Three studies were conducted to characterize and present early-seral competition between Douglas-fir seedlings and the surrounding vegetation communities during Pacific Northwest forest establishment. The first experiment served as the foundation for this dissertation and was designed to quantify tradeoffs associated with delaying forest establishment activities by introducing a fallow year in order to provide longer-term management of competing vegetation. A range of six operationally relevant treatments were applied over two growing seasons that included in the first (1) a no-action control, (2) a spring release only, (3) a fall site preparation without sulfometuron methyl followed by a spring release, as well as (4) a fall site preparation with sulfometuron methyl and a spring release. In the second year, there was (5) a fall site preparation without sulfometuron methyl followed by a spring release and also in the second year (6) a fall site preparation with sulfometuron methyl and a spring release. Treatments 5 and 6 were left fallow without planting during the first year. These treatments were applied in two replicated experiments within the Oregon Coast Range.

After adjusting for initial seedling size, year-3 results indicated that plantation establishment and competition control immediately after harvest (i.e. no fallow period) enabled seedlings to be physically larger than those planted after a one year delay. At the Boot study site, limiting vegetation below 20% for the first growing season improved year-3 Douglas-fir seedling stem volume over 273 cm$^3$. Delaying establishment activities
one year and reducing competing vegetation below 11% enabled seedling volume after
two years to be statistically the same as three year old seedlings in the no-action control,
a volume range of between 148 to 166 cm$^3$. Delaying forest establishment at Jackson
Mast improved seedling survivorship over 88% when a spring heat event reduced
survivorship of trees planted a year earlier to less than 69%. The combined effect of
applying a fall site preparation and spring release was necessary to reduce competitive
cover below 10% in the year following treatment and provided longer-lasting control of
woody/semi-woody plants. Less intense control measures (i.e. no-action control and
treatment 2) were not able to restrain woody/semi-woody plant cover which grew to
nearly 40% at Boot and over 24% at Jackson Mast in three years. No treatment regime
provided multi-year control of herbaceous species. Including sulfometuron methyl in the
fall site preparation tank-mix did not have a negative effect on seedling growth or provide
significant reductions in plant community abundance in the year following application
when compared to similar regimes that did not include the chemical. Delaying
establishment lengthened the amount of time associated with forest regeneration except
on a site that accentuated a spring heat event.

In the second study, horizontal distance and azimuth readings provided by a
ground-based laser were used to stem map seedling locations and experimental unit
features at Boot. These data were used to create a relative Cartesian coordinate system
that defined spatially explicit polygons enabling, for the first time, the ability to collect
positional data on competing forest vegetation within an entire experimental unit.
Deemed “vixels” or vegetation pixels, these polygons were assessed for measures of total
cover and cover of the top three most abundance species during the initial three years of
establishment. An alternate validity check of research protocols was provided when total
cover resulting from this vixel technique was compared to a more traditional survey of
four randomly located subplots. The resulting linear regression equation had an adjusted
$R^2$ of 0.90 between these two techniques of assessing total cover. When compared within
a treatment and year, total cover differed by less than 12 percentage points between the
two techniques. Analysis of year-3 woody/semi-woody plant cover produced by the
techniques led to identical treatment differences. Two treatments resulted in
woody/semi-woody cover of approximately 1500 ft$^2$ by the vixel method and nearly 40%
cover by the subplot method while the remaining four treatments were grouped below 600 ft² or 20% cover, respectively. With continued refinement, these techniques could visually present forest development through all phases and provide long-term information used to bolster growth and yield models, measures of site productivity, as well as community ecology research.

The third study evaluated the season-long gas exchange and biomass partitioning of four weedy plant species capable of rapidly colonizing Pacific Northwest regenerating forests. *Cirsium arvense*, *Cirsium vulgare*, *Rubus ursinus* and *Senecio sylvaticus* were studied at two sites. A greenhouse was used to introduce two levels of irrigation (well-watered and droughty). These species were also studied while growing among a larger vegetation community at a field site. Irrigation treatments had little impact on gas exchange rates. Species achieved maximum photosynthetic rates of 30, 20, 15 and 25 µmol CO₂ m⁻² s⁻¹ (respectively) prior to mid-July coinciding with an active phase of vegetative growth. As the season progressed, photosynthetic rates declined in spite of well-watered conditions while transpiration rates remained relatively consistent even when soil water decreased below 0.25 m³ H₂O/m³ soil. Water use efficiency was high until late-July for all study species, after which time it decreased below 5 µmol CO₂ · mmol H₂O⁻¹. Multi-leaf gas exchange measurements as well as biomass data provided a holistic view of plant-level mechanisms used to shunt activity toward developing tissues. Herbaceous species had assimilation rates that differed vertically (within each species) by as much as 10 to 20 µmol CO₂ m⁻² s⁻¹ from July to September as lower leaves senesced in favor of those higher on study plants. Specific leaf area was greatest in June for all species then declined indicating species placed little effort into sacrificial early season leaves when compared to those higher on the plant that could continue to support flowering or vegetative growth. The study of seasonal gas exchange in the presence of declining water availability has helped to describe competitive mechanisms at work during forest regeneration as well as provide physiologic support for the application of vegetation management regimes.