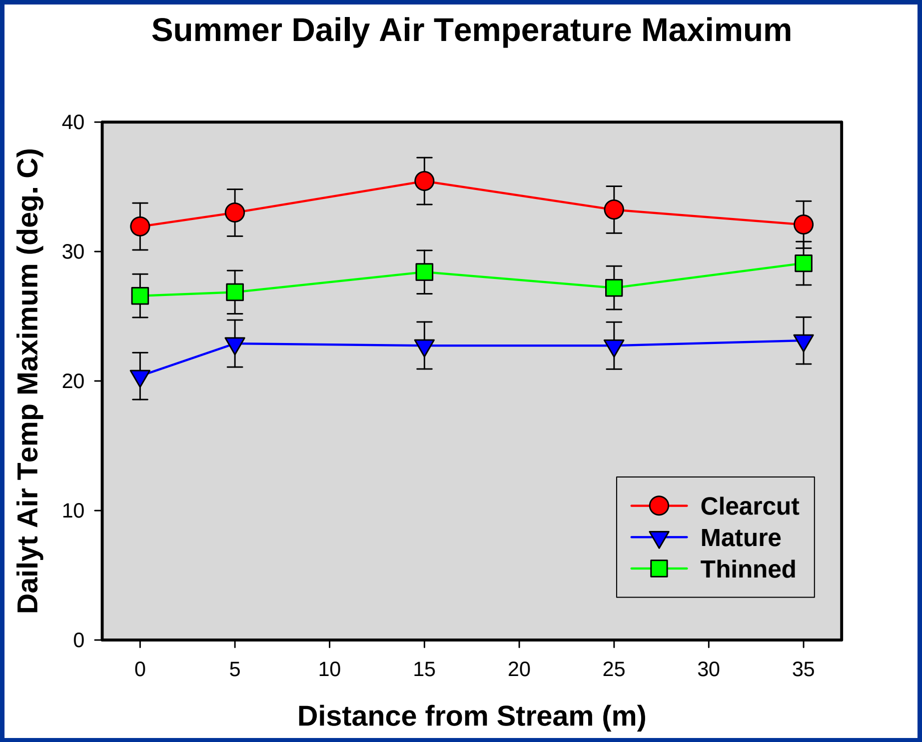
Retrospective Assessment: Thinning versus Clearcut without Buffers

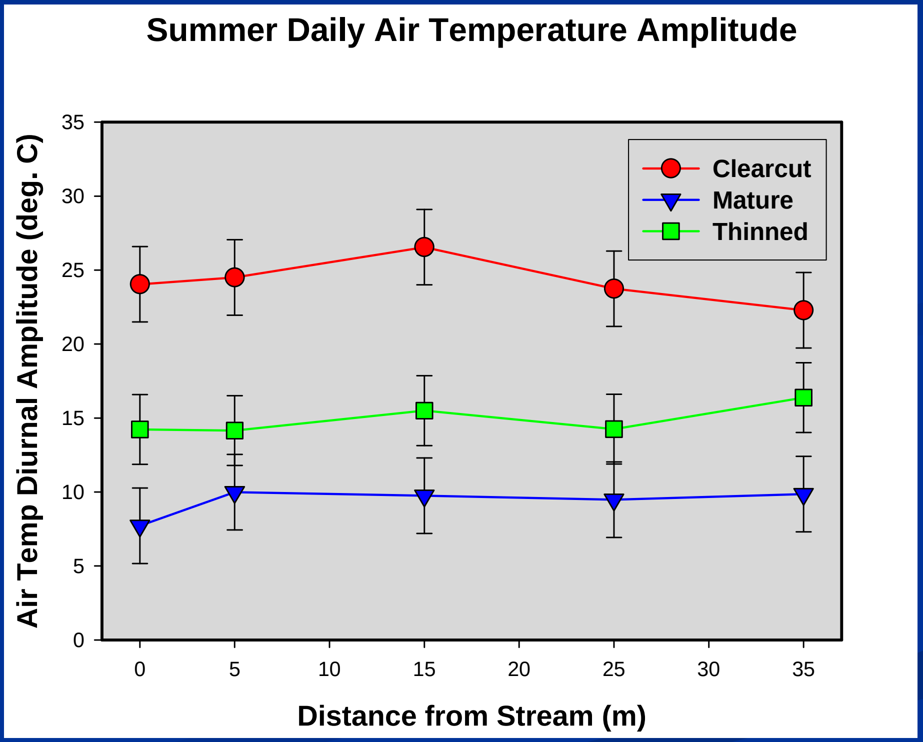




Chan et al. In Prep

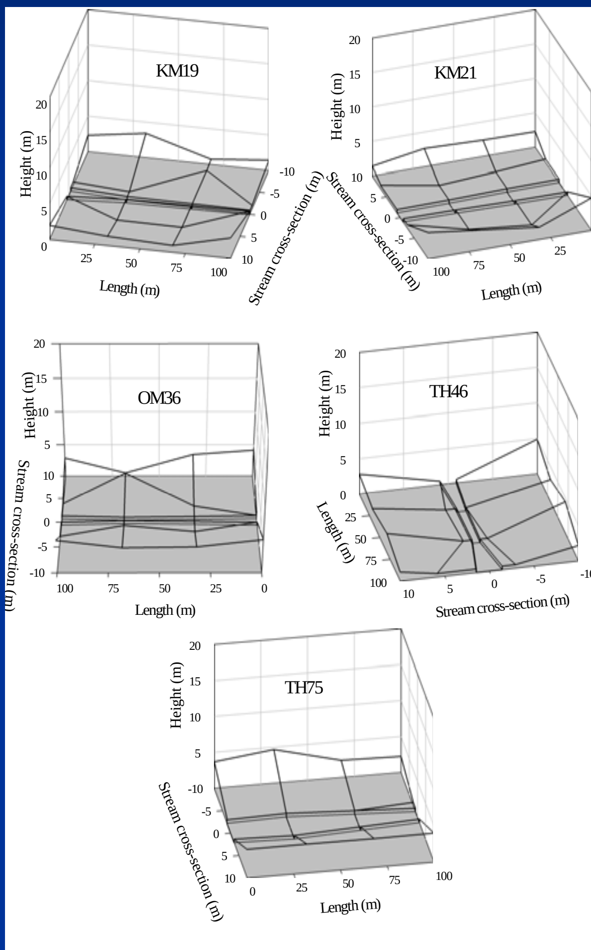
Air Temperature Response: Thinning versus Clearcut without Buffers





Chan et al. In Prep

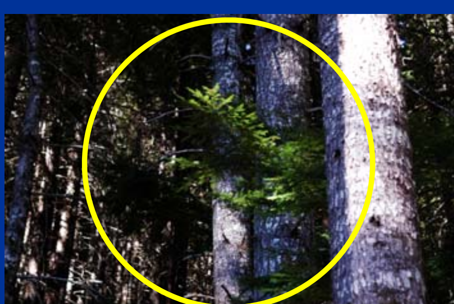
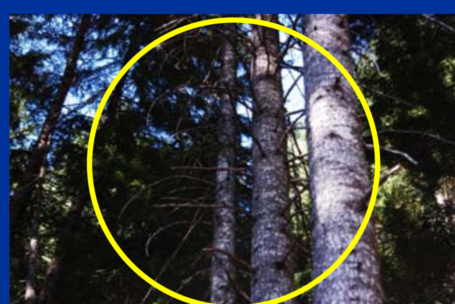
Channel Orientation and Side Slope: Correlation with Microclimate

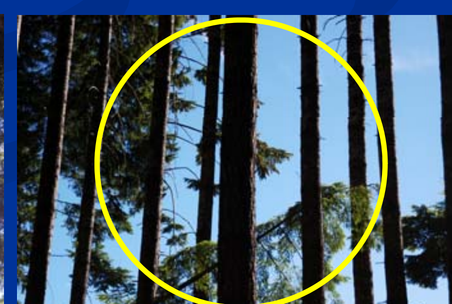


Microclimate Variable	Stream Width	Valley Width	Side Slope	Orientation
Temp Mean	-0.28	-0.19	0.21	**-0.44**
Temp Min	0.04	0.06	**0.52**	**-0.64**
Temp Max	-0.01	0.01	0.28	-0.41
Temp Amp	0.09	0.02	0.10	-0.24
RH mean	-0.10	0.02	-0.20	**0.70**
RH Min	-0.20	-0.05	-0.04	**0.53**
RH Max	-0.19	0.11	-0.23	**0.67**
RH Amp	0.09	0.05	0.01	**-0.49**

Canopy Density in the Shade Zones: Correlation with Microclimate

Microclimate Variable	6 am Secondary	10 am Primary	2 pm Primary	6 pm Secondary	DIFN
Temp Mean	-0.28	-0.19	0.21	0.32	**-0.44**
Temp Min	0.04	0.06	**0.52**	**0.72**	**-0.64**
Temp Max	-0.01	0.01	0.28	0.22	-0.41
Temp Amplitude	0.09	0.02	0.10	0.09	-0.24
RH Mean	-0.10	0.02	-0.20	-0.41	**0.70**
RH Min	-0.20	-0.05	-0.04	-0.16	**0.53**
RH Max	-0.19	0.11	-0.23	**-0.46**	**0.67**
RH Amplitude	0.09	0.05	0.01	0.17	**-0.49**



Microclimate Conclusions

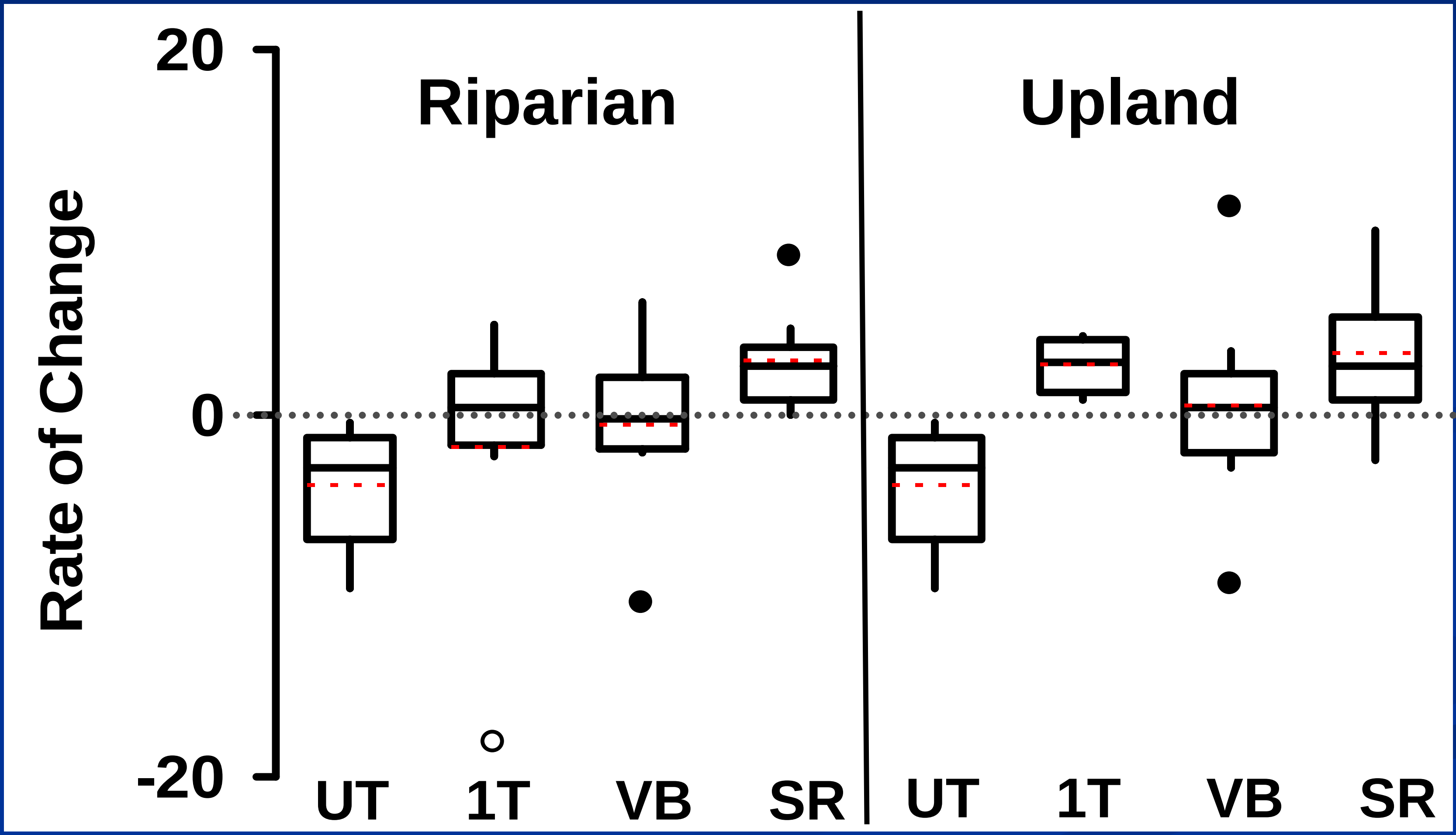
- Basal area in young Douglas-fir stands must be substantially reduced in order to achieve light levels that will potentially stimulate understory vegetation.
- Differences in microclimate along transects with different buffer widths and upslope treatments tend to occur only during the warmest part of the day and in the upslope treated zone.
- Microclimate is moderated within approximately 10m of the stream, regardless of upslope density treatment when buffered a minimum of 15-25 m.

Preliminary Conclusions: Shade Analysis for Headwater Streams

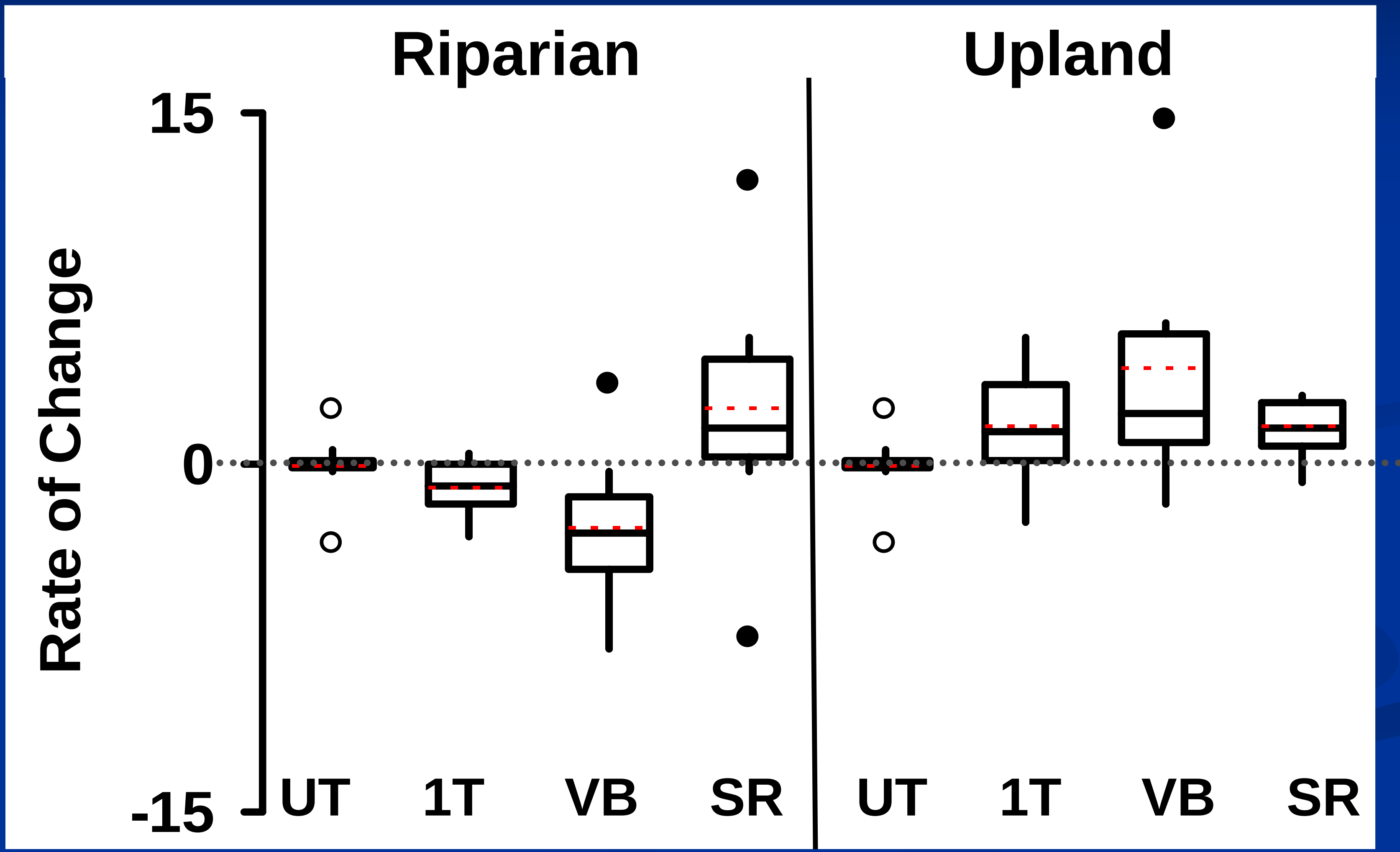
- Topographic shading is an important element of stream shading in headwater streams.
- Streams with a general east-west orientation tend to receive more topographic shading
- Streams with steep side slopes tend to receive more topographic shading
- Vegetation shading effectiveness increases with tree height and canopy density
- The relative importance of topographic shading as compared to canopy shading is difficult to discern in areas of relatively dense, uniform canopy.

Microhabitat Responses to Thinning

Post-harvest Dynamics: Percent Shrub Cover



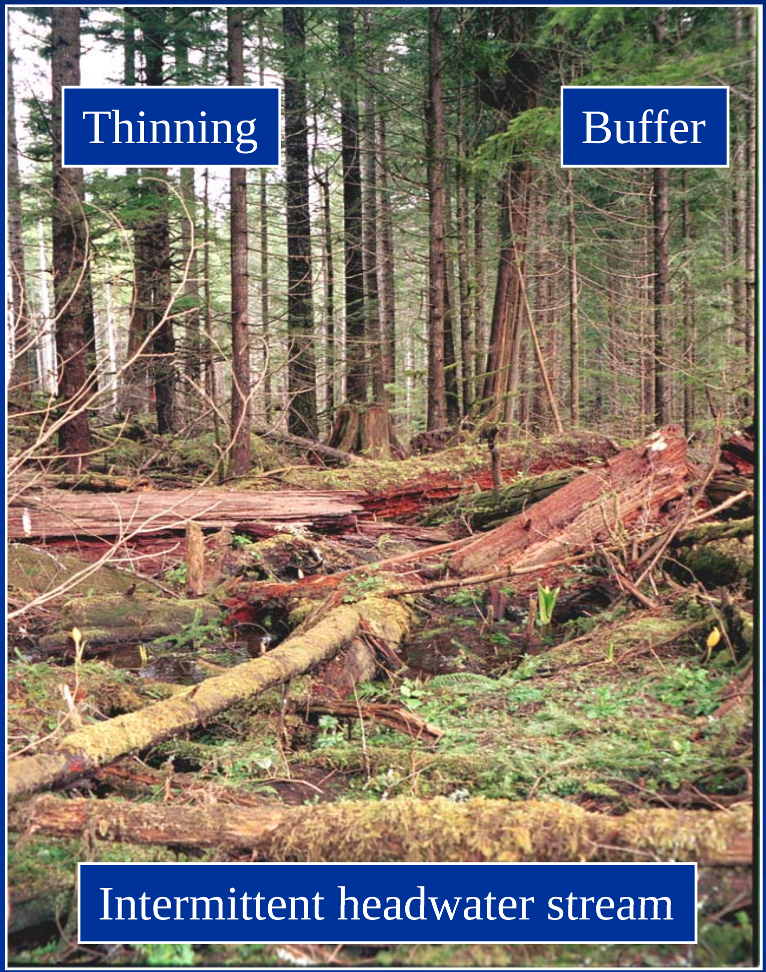
Post-harvest Dynamics: Percent Herb Cover



Riparian Buffer Microhabitat Responses to Thinning

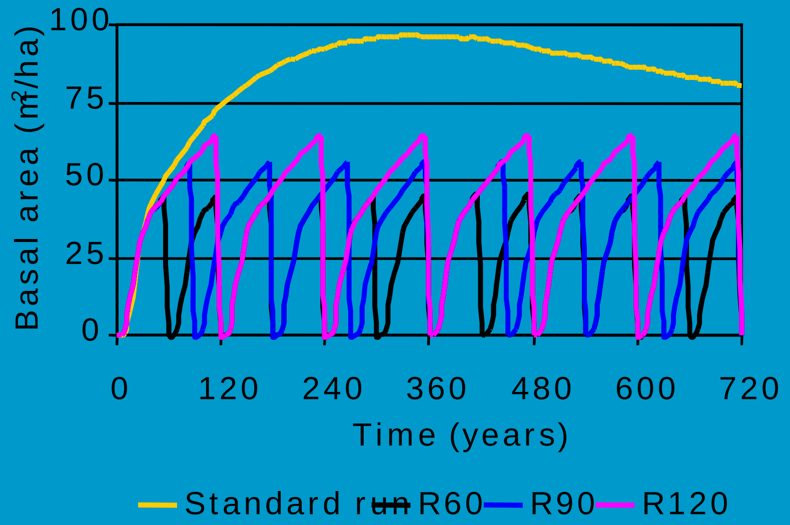
- Buffer zone understory vegetation abundance responded to thinning in the adjacent upland
  - Initially, shrub cover was decreased in narrow buffers with SR buffers being most impacted
  - Herbaceous vegetation cover was increased in narrow buffers with the increase in SR buffers being greater than in the VB buffers
  - Moss cover was much greater in wide buffers than in narrow buffers and the abundance in VB buffers being greater than in SR buffers
- Coarse wood and forest floor responses generally non-detectable

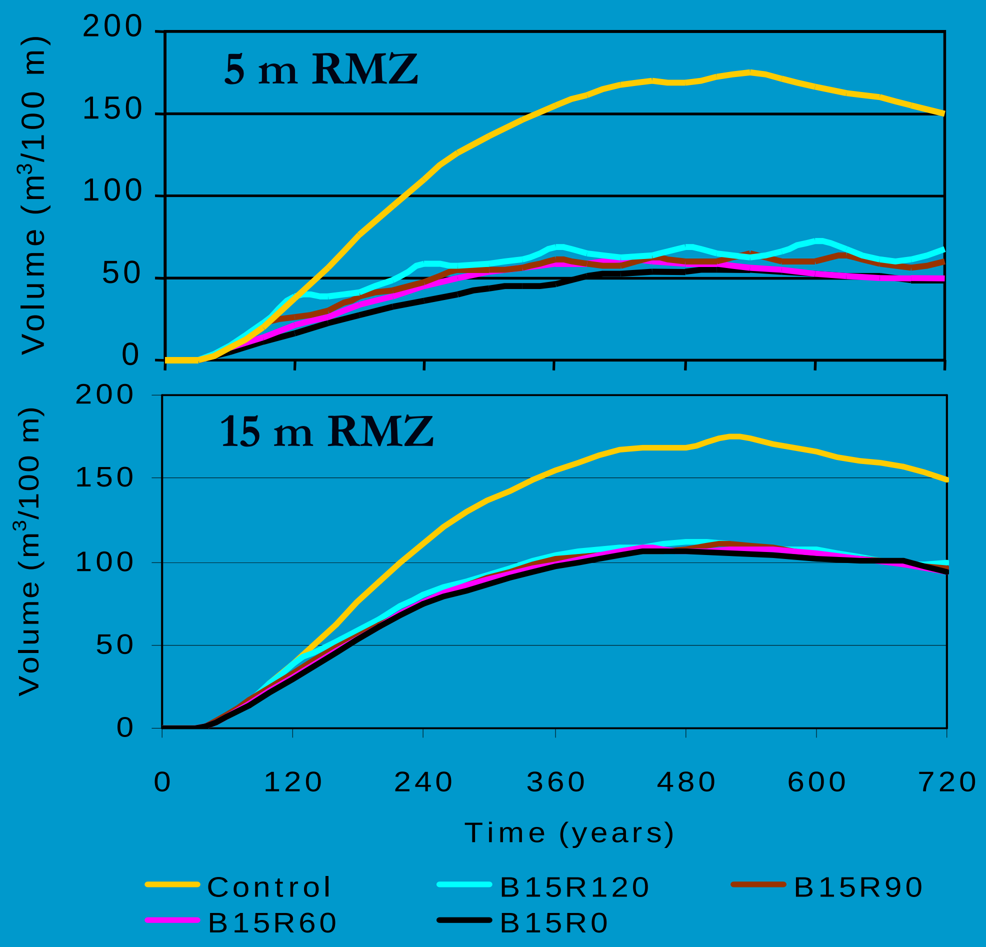
Riparian Zones as a Source of Stream Wood



Supply of Wood to Streams:

Simulation of Total Standing Stock and In-stream Wood by RMZ Width and Rotation Length in Managed Stands



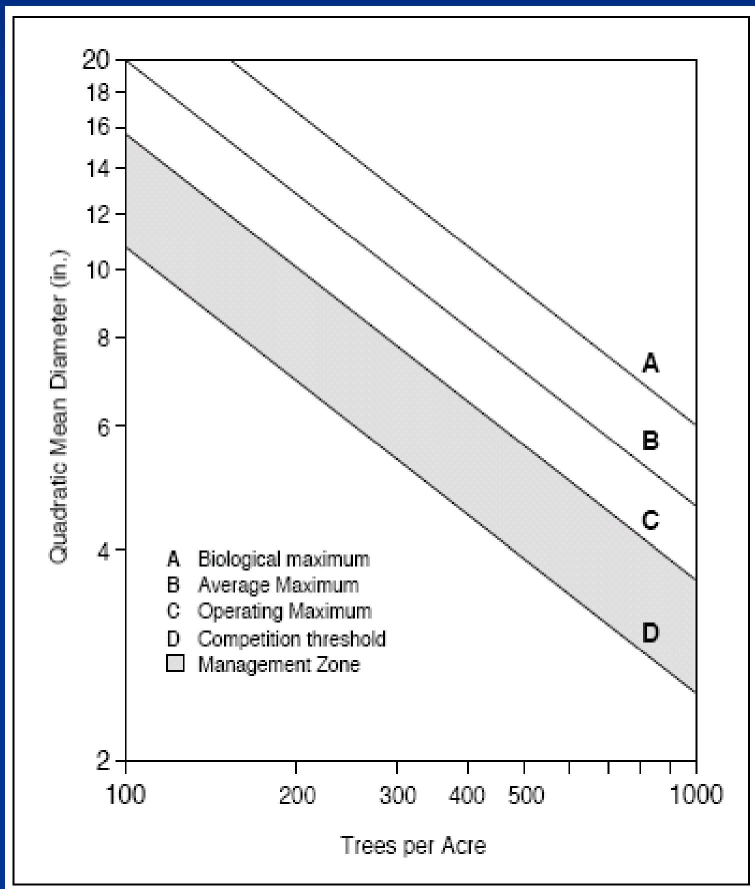


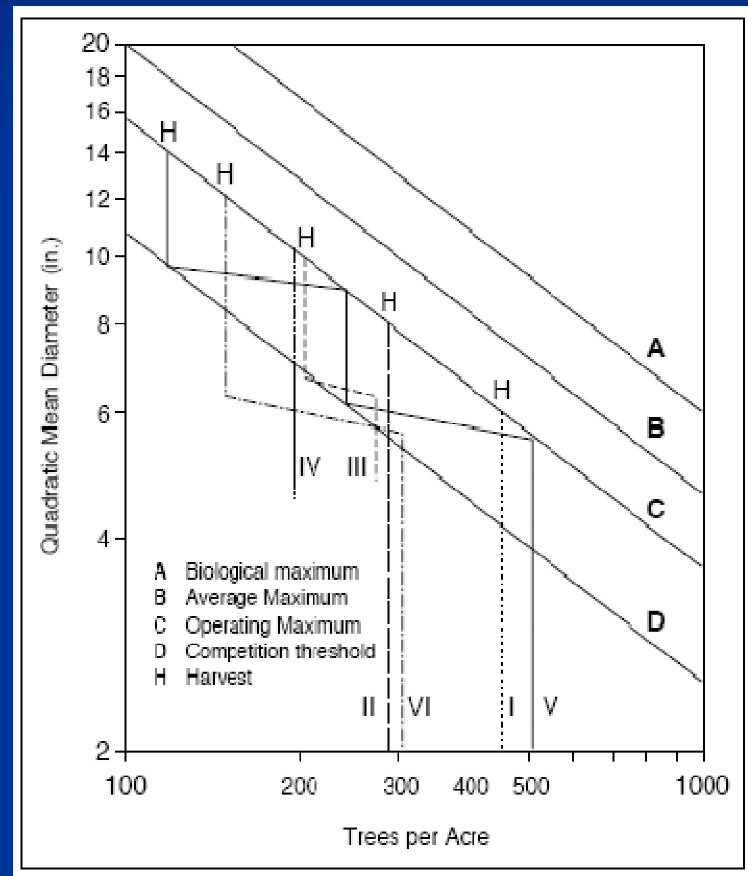
Meleason et al. (2003)

Riparian Zones as a Source of Stream Wood

- The influence of riparian zone width and management regime:
  - Stream wood abundance increases with -
    - Stand age
    - Riparian zone width
    - Proportion of conifer in the stand
  - For plantations, rotation length has little effect on stream wood abundance
- Effectiveness of wood is dependent on piece size
  - The greater the flow, the larger the minimum effective size

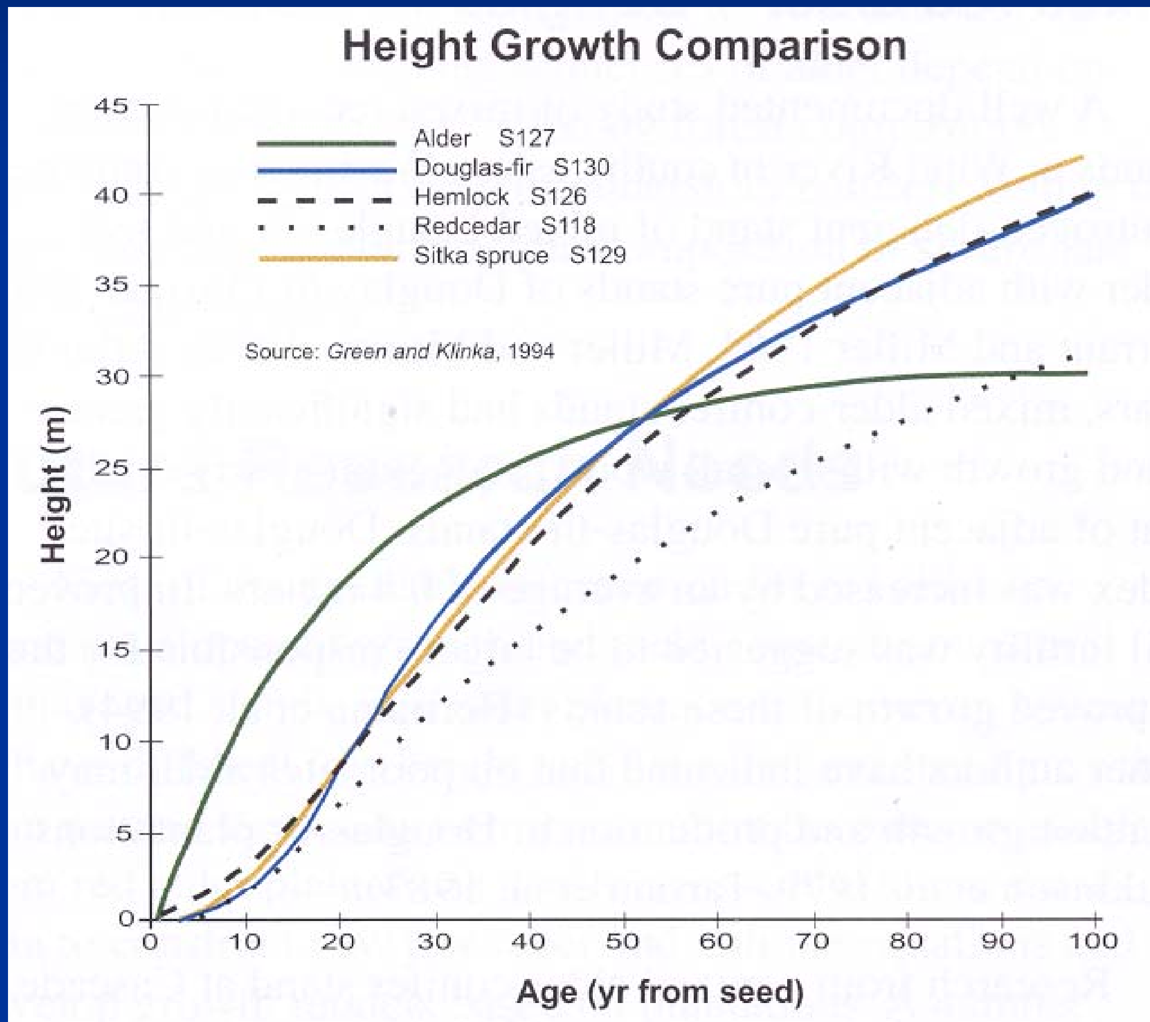
Density Management in Alder





Puettmann 1993

Relative Height Growth of Alder and Conifers



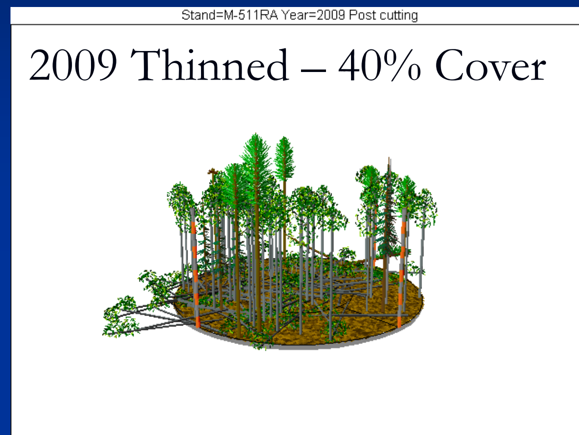
Deal (2007)

Considerations for Alder Thinning

- Alder is relatively short lived
- Demonstrates rapid early growth
- Intolerant species susceptible to growth inhibition if overtopped
- May display poor stem from if grown at low density during early life
- Completes majority of height growth prior to age 40
- Demonstrates little ability to increase crown length with thinning at maturity
- Demonstrates little radial crown expansion in response to thinning

An Example of Alder Thinning: FVS Simulation for McFall Creek

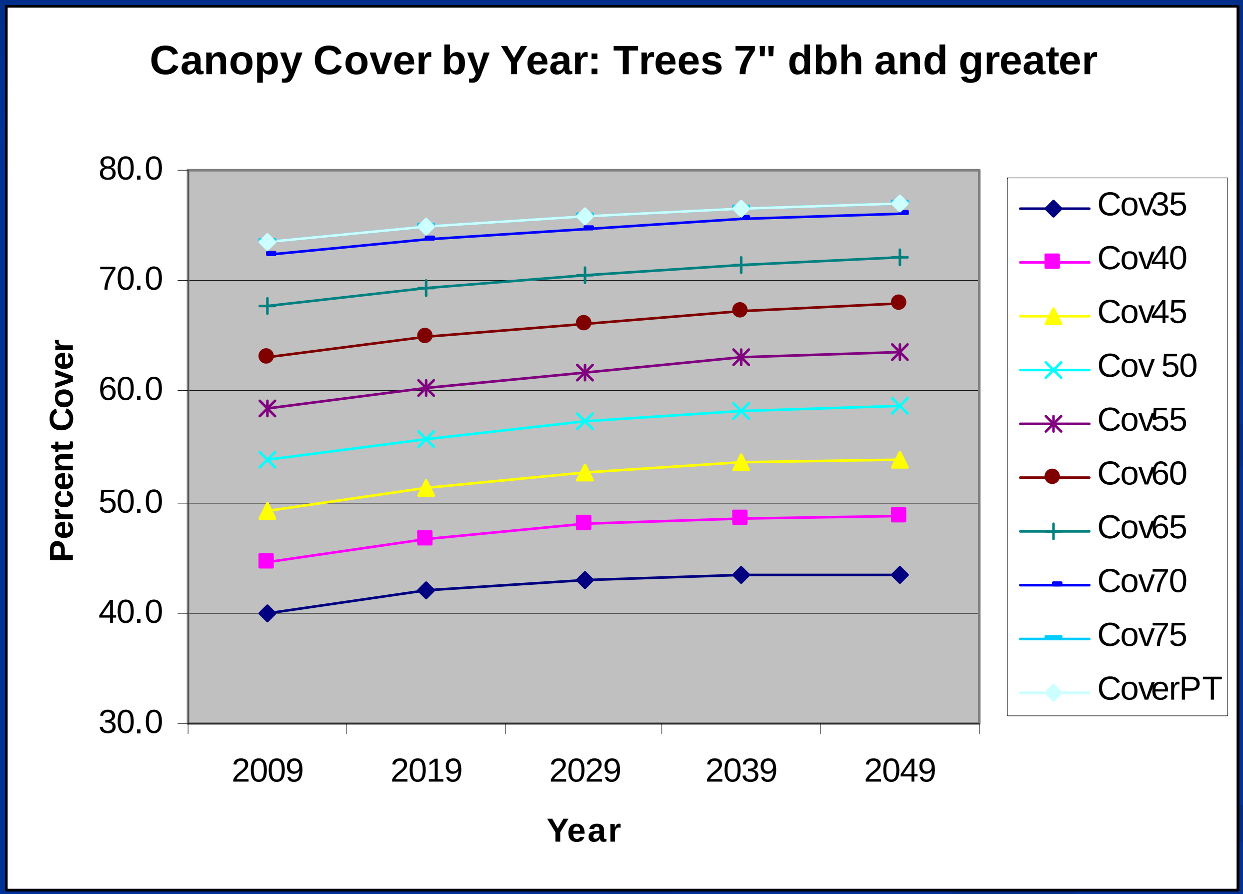
Thinning to a residual canopy cover target:



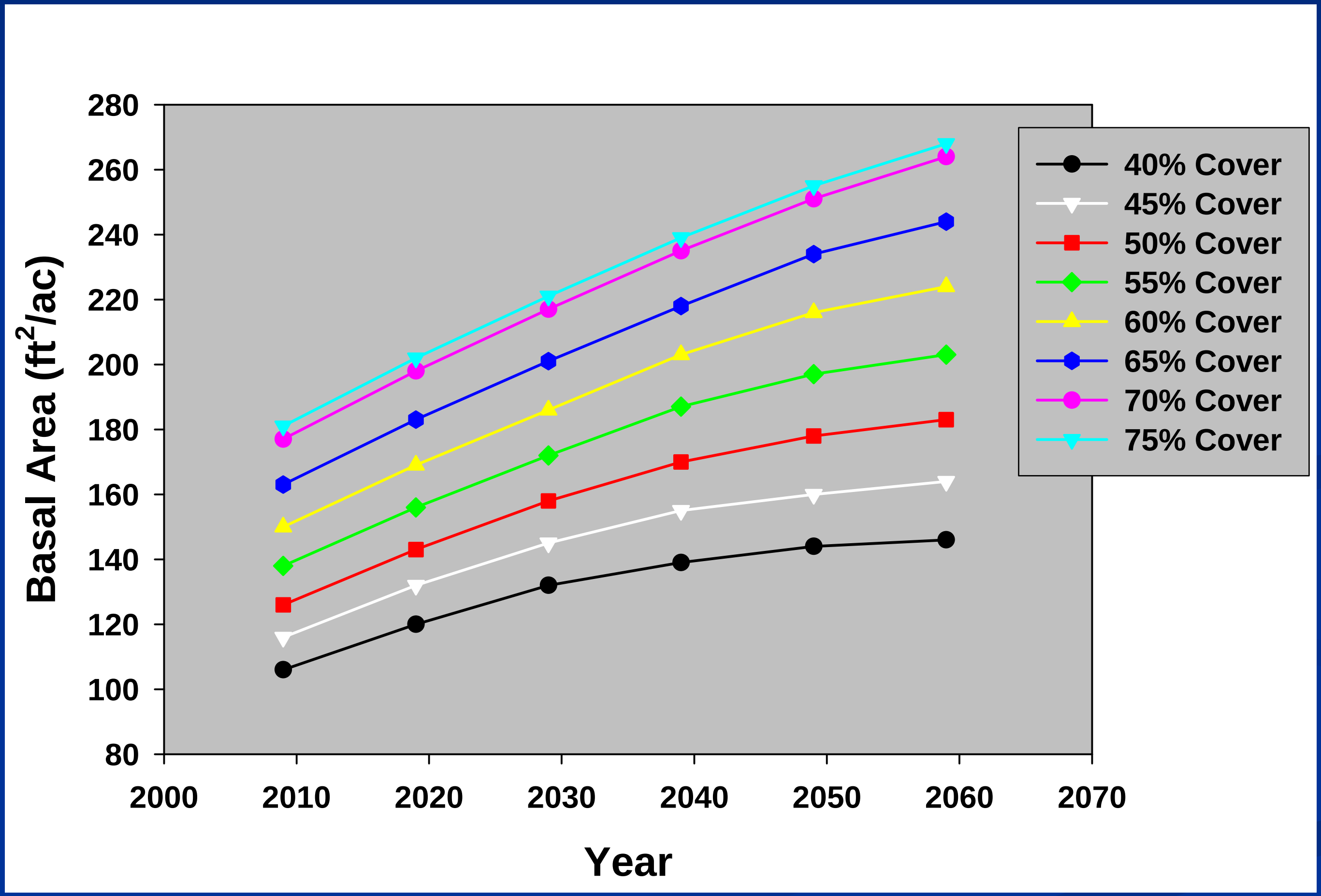
Pre- and Post-Thinning Stand Conditions: Trees >7” dbh

Year	Cover Target	Pre-thin or Residual Stand Attributes					Removals	
		QMD	TPA	BA	RD	%Cov	TPA	BA
Pre-thin 2009	- -	17.7	105	180	48	73	- -	- -
Post-thin 2009	0.40	21.2	43	105	29	40	62	75
	0.45	20.7	50	116	31	45	55	64
	0.50	20.1	57	126	34	49	48	54
	0.55	19.6	65	138	37	54	40	42
	0.60	19.1	75	150	40	59	30	30
	0.65	18.5	87	163	43	63	18	17
	0.70	17.9	101	177	47	68	4	3
	0.75	17.7	105	180	48	72	0	0

Canopy Cover Response



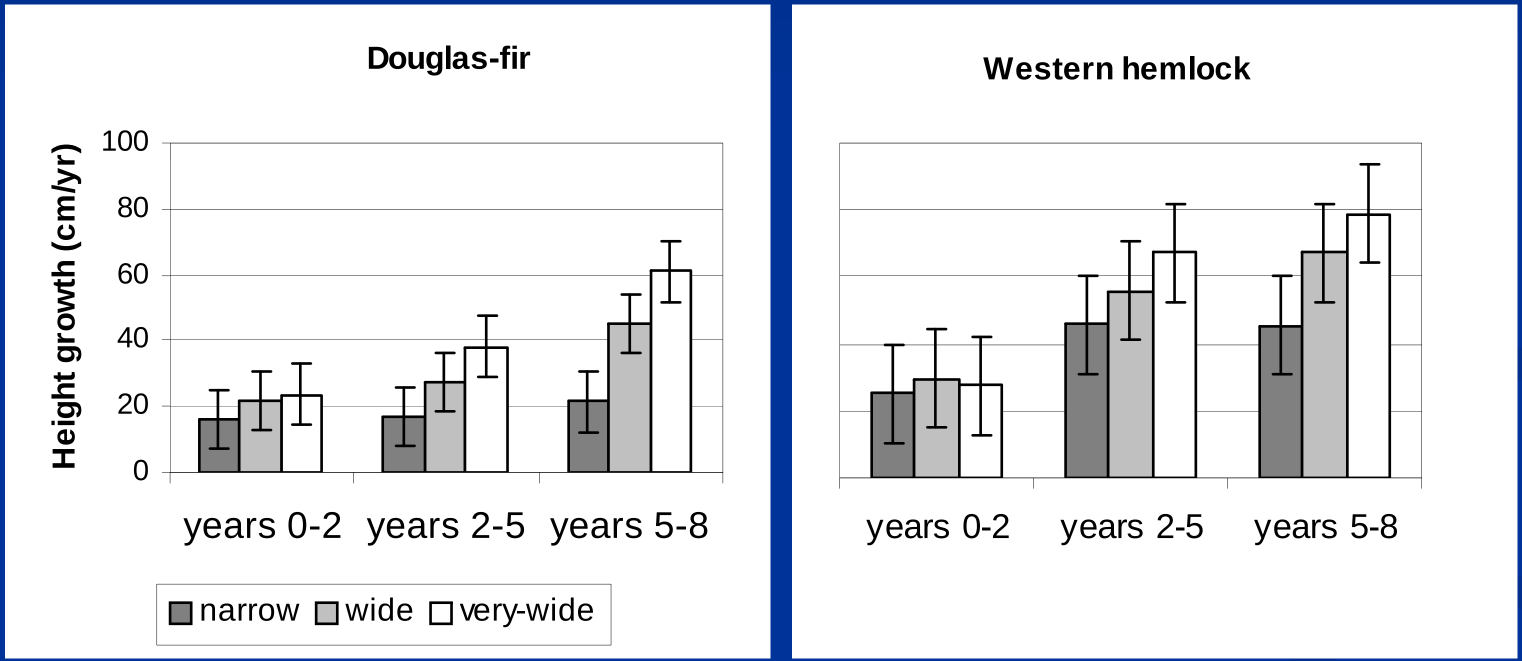
Basal Area Growth Response



Successional Tendencies

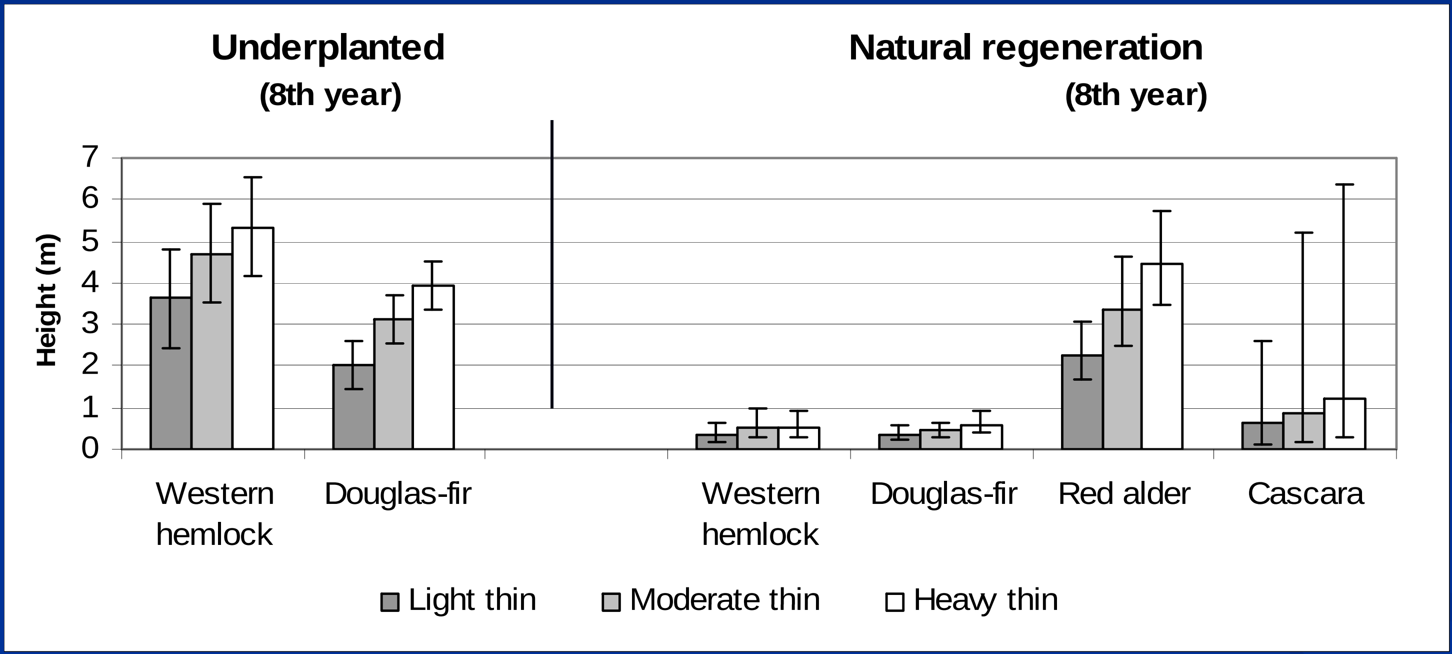
- Alder
  - Without disturbance – transition to shrub dominated stand
  - With disturbance – alder regeneration or transition to shrub dominance
- Conifer
  - Without disturbance – transition to shade tolerant confiners
  - With disturbance – conifer, hardwood or shrub dominance

Development of Underplanted Conifers in Thinned Stands



Chan et al. 2006

Comparison of Underplanted Seedlings and Natural Regeneration



Chan et al. 2006

Summary

- Riparian forests are structurally diverse and dynamic
- Although the silvicultural principles employed are similar to those for upland forests, a different array of management objectives often dictates an application that is unique to riparian forests
- Buffers play several important roles in mitigating impacts of adjacent harvest on riparian areas and streams and in providing habitat and wood inputs
- Although conifers may dominate a landscape, hardwood stands occurring in riparian zones may require specific consideration when practicing density management

Thank You!

Thanks to:

-Dan Mikowski, Val Banner, Jon Sewell, Emmalie Goodwin, Andy Neill, David Larson, Howard Weatherly and Dr. Mark Meleason of the BCTeam

-Dr. Dede Olson and Loretta Ellenberg, PNW ALI

-Larry Larson, John Cissel, Charlie Thompson, Chris Sheridan, George McFadden and the BLM Site Coordinators

-Dr. Bob Danehy and Maryann Reiter, Weyerhaeuser Company; Starker Forests; Boise Corporation

- Sam Chan, Dr. Temesgen Hailemariam, Theresa Marquardt of Oregon State University

Research Funded by:

- USFS PNW Research Station, RMP Program; PNW Sustainable Management Strategies Program; PNW Agenda 2020 Program

- USDI BLM, Oregon