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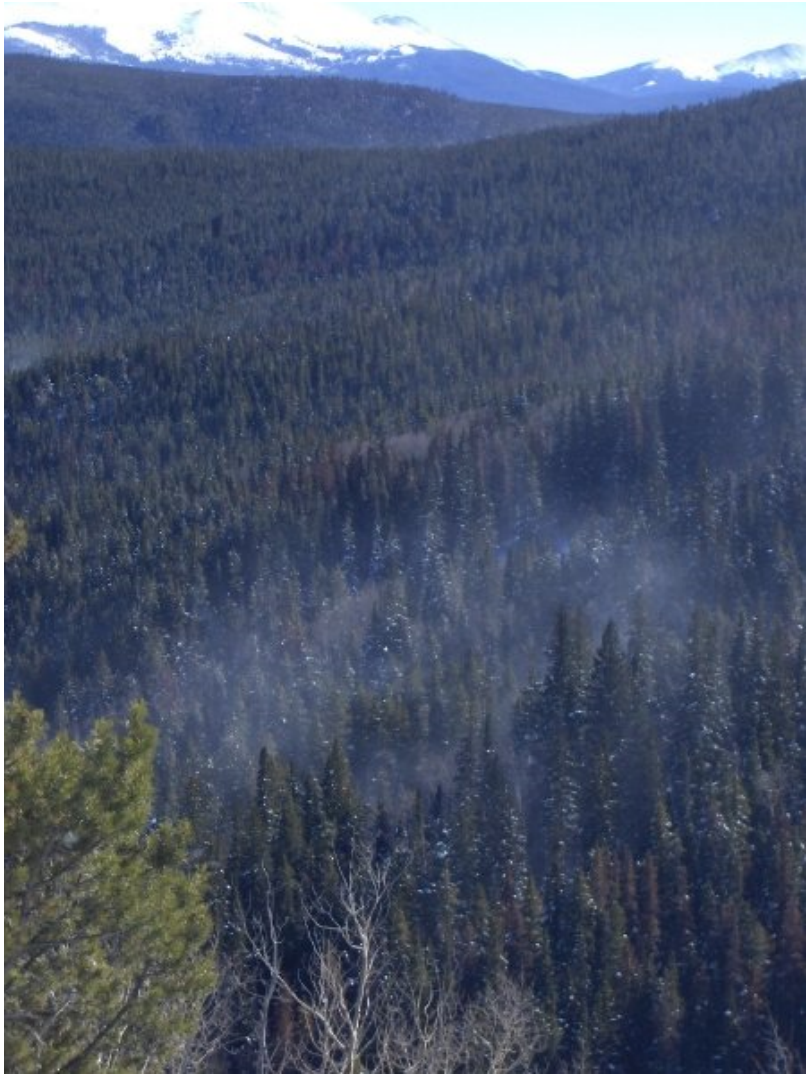
Forest vegetation structure 25-30 years following MPB outbreak: Implications for water yield

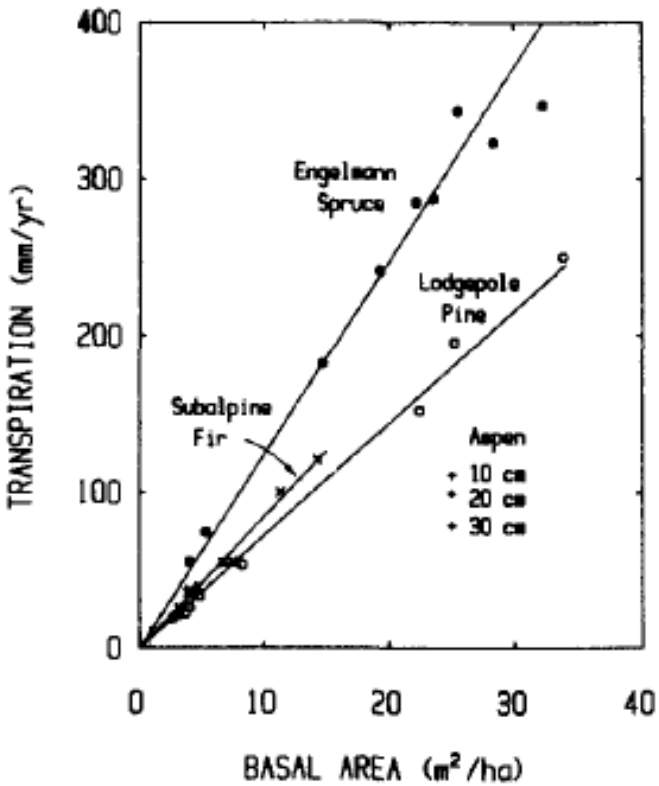
Sub-alpine and H_2O

- Snow
  - Surface accumulation
  - Sublimation
- Trees
  - Transpiration
  - Sublimation
  - Shading

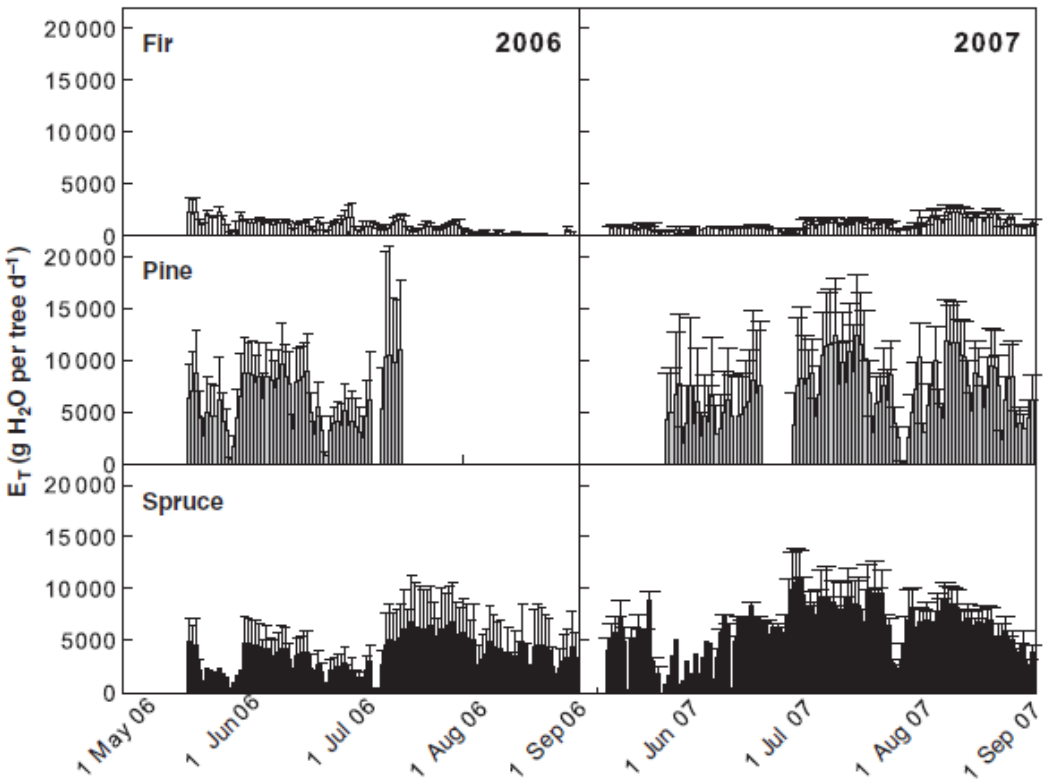


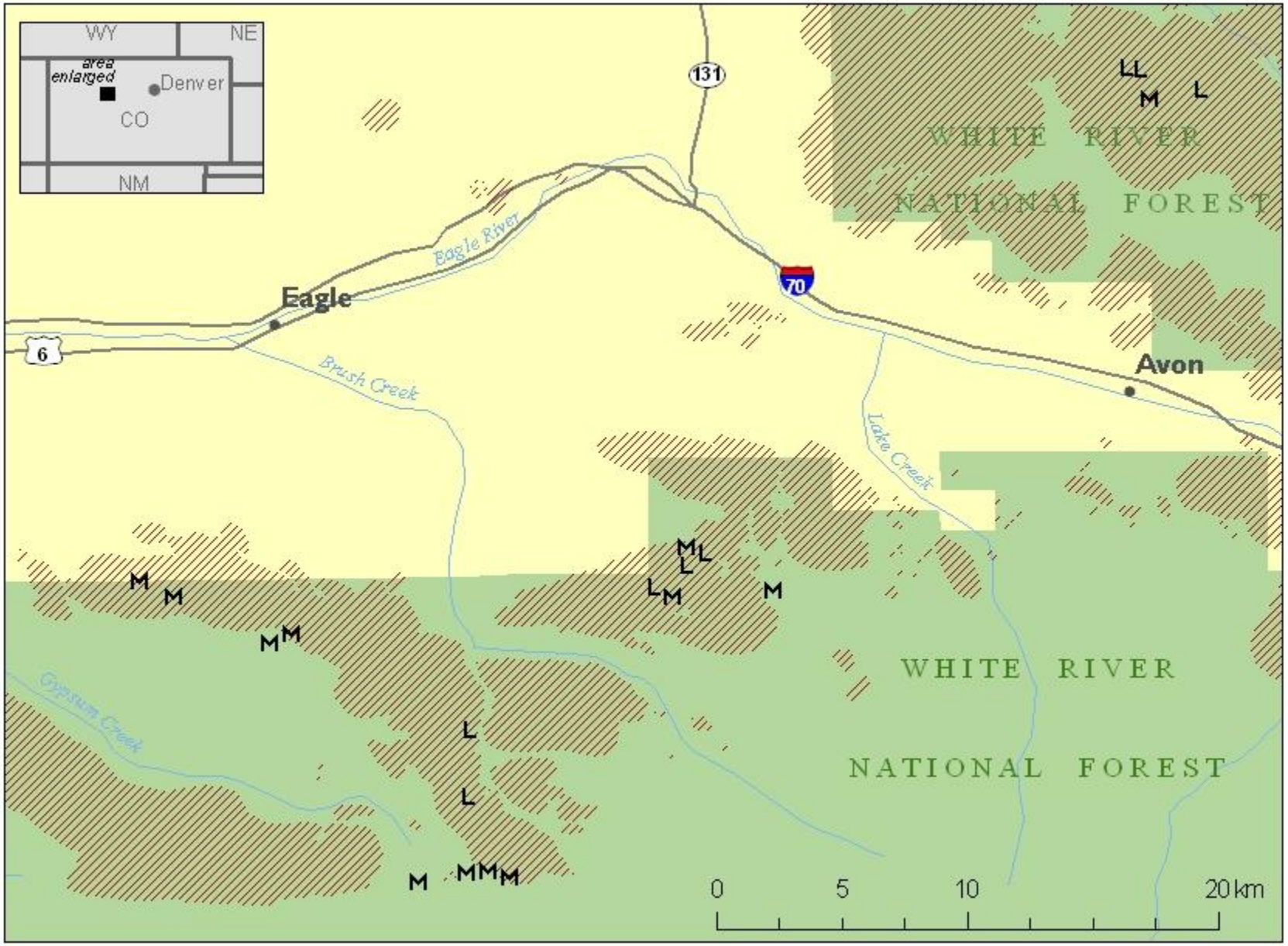
Differences among species transpiration rates

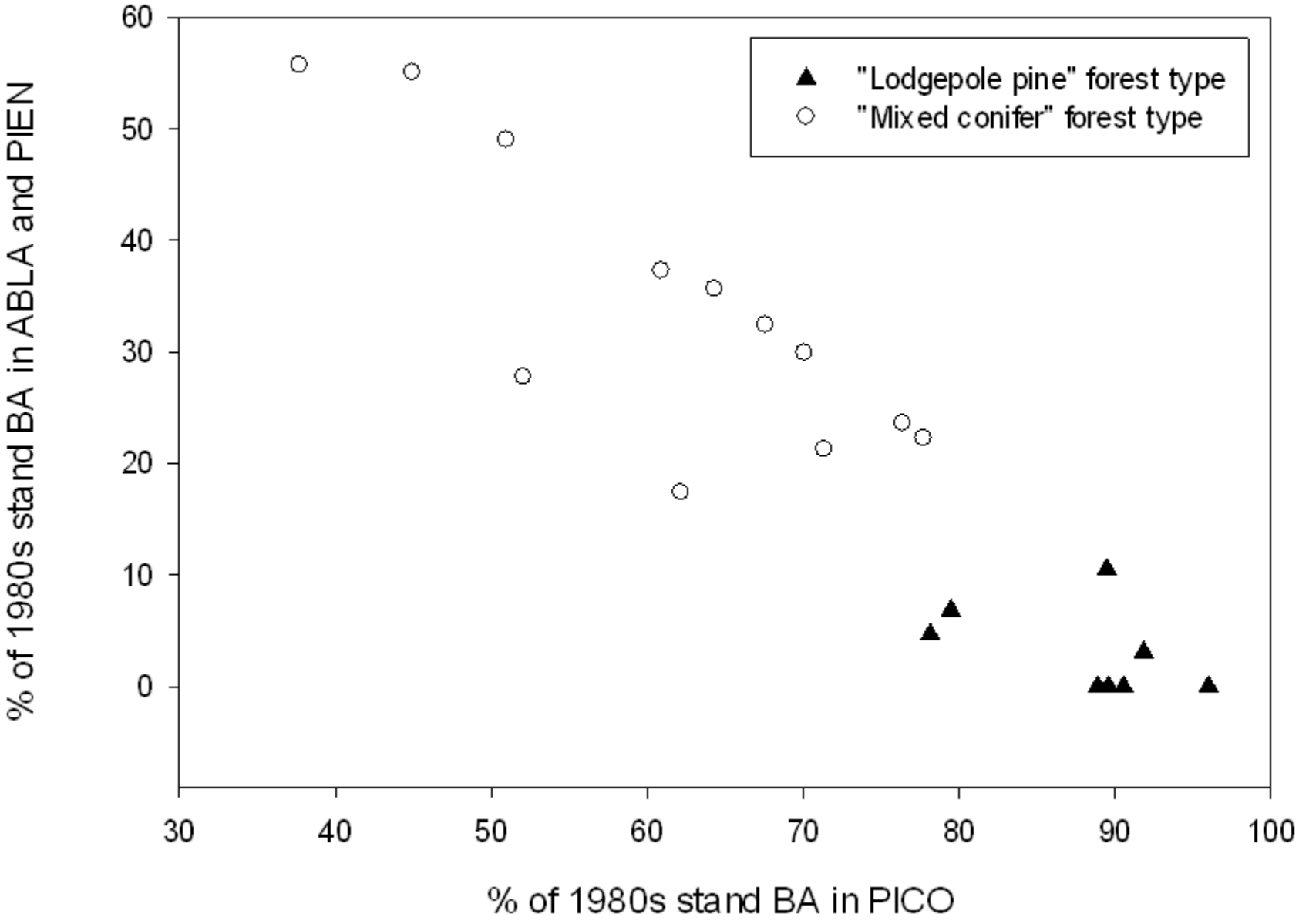
- Kauffmann (1985):

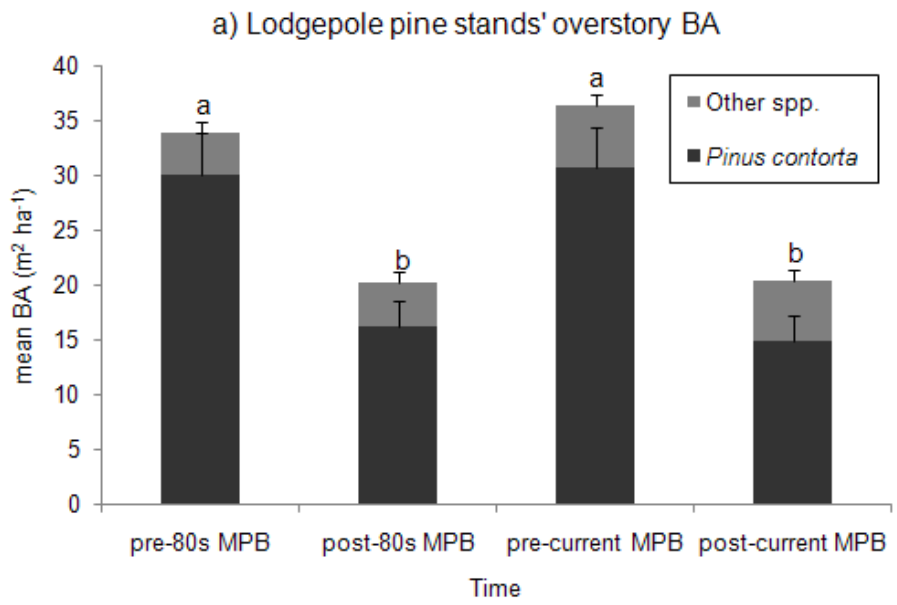


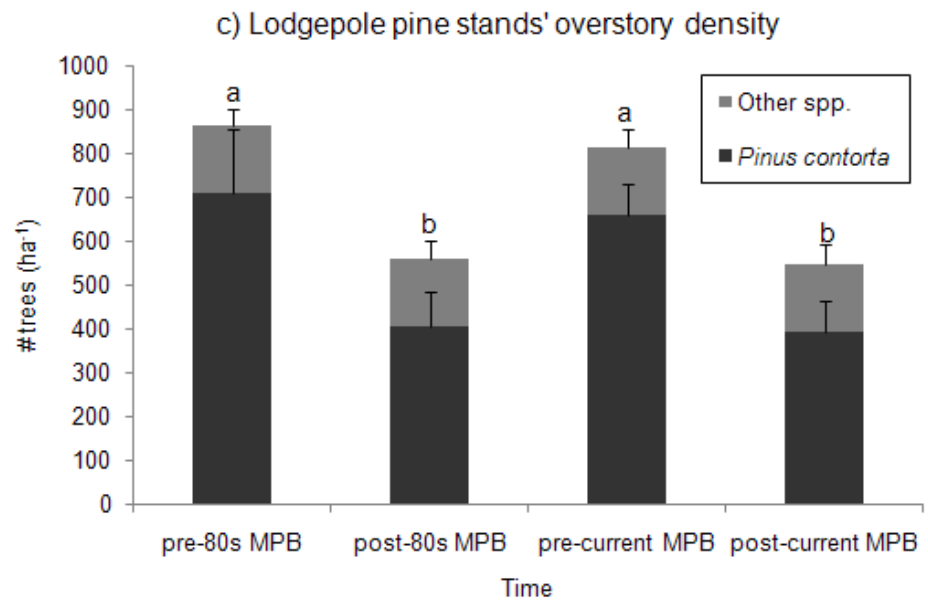
- Recent work by Hu et al. (2010):

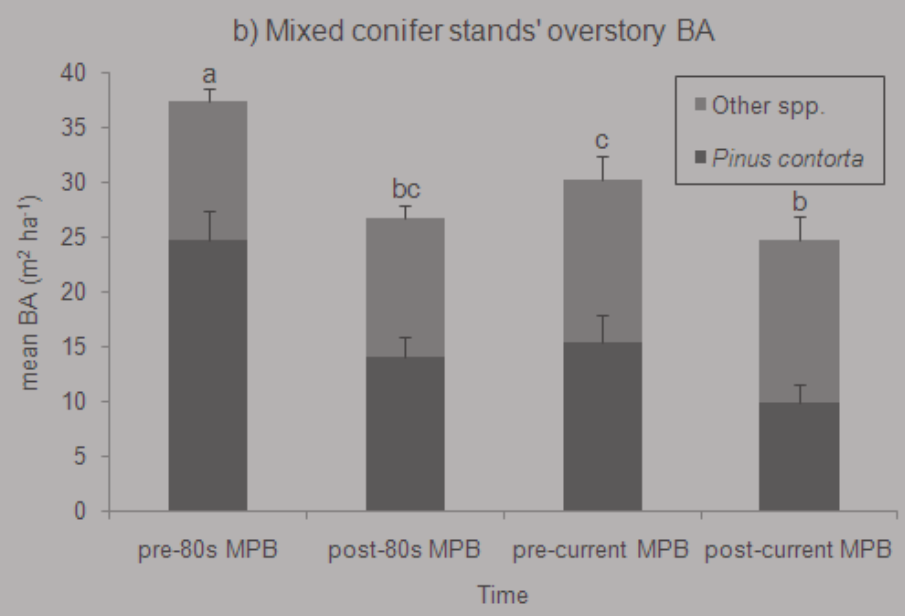


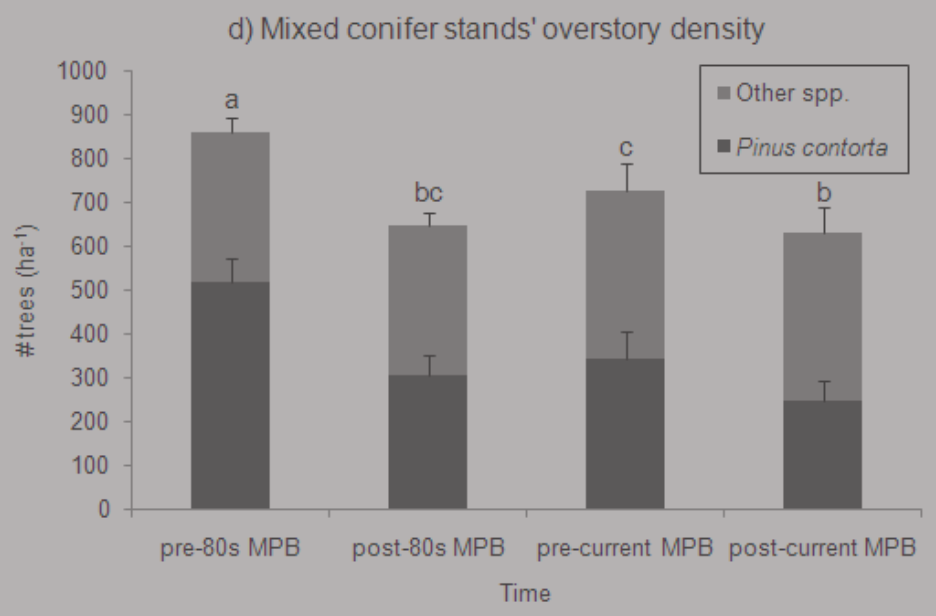

WY
NE
area enlarged
Denver
CO
NM
131
70
6
Eagle
Eagle River
Brush Creek
Avon
Lake Creek
Gypsum Creek
WHITE RIVER
NATIONAL FOREST
WHITE RIVER
NATIONAL FOREST
0
5
10
20 km

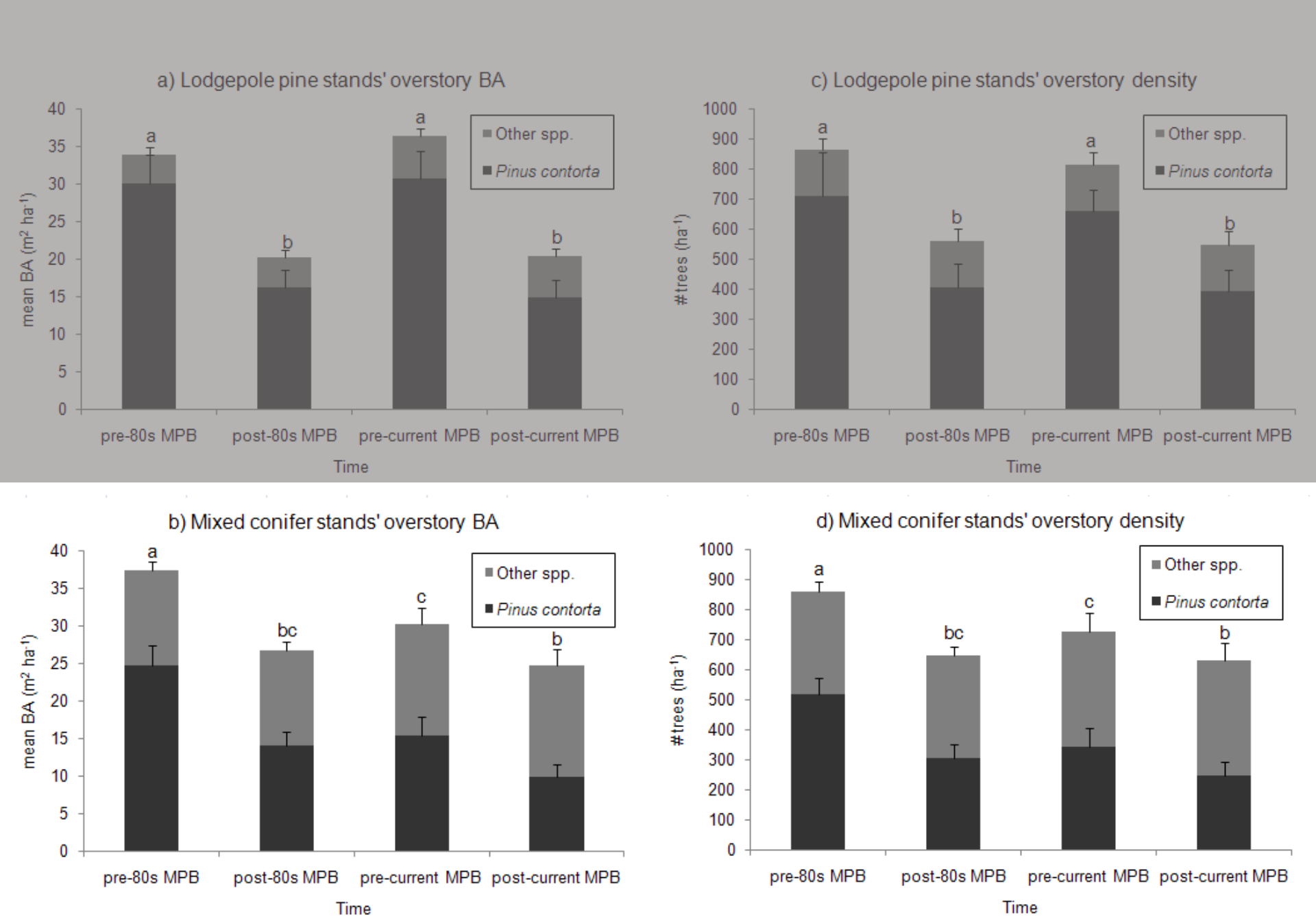

"Lodgepole pine" forest type
"Mixed conifer" forest type
% of 1980s stand BA in ABLA and PIEN
% of 1980s stand BA in PICO
60
50
40
30
20
10
0
30
40
50
60
70
80
90
100


a) Lodgepole pine stands' overstory BA
mean BA (m² ha⁻¹)
40
35
30
25
20
15
10
5
0
a
b
a
b
Other spp.
Pinus contorta
pre-80s MPB
post-80s MPB
pre-current MPB
post-current MPB
Time


c) Lodgepole pine stands' overstory density
#trees (ha⁻¹)
1000
900
800
700
600
500
400
300
200
100
0
a
b
a
b
Other spp.
Pinus contorta
pre-80s MPB
post-80s MPB
pre-current MPB
post-current MPB
Time

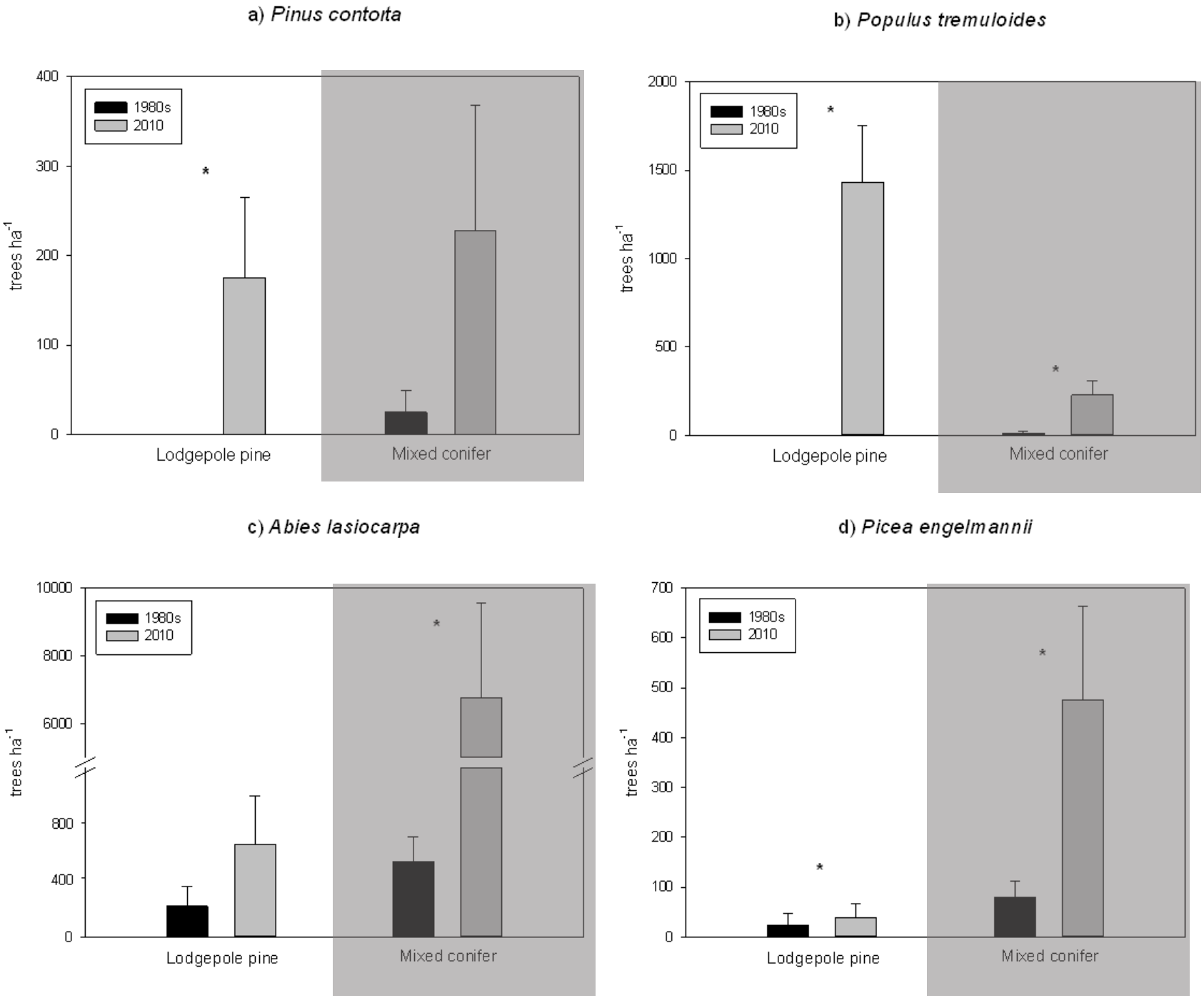

b) Mixed conifer stands' overstory BA
mean BA (m² ha⁻¹)
40
35
30
25
20
15
10
5
0
a
bc
c
b
Other spp.
Pinus contorta
pre-80s MPB
post-80s MPB
pre-current MPB
post-current MPB
Time


d) Mixed conifer stands' overstory density
#trees (ha⁻¹)
1000
900
800
700
600
500
400
300
200
100
0
a
bc
c
b
Other spp.
Pinus contorta
pre-80s MPB
post-80s MPB
pre-current MPB
post-current MPB
Time


a) Lodgepole pine stands' overstory BA
mean BA (m² ha⁻¹)
Other spp.
Pinus contorta
a
b
a
b
pre-80s MPB
post-80s MPB
pre-current MPB
post-current MPB
Time
c) Lodgepole pine stands' overstory density
#trees (ha⁻¹)
Other spp.
Pinus contorta
a
b
a
b
pre-80s MPB
post-80s MPB
pre-current MPB
post-current MPB
Time
b) Mixed conifer stands' overstory BA
mean BA (m² ha⁻¹)
Other spp.
Pinus contorta
a
bc
c
b
pre-80s MPB
post-80s MPB
pre-current MPB
post-current MPB
Time
d) Mixed conifer stands' overstory density
#trees (ha⁻¹)
Other spp.
Pinus contorta
a
bc
c
b
pre-80s MPB
post-80s MPB
pre-current MPB
post-current MPB
Time

Lodgepole pine understory

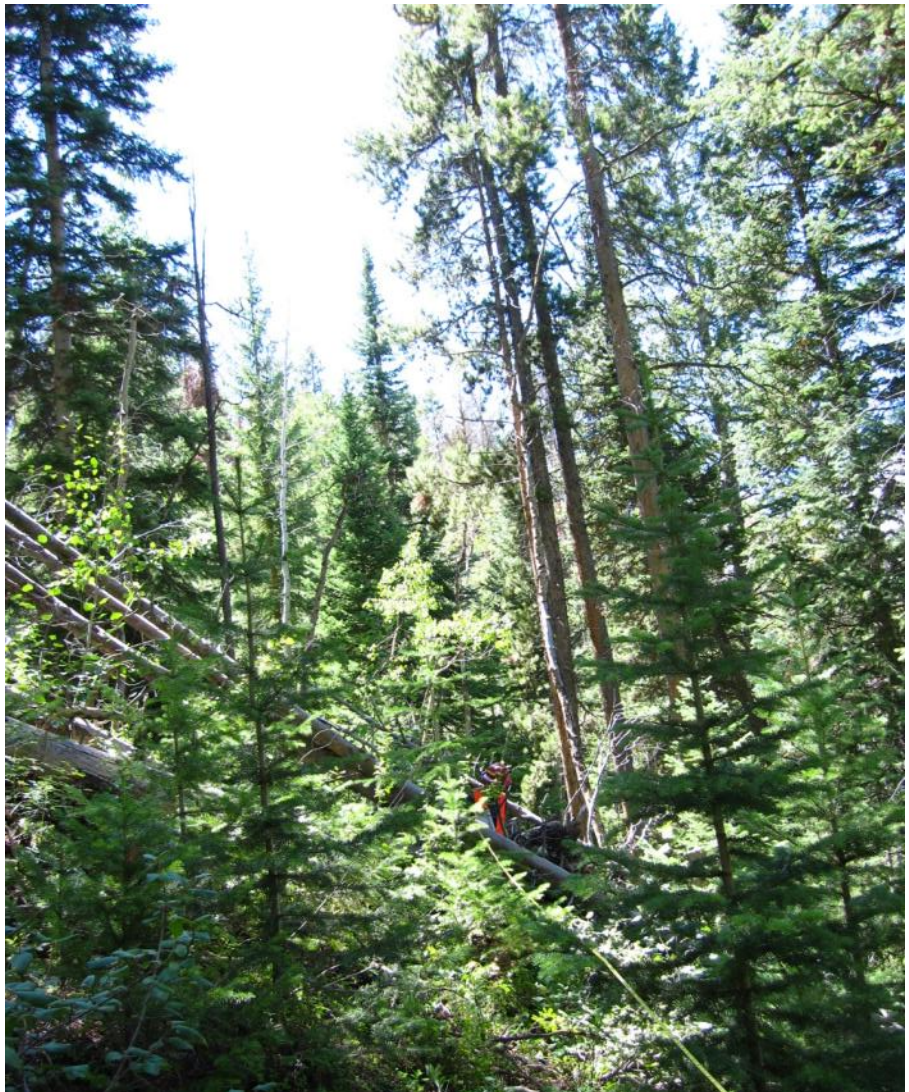
- 1980s
  - 239 trees/ha .6 m tall to 3.8 cm dbh
    - 90% fir, 10% spruce
- 2010
  - 2374 trees/ha .6 m tall to 3.8 cm dbh
    - 62% aspen, 27% fir, 7% lodgepole
  - 6236 trees/ha <.6 m tall
    - 78% fir, 15% aspen, 1% lodgepole, 4% spruce

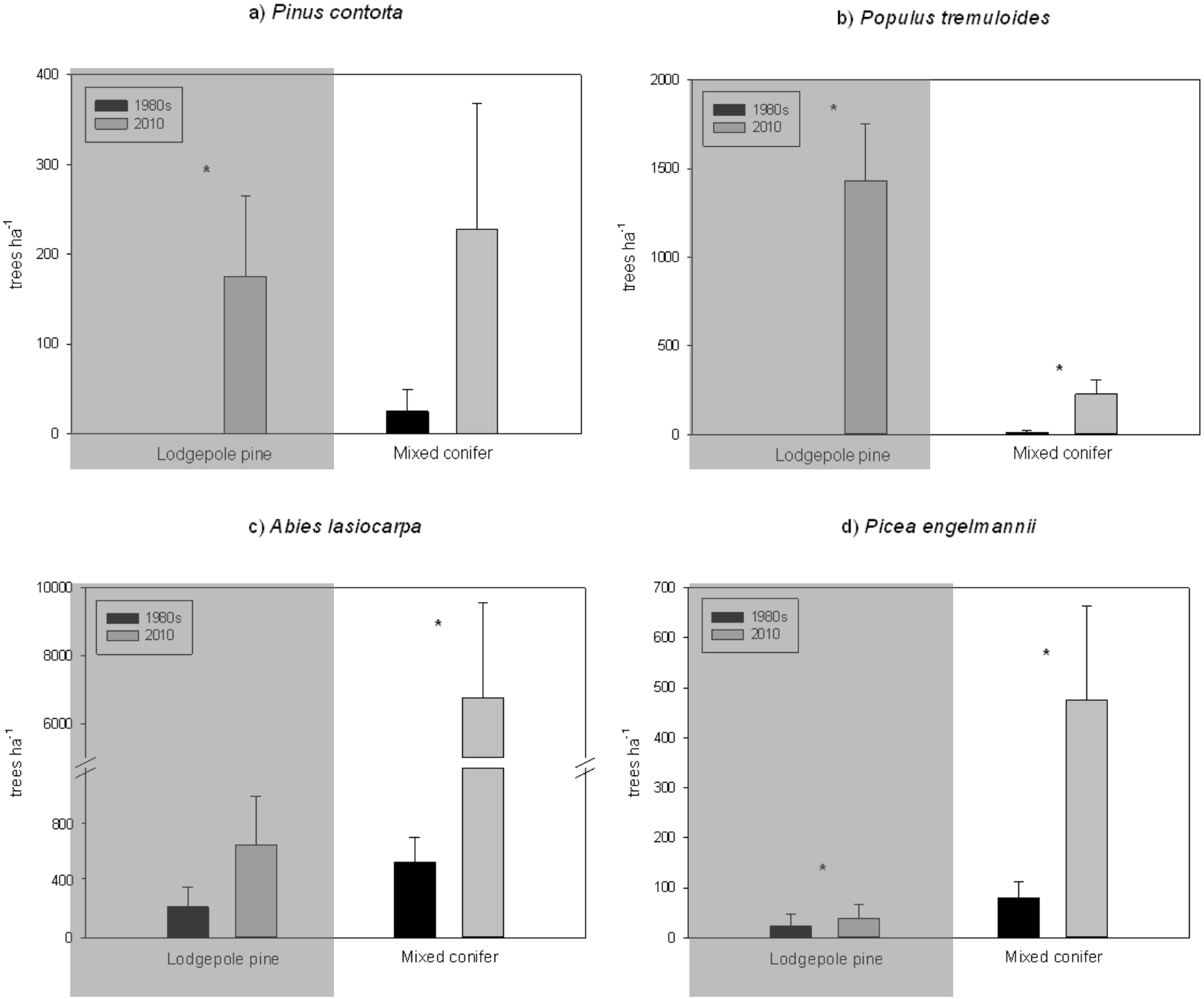

a) Pinus contorta
b) Populus tremuloides
c) Abies lasiocarpa
d) Picea engelmannii
1980s
2010
trees ha-1
Lodgepole pine
Mixed conifer
*

Mixed conifer understory

- 1980s
  - 651 trees/ha .6 m tall to 3.8 cm dbh
    - 82% fir, 12% spruce 4% lodgepole, 2% aspen
- 2010
  - 7713 trees/ha .6 m tall to 3.8 cm dbh
    - 87% fir, 7% spruce, 3% aspen, 3% lodgepole
  - 6236 trees/ha <.6 m tall
    - 92% fir, 8% spruce,

  <1% aspen and lodgepole




a) Pinus contorta
b) Populus tremuloides
c) Abies lasiocarpa
d) Picea engelmannii
1980s
2010
trees ha-1
Lodgepole pine
Mixed conifer
*

Conclusions

- Overstory canopy cover may recover in 25-30 years in some stands, but not in others
  - Decreased canopy cover *could* increase snowpack, reduce water loss to overstory transpiration
  - Where overstory canopy cover is reduced over long term, understory likely to release
- Understory densities increase about 10 fold
  - May negate any increase in yield due to overstory reduction
- Long-term species composition change
  - May impact water loss due to transpiration
- Other important aspects for water yield:
  - Canopy gap size
  - Forest floor rugosity
- Net effect on water yield unclear…

References and thanks

- Hu, J., Moore, D.J.P., Riveros-Iregui, D.A., S.P. Burns and R.K. Monson. 2010. Modeling whole-tree carbon assimilation rate using observed transpiration rates and needle sugar carbon isotope ratios. New Phytologist, 185:1000-1015.
- Kauffman, M.R. 1985. Annual transpiration in subalpine forests: Large differences among four tree species. Forest Ecology and Management, 13:235-246.

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