

Sierra Cascade Intensive Forest Management Research Cooperative Proposal 12-01

Fruit Growers Soil Pits

Principal Investigator: Brent Roath

Title: Fruit Growers Stock Type Soil Investigation

Year Approved: 2012

Executive Summary:

In February 2002 this plantation was established as one of three replications for the Sierra Cascade Intensive Forest Management Research Cooperative Proposal 00-05, Timmer/Jopson Study. This proposal was titled "Improving Seedling Nutrition in the Nursery to Increase Seedling Performance in the Field". The original stock trial was located in the July 2000 Bark Fire. The stock trial area was subsoiled using a winged subsoiler in two directions. The spacing between the tines was 8 feet, leaving an effective 4 X 4 rip spacing considering the cross ripping. Following the subsoiling operation, the plantation was planted with white fir, Douglas-fir, and ponderosa pine. The white fir seed source was slightly off-site, but the Douglas-fir and the ponderosa pine seed sources were within the same seed zone as the plantation. The plantation received atrazine treatments in 2002 and 2003. The general aspect for the trial area is 225 degrees or southwest and the slope is about 15 percent.

In July 2011 the California Forest Soils Council held their annual summer meeting and visited the site as one of the stops on their field trip. Everyone was impressed with the exceptional growth of all the

conifers, but the good survival and growth of the white fir on such an exposed site was amazing. One of the participants of the field trip wondered if the subsoiling led to this improved survival and growth.

Brent Roath volunteered to examine and describe the soils on the site to help answer the question: "What influence did the subsoiling have on seedling survival and growth?" Brent submitted a proposal for funding to the Co-op membership at their annual meeting on March 6, 2012. This proposal proposed addressing the question by digging at least two backhoe pits in subsoiled plots in the study area and one pit in an adjacent undisturbed (not subsoiled) area. One pit would be dug at right angles to a single subsoil channel to determine how much one pass loosens the soil and to determine density or pattern of root growth associated with the subsoiling. A second backhoe pit would be dug at a 45 degree angle at a point where cross subsoiling had occurred. At each backhoe pit: basic soil profile characteristics would be described; visual assessments would be made to determine how much soil was loosened between rip channels; undisturbed soil core samples from each horizon would be

collected to determine bulk density and to develop soil moisture retention curves; and soil samples from each horizon would be collected in case further analysis is desired at a later date.

2012: The soil pits were put in on May 7th and 8th. The Forest Service GIS geology layer of the project area was examined. This layer showed inclusions of ultramafic bodies within a larger metasedimentary rock zone. This mixing of rock types created variability in the soil profiles found in Pit 1 (Douglas-fir) and Pit 2 (ponderosa pine). Surface cobbles and stones uplifted during subsoiling revealed the widespread presence of the ultramafic rock types. Upon examination of the soils in the trenches, inclusions of talc were mixed in the soil and bedrock. Prior to subsoiling, the presence of this ultramafic rock could have given the general impression that the whole area had low site potential.

General soil productivity in the stock trial was calculated using a standardized Region 5 Forest Service guide for estimating soil productivity from soil and site properties. This estimation indicated that the soil productivity was moderate (Forest Service Site Class FSSC 3-4) for **Pits 1 and 2** and low for **Pit 3**. Soil water holding capacity (plant available water) calculated from estimated soil textures and rock fragments indicated that **Pit 1** holds 6.9 inches of water, **Pit 2** 7.9 inches of water, and **Pit 3** 2.6 inches of water. The high soil water holding capacity for **Pits 1 and 2** within the stock trial would have given seedlings good survival potential and the first 10 years of

tree growth. Tree growth after this first 10 year period will be controlled by the seasonal precipitation levels, which are estimated to be 25-30 inches per year (Forest Service GIS precipitation layer) and the evapotranspiration demand on the southwestern aspect.

Pit 1: Soil parent material was a mixture of ultramafic and metasedimentary rocks. A fractured stone layer which will slow root penetration to greater depth was found in this pit. The depth to the stone layer varied across the pit face because it was not parallel with the soil surface. The stone layer thickness was about 6 to 8 inches across the pit face. Since it was fractured, fine roots did exist below this stone layer.

The soil in the surface has a cobbly loam to cobbly light clay loam texture, which has good water holding capacity and would be very favorable for seedling survival. The soil below the stone layer has a very cobbly clay loam texture and a high water holding capacity. Once roots are able to move through the stone layer this additional soil water will promote good tree growth.

As mentioned the stone layer was not parallel with the slope or soil surface. Due to the angle of the slope of the stone layer compared to the general gradient of the soil surface, the stone layer appeared to daylight at the lower end (down slope) of the soil pit and on the uphill side angled downward into the slope. Therefore further upslope the depth to the stone layer will increase and more soil will be available for early tree root growth.

In regard to the depth of effective subsoiling, it was difficult to discern the depth of mixing due to the darker color of the upper soil found in **Pit 1**.

Pit 2: Soil parent material was metasedimentary rock. There was no stone layer.

The surface texture in the upper 13 inches was a loam texture changing to a light clay loam at 27 inches and at greater depth a clay loam.

The mixing from the subsoiling was quite evident in **Pit 2** and an 18 foot transect across the pit face between 3 trees was examined. Approximately 85% of the transect showed signs of mixing of the dark organic rich A horizon with the redder colored subsoil. Due to the cross ripping, soil mixing was both actual subsoil penetration and mixing and also deposition or mounding occurring along the subsoiler path. The depth of the mixing across the transect was measured to determine the overall effective depth that the tines of the subsoiler penetrated. Depth of mixed soil ranged from 10 to 18 inches and averaged about 14 inches based upon eleven sample points across the transect. Due to the fact that the soil surface was uneven due to the subsoiling, the subsoiler tines were not able to penetrate to their full depth, which probably exceeded 20 inches.

The soils in **Pit 1** and **2** were 42 and 54+ inches deep, which would classify them as deep and very deep, respectively. A few

fine tree roots were observed within the fractured bedrock below the soil at 60 inches deep.

Pit 3: This pit was outside the stock trial area and below the road. This area had not been subsoiled. The soil was only 19 inches deep to a highly fractured, but massive and continuous bedrock, which generally hinders root penetration. Therefore the trees below the road will not have as much available soil water during the normal summer drought period. The shorter intermodal growth rate observed around **Pit 3** seemed to confirm this, at least for the trees near the pit.

Summary: Knowing the good waterholding capacity of the surface soil and subsoil and the deep soil depth at both **Pits 1** and **2**, along with the two atrazine treatments in the trial area, good seedling survival and growth for at least 10 years could have been expected even without the subsoiling.

Since the salvage operations were done in August, no appreciable increase in soil bulk density, above natural conditions, due to the skidding operation would be expected.

In attempting to take soil core bulk density samples, the sampler tip was damaged due to the high content of gravels especially in the case of the A horizon at **Pit 1**. The values for the limited number of samples collected are given in the Appendix of the Final Report which can be found at the Co-op manager's office in Redding.

The amount of roots observed in the soil pits seemed small in both quantity and size considering the size of the trees. But the soil pits only exposed about one-half of the root crown. The size and location of the roots that were within 3 feet of either side of one tree that bordered the soil pit were diagramed. The diagrams are in the Appendix.

Photos

Site 1 – Douglas-fir - Back hoe begins digging



Soil Profile at Douglas-fir pit. Note limited quantity of roots visible. Less than might have been expected due to good tree growth. However, the pit face only represents about one-half of the root crown.



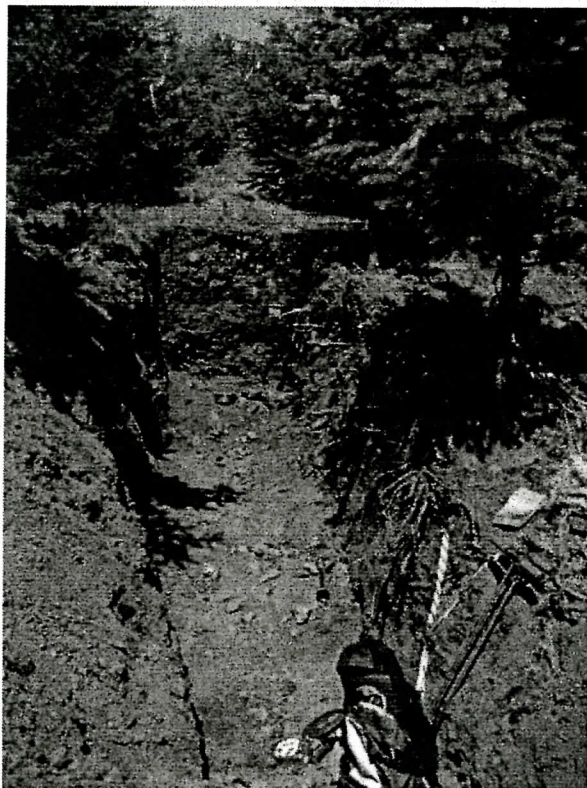
Douglas-fir pit. Soil knife on roots for scale. Large roots appear to be growing horizontal (layering out) just above fractured, but continuous stone layer.



Closeup of stone layer. Note it is fractured but still in original orientation.



Flags were placed at top of stone layer to show depth and direction. Despite stone layer, note overall soil depth is deep to very deep.



Site 2 – Ponderosa pine

Soil depth was deep, no stone layer present here. Blue/white ribbon indicates general area of root description which was 3 feet on each side of tree bole. Note number and size of roots present. An attempt was made to diagram root locations and sizes and is given in the Appendix. Also note undulating soil surface due to cross ripping with final pass on slope contour.



Soil horizons revealed here by color changes. Soil texture was loam in A horizon increasing to clay loam in B and deeper.



Boundary marked by nails shows mixing of A (darker) and B (redder) horizons due to subsoiling.



Broader view showing undulating and mixing of A and B horizons from subsoiling.



Depth of mixing ranged from 10 to 18 inches, but averaged about 14 inches. The uneven soil surface probably limited tine penetration.



Interesting observation - new root following burned out root channel. Note blackened area of charcoal from burned root.



Site 3 – Outside stock trial area, no subsoiling done. Soil depth to a highly fractured, but massive bedrock is limited and ranged from 17 to 35 inches within the pit.



Closeup of highly fractured, but massive and continuous bedrock that will severely retard root growth. Knife blade for scale.



Photo displays typical internodal growth here. Much less than in stock trial area.
Area was treated one time with Velpar.

