

## Discussion Paper #1

Future successional trajectories of thinned ponderosa pine (PIPO) stands are highly dependent on top-down controls (i.e. fire regime, climate) and bottom up controls (i.e. site aspect, edaphic conditions). Fire regime is an important influence on stand development in PIPO forests; therefore, successional trajectories are described for two cases: (1) historic fire regime and (2) fire suppression. It is assumed that site conditions are similar to those studied by McDowell et al., namely an annual rainfall of 360 mm and an elevation of 1,000 meters.

Stand development for the first twenty years following thinning will be similar for both fire regime scenarios. Most stands, except those with very high tree density prior to thinning, will contain a sparse regenerating cohort of PIPO (McDowell et al. 2003). These trees will be released by the thinning and exhibit greater growth rates. This release will be seen in carbon isotope ratios ( $\delta^{13}\text{C}$ ). Increased moisture availability will result in greater stomatal conductance in the tree crown, supplying ample amounts of  $\text{CO}_2$  for photosynthesis such that  $\text{CO}_2$  with  $^{12}\text{C}$  will be used preferentially over  $\text{CO}_2$  with  $^{13}\text{C}$ . Under this scenario,  $\delta^{13}\text{C}$  will decrease.

Further recruitment of PIPO may occur on these sites after thinning. This recruitment will be increasingly sparse because of competition with understory vegetation but? will occur where local disturbances provide bare ground (Harrod et al. 1999, Franklin and Dyrness 1988). These limitations will result in episodes of PIPO recruitment, forming small clumps of even-aged saplings. The initial recruitment on wetter sites may be greater but still exhibit clumping. Site aspect and soil moisture conditions will mediate species composition and density of the regenerating cohort. On south facing slopes and site with xeric soils, recruitment of other species, such as ABGR or PSME will be minimal or non-existent. Densities of PIPO saplings will be very low because of high seedling mortality. On north facing slopes, sites with mesic soils and potentially along drainages and at the toe of south facing slopes, recruitment of ABGR and PSME is likely, and overall sapling densities will be higher than those found on south facing slopes. These aspect patterns were observed at site A of the Wenatchee field trip.

During the next 100 years, the trajectories of the two fire regime scenarios will diverge. In stands with historic fire patterns, one or more low intensity and severity fires will occur, killing seedlings and fire intolerant saplings such as ABGR and PSME. Mature PIPO trees will survive the fire.  $\delta^{13}\text{C}$  will generally remain low, except in isolated sapling clumps where tree densities may result in moisture competition. Fire will also create hotspots where PIPO regeneration may

occur (Harrod et al. 1999). Frequent low intensity fires will eventually create an open, park-like PIPO forest with small clumps of even-aged trees in a mixed age stand with large gaps between trees. Tree density will be greater on north facing and moister sites whereas drier sites will exhibit the highest degree of clumping (Harrod et al. 1999). Inter-stem distances within clumps will be controlled by competition, with greater inter-stem distances on drier sites.

With fire suppression, continued recruitment will reduce gaps, leading to canopy closure and intense tree competition. Tree growth slows and most trees will be small diameter, similar to conditions observed on site B of the Wenatchee field trip. On wetter sites, shade tolerant species such as ABGR will also occur in the younger cohort.  $\delta^{13}\text{C}$  levels will increase throughout the stand, reflecting the severe moisture limitations of the site. New recruitment will halt and mortality will increase due to intense competition and susceptibility to bark beetle. Eventually, a high intensity, stand-replacing fire will occur, preventing these stands from reaching maturity.

## References

- Franklin, J. F. and C. T. Dyrness. 1988. Natural Vegetation of Oregon and Washington. Oregon State University Press.
- Harrod, R.J., B.H. McRae, and W.E. Hartl. 1999. Historical stand reconstruction in ponderosa pine forests to guide silvicultural prescriptions. *Forest Ecology and Management* 114: 433-446.
- McDowell, N., J.R. Brooks, S.A. Fitzgerald, and B.J. Bond. 2003. Carbon isotope discrimination and growth responses of old *Pinus ponderosa* trees to stand density reductions. *Plant Cell and Environment* 26: 631-644.