

## Trial Lake

The Trial Lake site, which consists of both a snow course and a SNOTEL site, is key to the water supply forecasts of four of the major rivers in Utah: the Bear, Weber, Provo and Duchesne. It is located close to the head of each of these basins, and more specifically, near the top of the Provo watershed neighboring Trial Lake, its namesake. The snow course is on the west side of a small meadow that is about 100 yards in length and about 50 yards wide. The meadow has small ponds with a stream and is primarily vegetated by small grasses and sedges. The distance to both ground water and bedrock is very shallow and is likely a reason why the meadow has not had complete conifer encroachment. The SNOTEL site is tucked about 20 yards into the trees on the south side of the meadow. There is also evidence of shallow water here both physically as well as in the soil moisture sensor data. The sensors had to be moved from the initial position near the shelter to a location further east and upslope due to continued saturation of the 20 inch sensor.

Potential weather modification: 77, 89-93, 95, 01-

This is a 1936 photo looking from the north end of the course to the lake. These points were discontinued and only the points upslope and to the south are currently used.





This 1936 photo was taken looking south along the length of the course, which is on the right side of this meadow. Note the general height and density of the trees. The snow course runs the length of the meadow on the right side (west) and in this photo is estimated to be some 15 to 25 feet from the edge of the trees. The SNOTEL site is located just beyond the trees behind the snow drift at the end of the meadow.

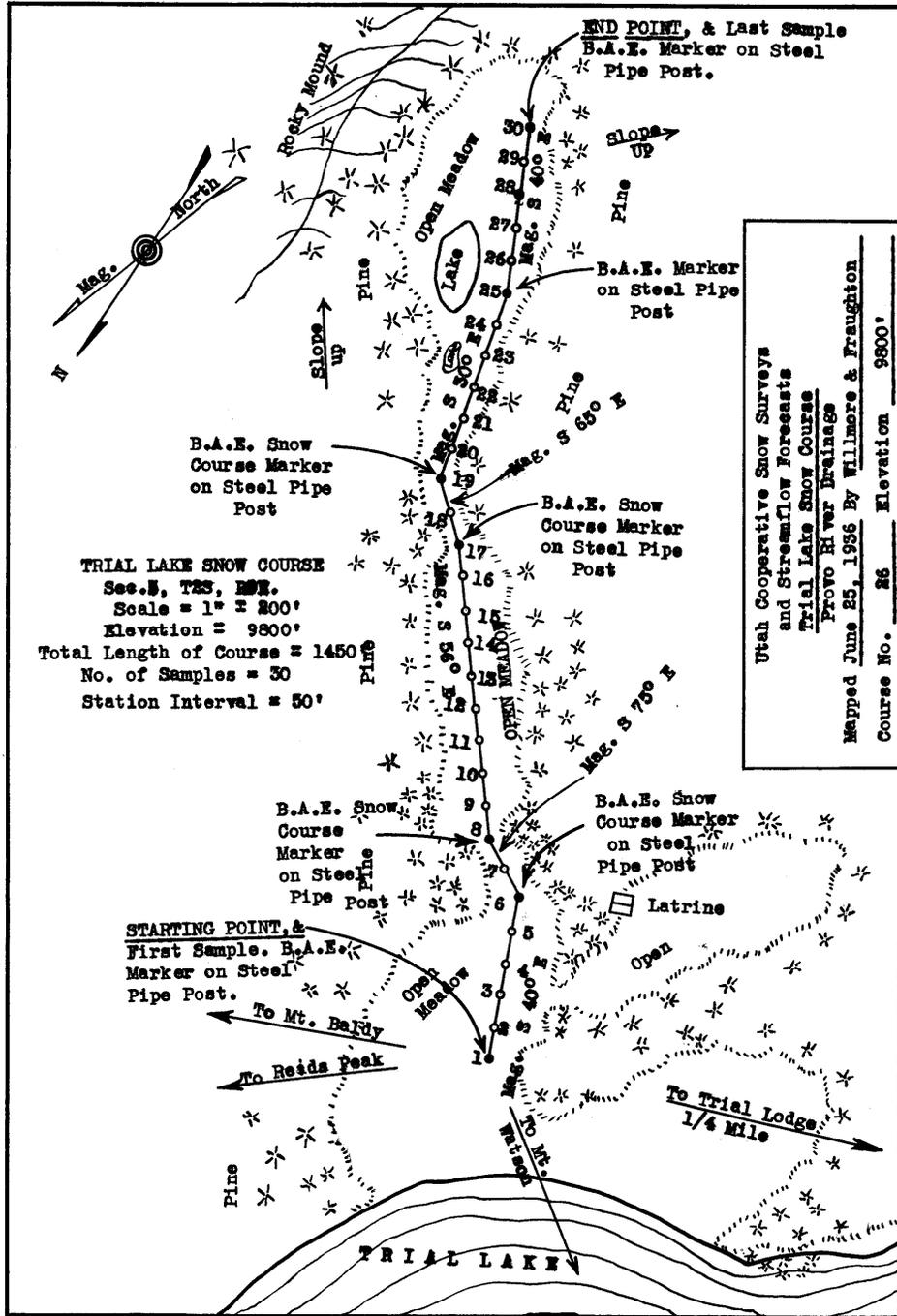


In this photo, also taken looking south along the snow course, one can see that the trees have encroached on the meadow to some extent and are getting much closer to the snow course. They have certainly increased in size, both vertically and horizontally. The snowpack appears to lie fairly uniformly across the meadow with some discontinuities near the spring and pond (upper left of photo near where the helicopter is sitting). There are also some drifts and low areas marking the edges of the conifers and the openings between them.

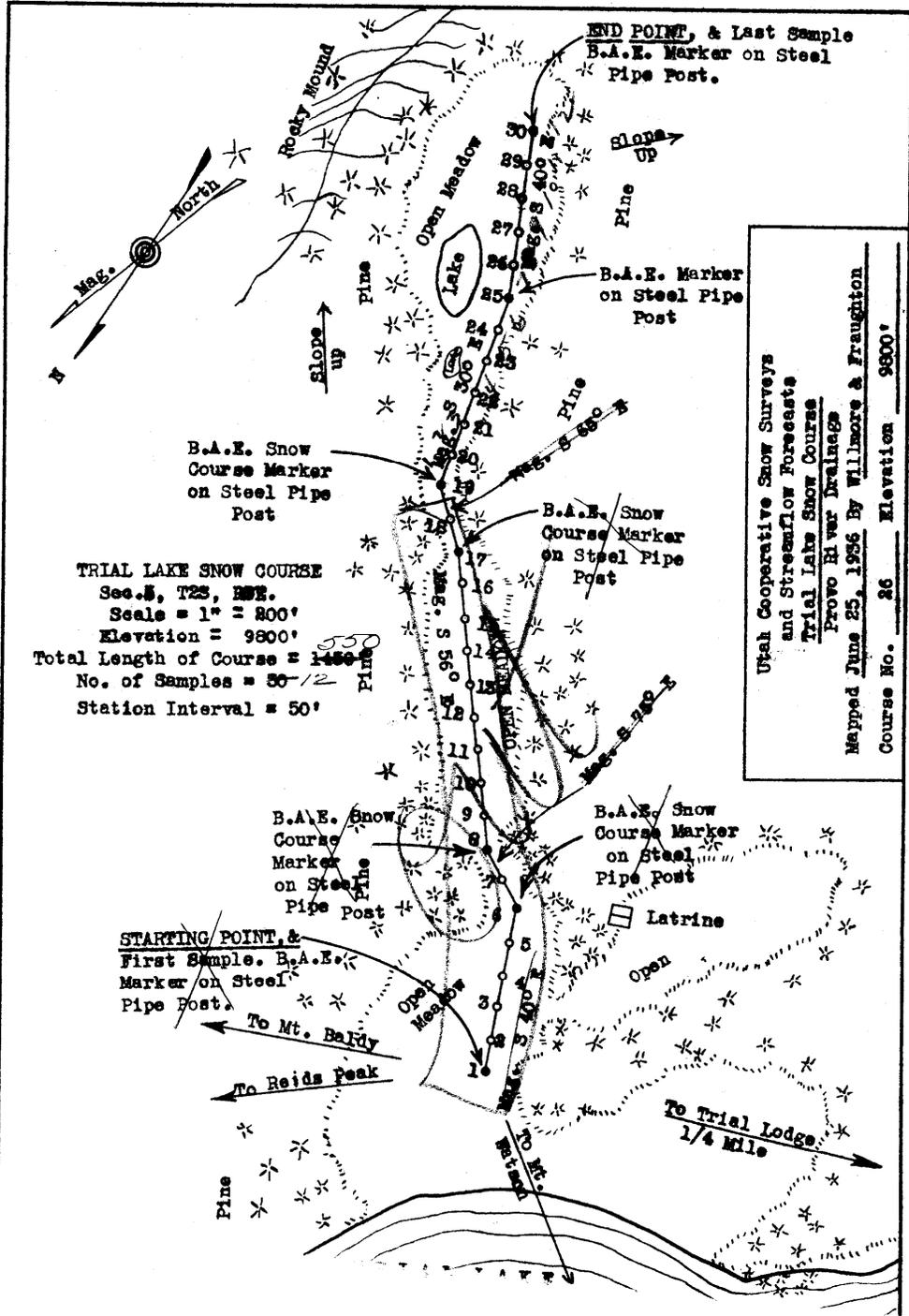


This shot is looking toward the north along the course. One can see the slight outline of a snowmobile track just to the right of the course as well as some minor drifting from the trees.

Changes in accumulation/ablation characteristics at this site were considered to be minimal as of 2007. There appears to be some drifting from west to east (left to right here) from some of the trees but the course does not appear to be significantly impacted. Snow lays in this meadow in an apparently uniform pattern and samples are taken with relative ease and consistency. Impacts from recreation directly on the sample points are not significant at this time.

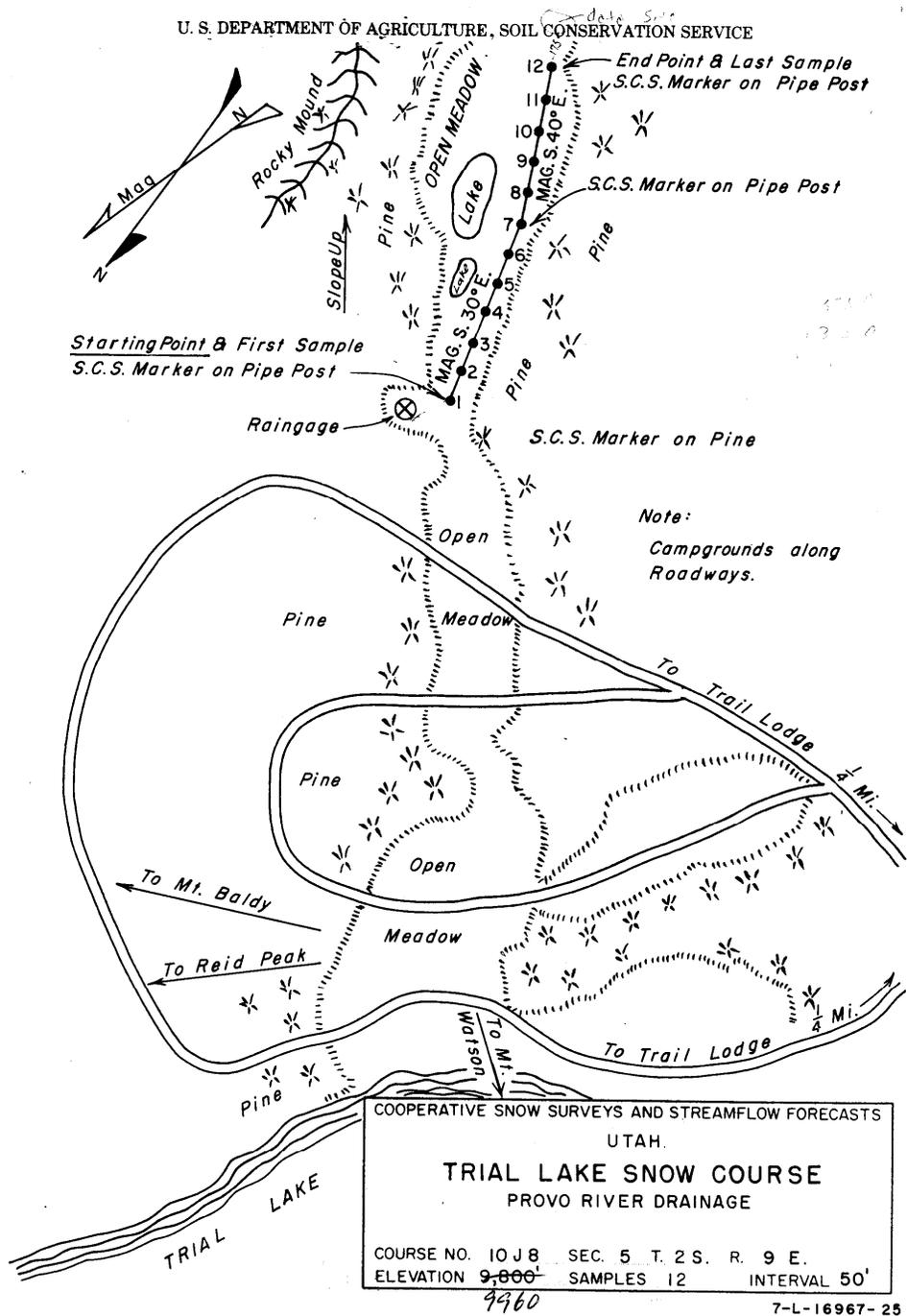


Original Trial Lake snow course map.

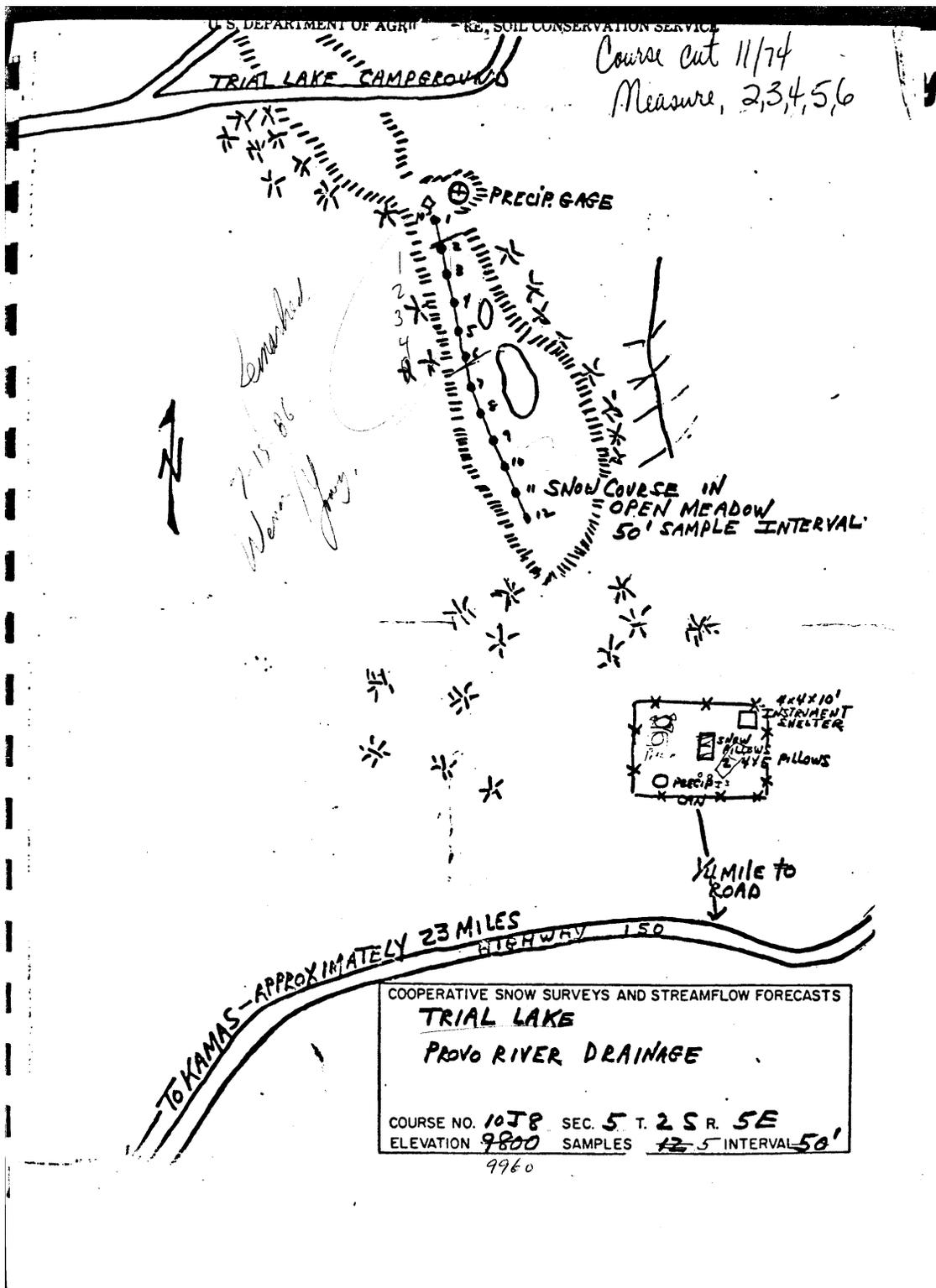


Snow course shortened.

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE



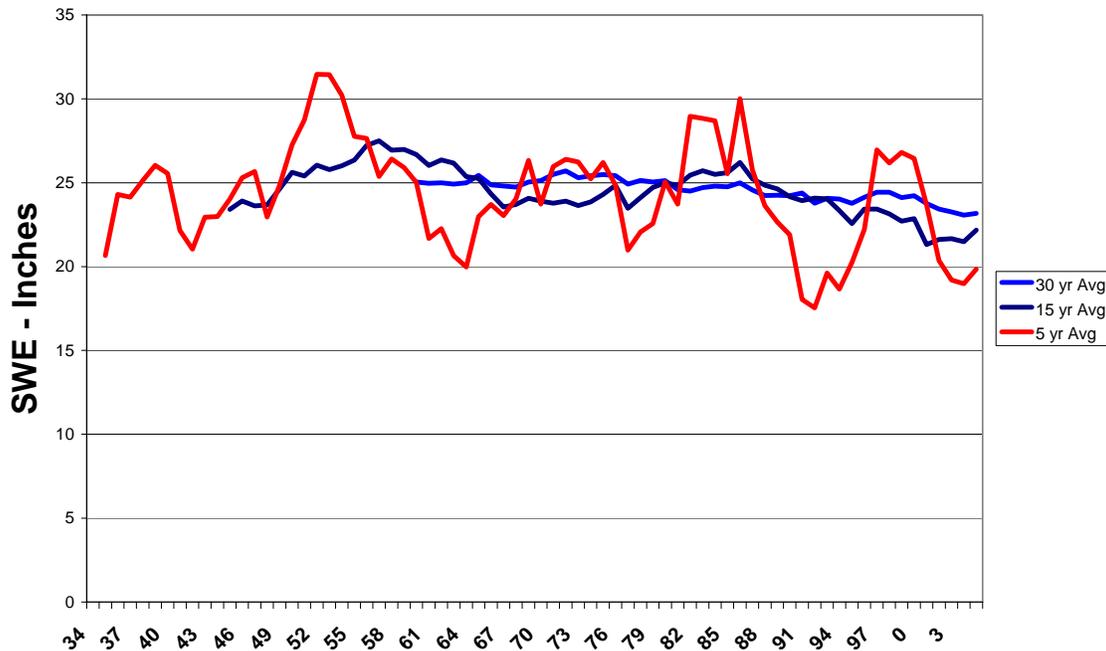
Snow course shortened again.



Current configuration of shortened course.

When a snow course was shortened, the original points continued to be measured although renumbered, thus points 1,2,3,4 and 5 may have originally been points 13,14,15,16 and 17. This map also shows the relative position of vegetation and other features with respect to the course. Distances are not measured and asterisks do not represent individual trees rather a general depiction of vegetation. The density of vegetation is also relative and not absolute.

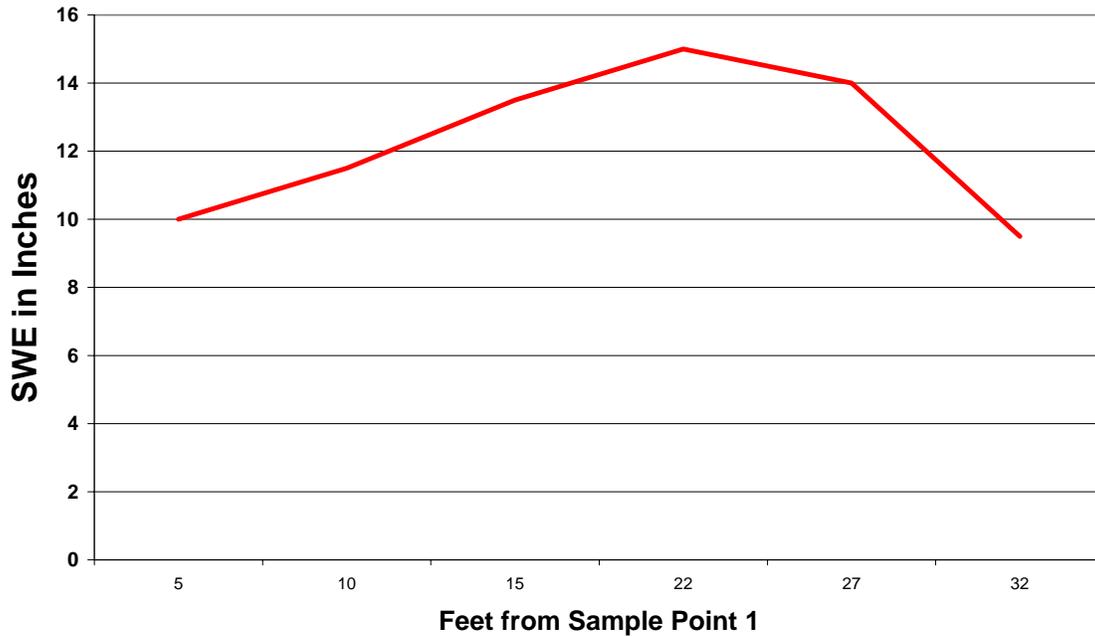
## Trial Lake



In this chart you can see the 5, 15 and 30 year running averages and the 30 year is declining slightly and steadily from 25 inches to the 23-24 inch level.

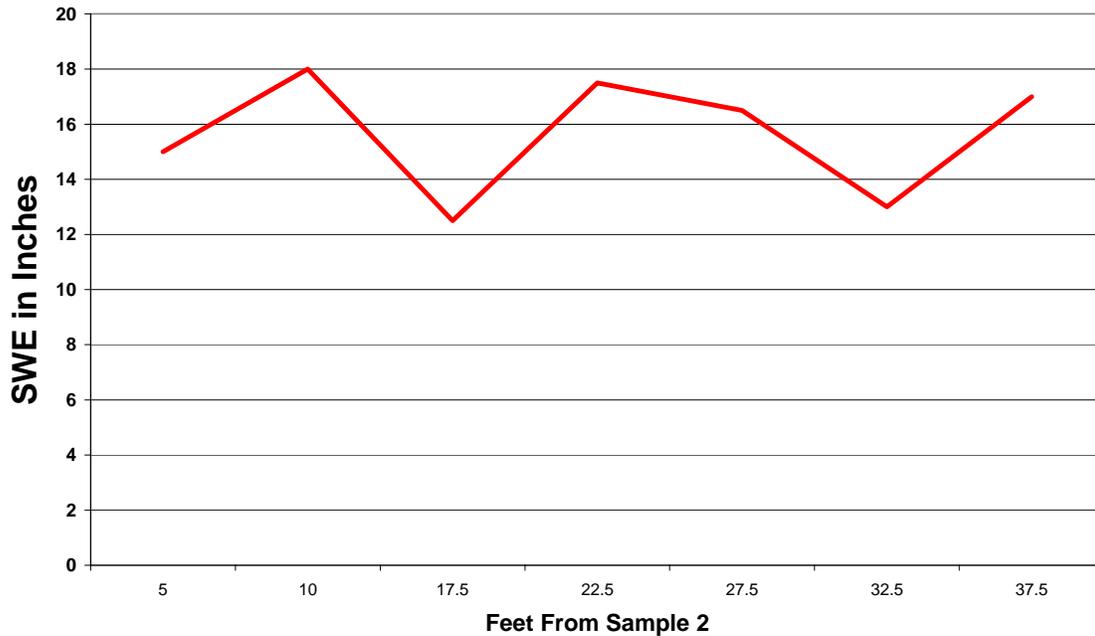
In order to better quantify the possible impacts that vegetation may be having on this course (prior to this time, we had assumed that the impacts at Trial Lake were negligible and thus all of our estimates of vegetation impacts on other courses may be unduly conservative) we took snow samples on March 16, 2007, in 5 foot increments across the meadow from west to east starting 5 feet from each of the 5 sample points. In spite of how uniform the snowpack looks at this site, there were some distinct accumulation patterns.

## Trial Lake - Sample Point 1



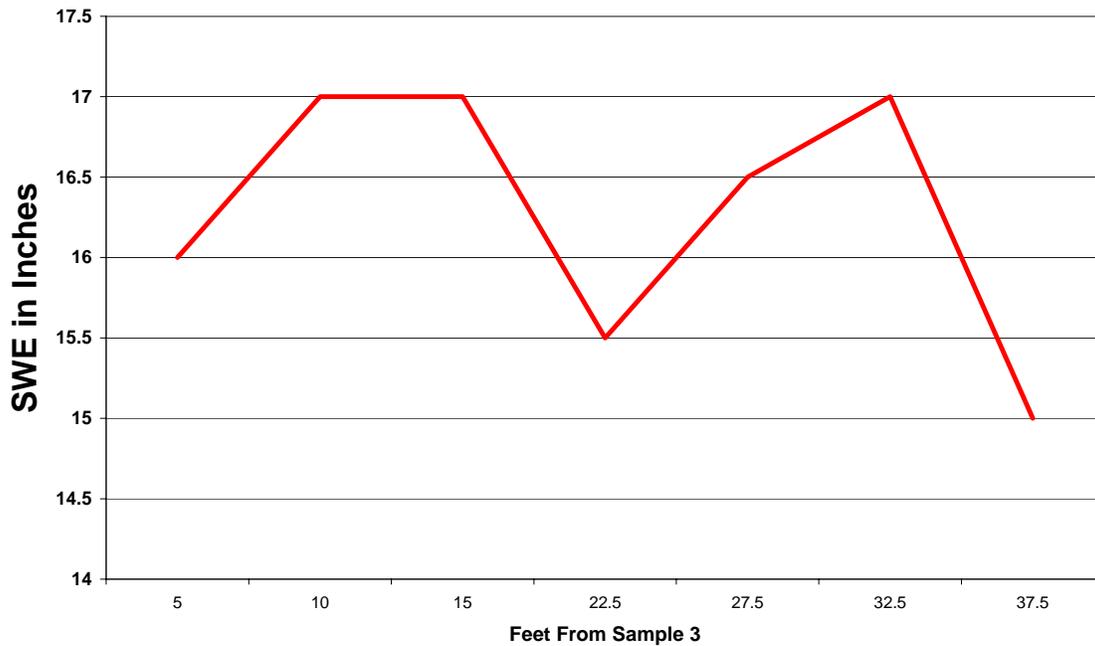
These are the data from sample point #1 at the north end of the course which has the most dense conifer coverage. There is a difference of almost 5 inches of snow water equivalent between the sample closest to the sample marker and just 22 feet away. The sample increments were adjusted along this transect to avoid a distinct snowmobile path that runs along the course. This year was a low snowpack (50% of average accumulation for the course) and the 5 inch SWE disparity is  $\frac{1}{2}$  of the number 1 sample point which has only 10 inches of SWE. A sample taken at the #1 sample marker would have been very helpful in this case to determine if it was the same, less than, or more than the first point in the transect. Nonetheless, a very distinct gradient increase progresses away from the snow course until a decrease is noted at 27 and 32 feet, where samples were taken on the far side of the meadow in the trees.

## Sample 2



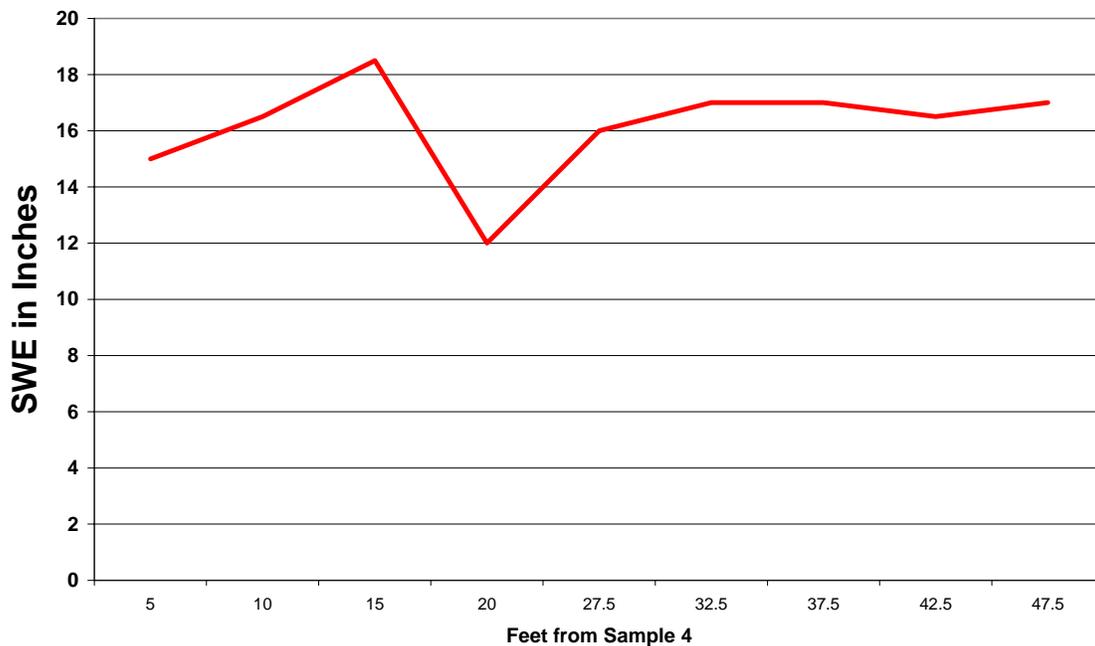
This is a plot of the sample point #2 transect. Again, at the 10 foot distance there is an increase of SWE from 15 to 18 inches. The 17.5 foot distance was in the snowmobile path and therefore, is likely not a good estimator. At the 22.5 foot distance, SWE is similar to the 10 foot level and then starts to decrease at the 27 and 32 foot distances. This was an obvious depression and is likely the stream outlet from the small pond further south. This depression or decrease in SWE is replicated in other transects. Open water and even sub surface water retains heat in the fall longer than the ground surface and also melts snow pack in the spring and this could be the reason for the apparent decline then the rise of SWE at the 37 foot distance.

### Sample 3



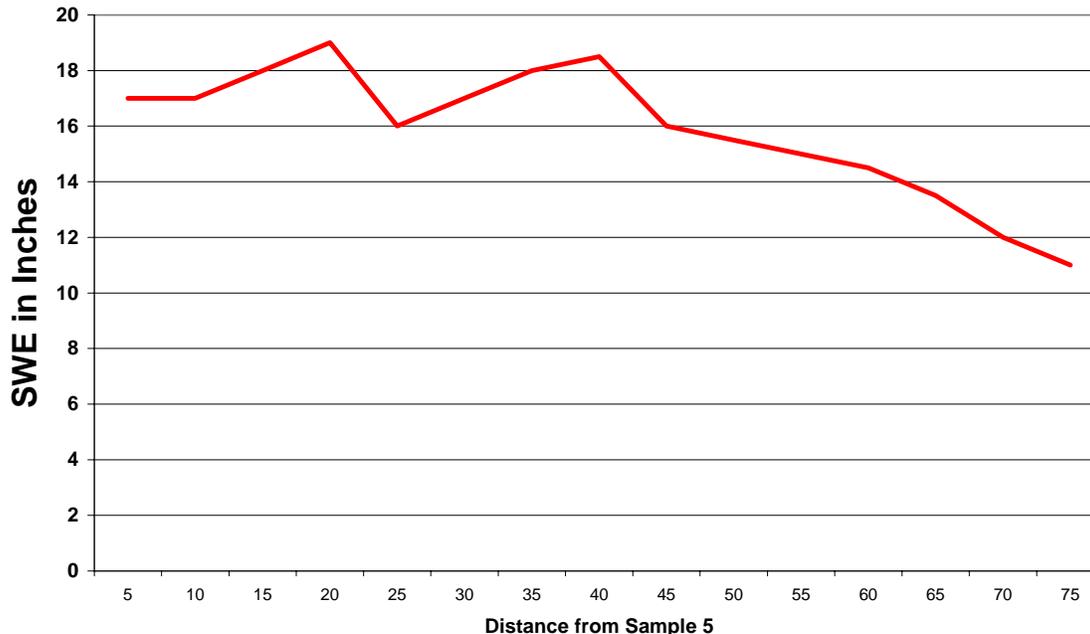
Snow Course transect at sample point 3. Again, note the increase at 10, 15 and the decrease at the stream with a subsequent increase and then the decrease as one gets to the conifers on the east side of the meadow. This one is not nearly as great an increase as previous graphs - only 1 inch of SWE increase.

### Sample 4



Sample point 4 and transect. Note again the increase of swe (about 3.5 inches), impact of stream and snowmobiles and the subsequent increase across the meadow.

## Sample 5



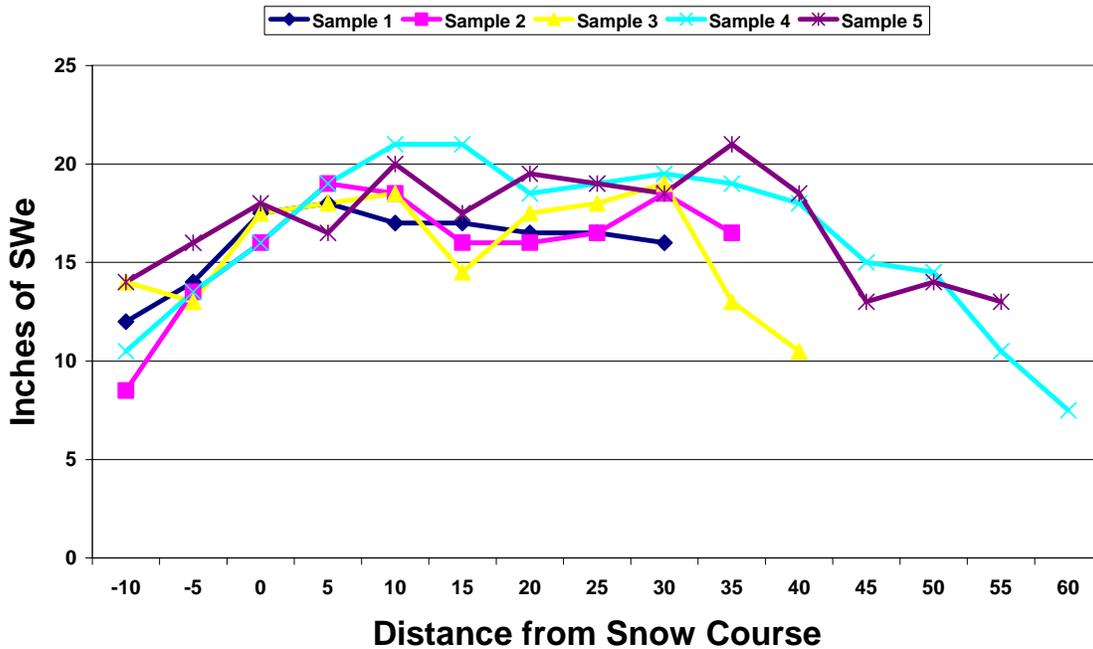
Sample point 5 and transect. This point is potentially the least impacted by conifer encroachment as well as having the largest area of the pond. In fact, starting at 45 feet, all samples were in a large circular depression and were likely directly on top of the iced over pond. SWE increased from 17 to 19 inches, fell in the middle of the snowmobile track at 25 feet, increased back to 18.5 inches and then decreases steadily as one moves further across the pond.

From these sample transects it is clear that there is a distinct increase in SWE as one moves across the meadow as has been demonstrated in other clearing studies. It is highly likely that the conifer encroachment and growth in height on the west side of the meadow next to the snow course is impacting the course to some degree. One measurement in time is not sufficient to quantify the impact if it can be accurately quantified at all. We will return and conduct measurements in the conifers, at the snow course points and across the meadow.

Continued examination of the Trial Lake Snow course.

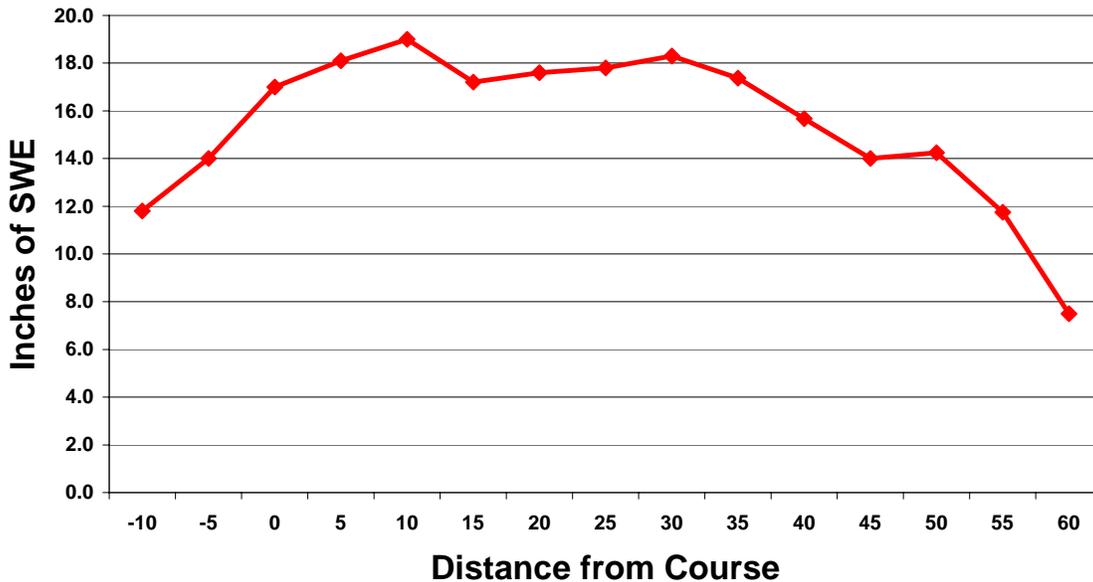
On March 29, 2007 we replicated the transects across the meadow as well as measuring the snow course itself for the April 1, 2007 measurement. There had been some increase in snowpack over this time frame. In this case, we started the measurements 10 feet inside the conifer stand on the west side of the course and measured every 5 feet across the meadow including the snow course points.

## Trial Lake Conifer Impact on Sample Points



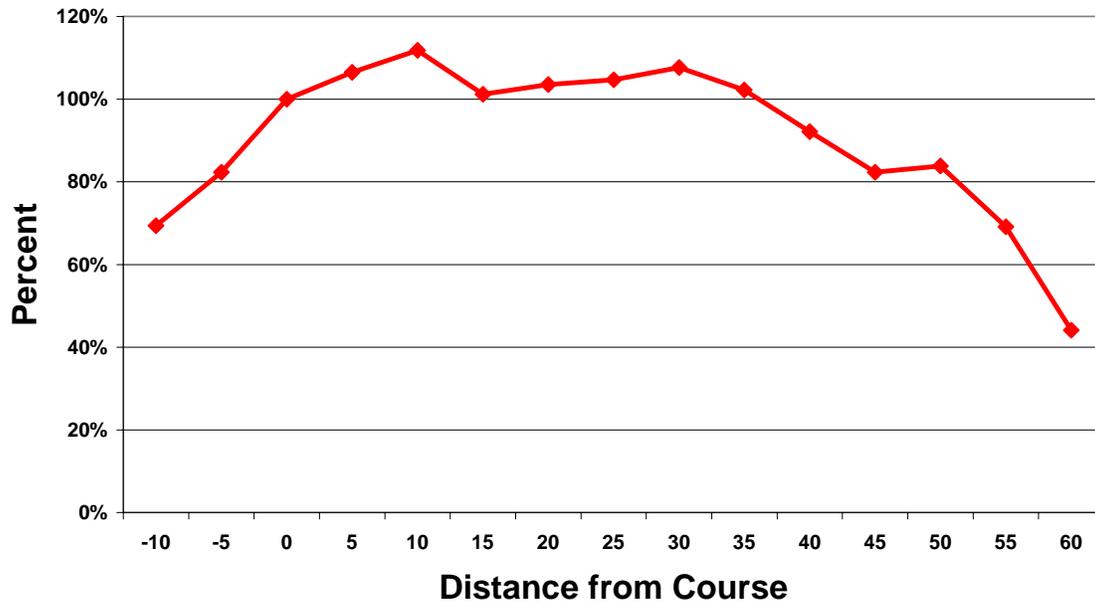
This graph shows a compilation of all 5 points and their respective distance perpendicular to the course and across the meadow. One can clearly see the impacts of the conifers at the -10 and -5 foot levels and this continues at most points to the +5 and +10 foot levels. Assuming that the conifers have encroached on the course 5 to 10 feet over the past 80 years, this course would be getting 5% to 20% less snow in 2007 than in the 1930's.

## Average Conifer Impact for all Sample Points at Trial Lake



In this graph we see the average of all sample points expressed as inches of SWE with the zero point being the snow course.

## Percent SWE Difference due to Conifer Encroachment at Trail Lake



This graph shows the percent difference. At the minus 10 foot level there is 30% less snow than at the course and at the minus 5 foot level, there is 20% less snow. The impacts of the snowmobiles are clear and contrary to popular belief, they have a negative impact on snow accumulation at this location. Prior to this, the theory was that a snowmobile track compacted the snow and the subsequent trench left would fill up with more snow on the next storm, increasing the amount of snow in that localized area. Each transect measured the snowmobile track and was consistent in that it had less snow. We will be repeating this analysis several times in future years to quantify low, average and higher snowpacks as well as snowmobile impacts.

It is clear that data from this site should be adjusted in order to make long term comparisons and that the adjustment for vegetation encroachment may be on the order of 5% to 20%. The observed decrease of April 1 SWE has been 8%.

R Julander  
2007

October 24, 2007.

We again visited the Trail Lake Snowcourse and SNOTEL to see the early winter conditions. Some valuable insights were gained. We measured depth of snow only at this time as the pack is very shallow. There were noticeable impacts from canopy interception and long wave radiation along the course. Snow depths were consistent in that the meadow samples were much deeper and more consistent than near the course or in the conifers. We also measured the depth of snow on the Steel versus the Hypalon

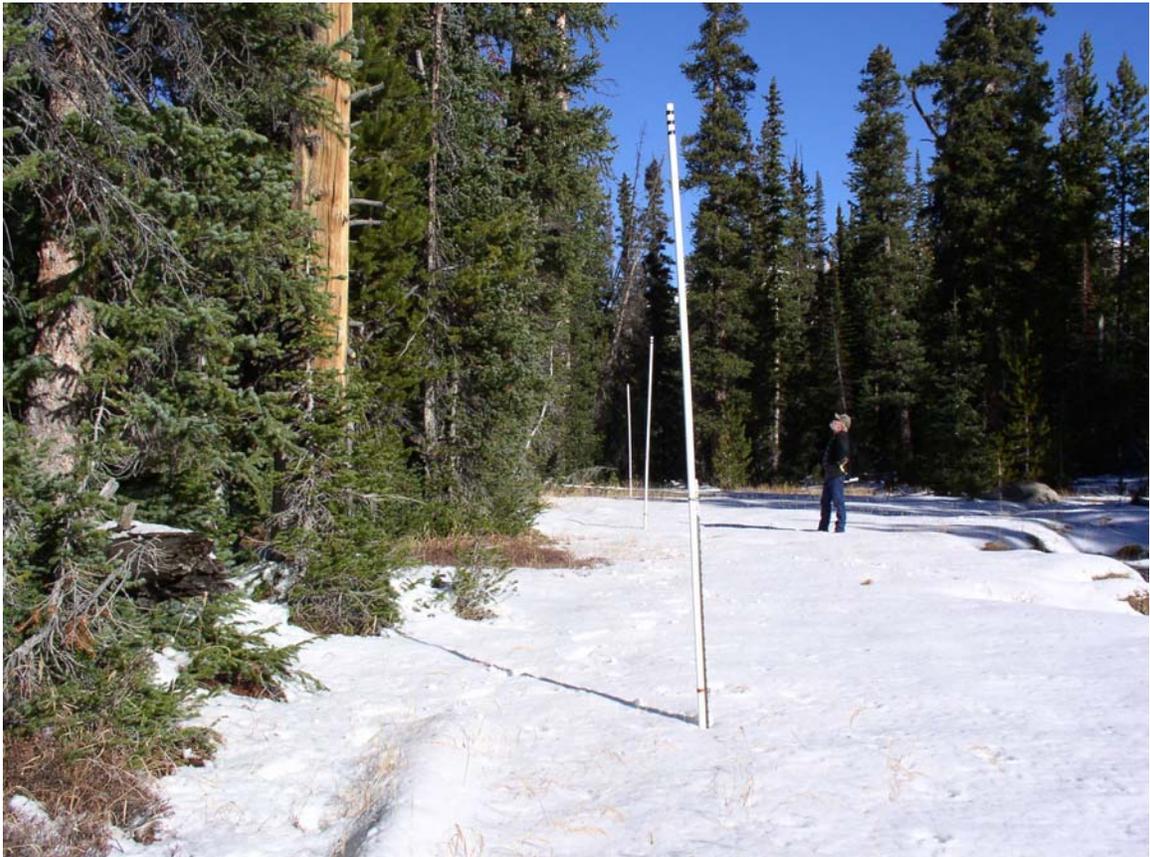
pillows and the steel pillows had more snow. Currently the temperature under the hypalon pillow is about 0.5 degrees C warmer than the steels.



The pond and other water features are much more distinct at this time of year than in summer during maintenance. The snow course is center right in this photo. This is the obvious reason for the decrease of snow depth in the transect samples related to sample points 4 and 5. The meadow here has consistent snow depth of 8 to 10 inches.



In this photo (center left), there are other water features that again are evident in the transect data. The pond in the previous photo is also center left. One can also see the impact of the conifers as the pack is shallow next to the trees.

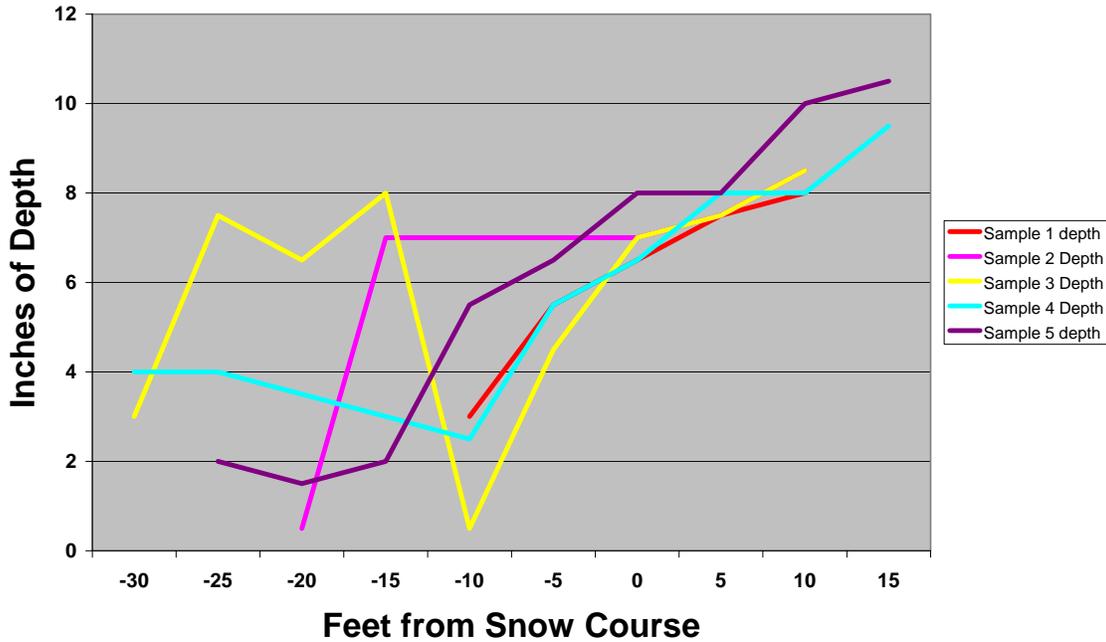


Notice the canopy interception and long wave radiation impacts from the conifers in the melt ring around the conifers extending farthest into the meadow, photo center, just past sample number 3 in the foreground.



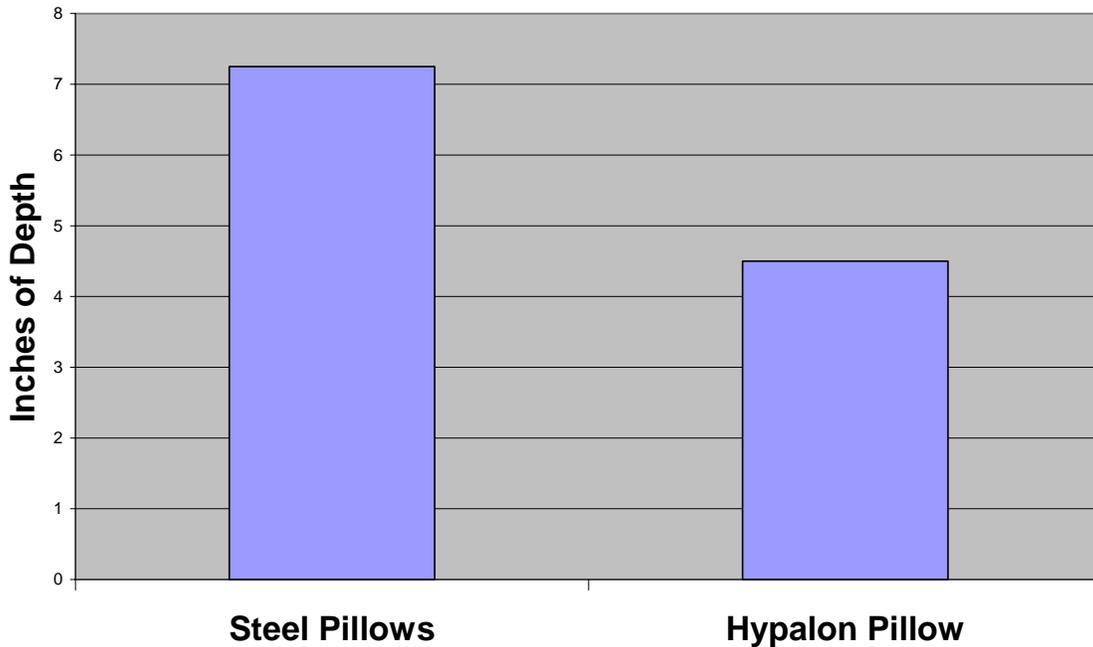
This is a view of the course looking from the north to the south. Notice the small pond, center and the drainage pattern that is not clearly evident in summer. These are reflected in the transect data and might be misconstrued as snowmobile impacts. The impact of water features, both surface and "near surface" clearly have a large impact on snow accumulation.

### October 24, 2007 Trial Lake Snow Depth



This chart shows the snow depth analysis for each perpendicular sample point transect for early season snow. The zero point indicates the snow course sample. Notice the steady increase in snow depth as one proceeds into the meadow area and the erratic but generally much shallower depths inside the conifer overstory.

### October 24, 2007 Trial Lake Pillow Depths



This chart shows the difference between the steel and hypalon pillow snow depth at the snotel site.

Rj, 10/2007