About this Unit

The ground sampling locations for the BC Resource Inventory can occur anywhere. The sample point marks the center of the sample location. Your sampling crew must get to it -- as long as it's not too dangerous. If the sample location is too dangerous to get to, a new sample point will be selected.

The topics covered in this unit are:

- Establishing a tie point in the field
- Measuring distance and slope in the field
- Navigating to the sample location

Acknowledgments

Some of the material in this unit has been taken, in modified form, from the following reference texts:

Forest Surveying and Mapping, TATLAN Program *[full reference pending]*.

Bark Beetle Probing Course, Ministry of Forests Cariboo Forest Region, 1995.

Vegetation Inventory Sampling Procedures, Vegetation Inventory Working Group, March 1995.

Performance Objectives

When you have successfully completed this unit, you will be able to:

- Given a field map with a sample point marked on it, use a scale rule and protractor to locate the point on an aerial photo.
- Explain what a tie point is.
- Identify possible tie points on aerial photographs.
- In the field, identify the tie point marked on the photo.
- Explain how to correctly mark a tie-point tree for referencing the tie point.
- Describe the information on the reference tree tag.
- Use a nylon chain to measure distance accurately.
- Fold and carry a nylon chain correctly.
- Use a hip chain to measure distance accurately.
- Explain the meaning of the term “slope.”
- Operate a clinometer to measure slope accurately.
- Use a slope table to adjust horizontal distance.
- Find horizontal distance across sloping ground, using a hip chain, a clinometer, and a slope table.
- Use a hip chain to navigate in the field from a tie point to a sample point, given the bearing and the horizontal distance.
- Perform offsets accurately.
- Confirm that you are in the right polygon by reading the field map.

Before You Begin

The skills you need before starting Unit 4 are:

- Successful completion of Unit 3, Read Maps and Aerial Photographs
- Successful completion of Unit 2, Describe Basic Inventory Practices
- Successful completion of Level 1 Resource Inventory Skills Training Program

Before you begin this unit, check that you have all the Level 1 skills needed for safe and successful completion of it. A detailed list of Level 1 skills is given in Unit 1 Course Introduction. This unit builds on the map reading skills in Level 1 and you will have difficulty if you do not know how to use a compass, read a map legend, or use UTM co-ordinates. So take time now to review the Level 1 Skills you should have.

Also ask your facilitator to help you assess your skills by having you complete the Unit 4 Skill Assessment Exercise which follows. It will give both of you a better idea of your skill level. If you find that you do not have all the Level 1 skills you need to begin this unit, work out a plan with your facilitator for developing these skills. This way you will have a better chance of successfully completing it.

Skill Assessment Exercise

1. Given a tape measure or ruler, measure something to the nearest millimeter.

2. Given two numbers, calculate the ratio of one to the other.

3. Given a compass, find the azimuth from your position to an object pointed out by the Facilitator.

4. On a map, find the scale of the map and explain what it means.

5. Your Facilitator will point out features on a map. State what they are by reading the map's legend.

6. State the approximate UTM coordinates of the features pointed out on the map.

Establishing A Tie Point

To get to the inventory sample point, the crew must first choose a *tie point.* The crew follows the bearing from this tie point, measuring the distance as they travel, until reaching the distance where the sample point is to be.

The tie point must be chosen to allow the easiest, safest, and most direct route to the sample point.

The tie point is also very important for other people to find the sample location later. It may be several years later that someone else will need to visit the site.

The field crew chooses the tie point when they arrive in the sampling area.

The tie point must be found and marked on:

- the field map
- the aerial photo
- the ground

Locating The Sample Point On The Aerial Photograph

The sample point will be marked on your crew's field map before you arrive in the field.

Your crew leader will find the matching point, roughly, on the aerial photo, and mark it on the photo.

This transfer of the sample point onto the aerial photo is important to help you confirm that you're in the right place when you finally get to the sample location.

You should be familiar with how this is done, even though you will not be required to do it yourself as part of your job on the field crew.

First, review the procedures in Unit 3 about reading maps and aerial photos. Read through the rest of this section. Then turn to the Practical Exercises at the end of this section.

Finding a Tie Point

The tie point must be a clear landmark on the aerial photograph.

There are many types of landmarks that make good tie points:

- road forks or crossings
- creek junctions
- bridges on stream crossings
- clear timber boundaries
- clear swamps, ponds, or lake edges

Once the tie point is decided on, the crew chief marks it on the photo with a pin prick.

On the back of the photo, the crew chief circles the pin prick and writes information for locating the tie point, including:

- project identification
- sample number
- azimuth and distance (from tie point to sample point)

Then the crew chief finds the matching point on the map. The point is marked and labeled with the same information as the photo.

Finally, the crew travels to the tie point location on the ground. When you get there, you can prepare to navigate to the sample location.

Identifying Possible Tie Points On A Photo

You should be familiar with how this is done. First, review the procedures in Unit 3 about reading maps and aerial photos. Read through the rest of this section. Then turn to the Practical Exercises at the end of this section.

Identifying The Tie Point In The Field

You should be familiar with identifying features in the field from completing Unit 3. Finish reading through the rest of this section, then turn to the Practical Exercises at the end of this section.

Flagging The Tie Point

The first reference point to mark is the tie point. You mark it by "flagging" a tree nearby with paint, a ribbon, and an aluminum information tag.

The crew leader will then take a bearing from the tie point tree to the tie point itself. The tie point itself is not marked. The crew leader will record, on the information tag, the bearing from the tie point tree to the tie point.

The crew leader will also record, on the crew's compass card, the diameter and species of the tie point tree.

The purpose is to give another person enough information to find the sample location some time later, if needed. The tie point flag should be visible to a field crew, but not too obvious to the general public.

Marking a tie point tree

Select a tree big enough that the stem will be still around in a few years. Don't pick one on the edge of a roadside, because it might get removed during road maintenance.

If there's no trees, use a stump, a rock cut, or a boulder. You may even need to build a cairn (a pile of rocks).

This is how the crew marks a tie tree:

1. Limb the complete stem up to shoulder height.
2. Remove the vegetation around the tree, if it's practical to do that.
3. Spray-paint the visible surfaces at eye level.
4. Tie a plastic ribbon around the tree stem.
5. Scribe the tie-point location information onto the aluminum tag.
6. Nail the tag to the tree at a point below powersaw-felling height (0.3 m).
7. If practical, the tag should face the tie point location.

This figure illustrates the markings on a tie point tree:

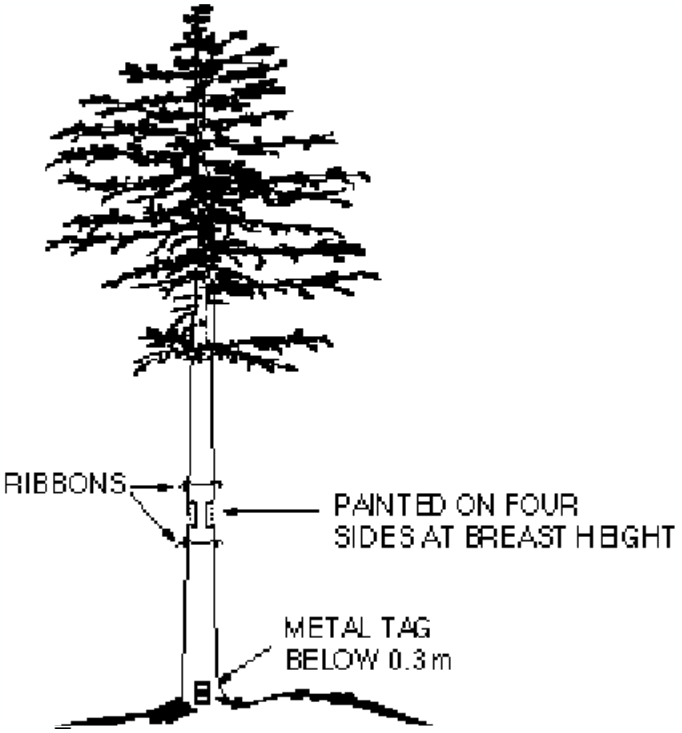

Figure FR4-1, Tie Point Tree Marking

You should be familiar with doing this. The practical exercises at the end of this section will let you practice this procedure in the field.

The Information On A Tie Point Tag

The figure below illustrates the information found on a tie point tag.

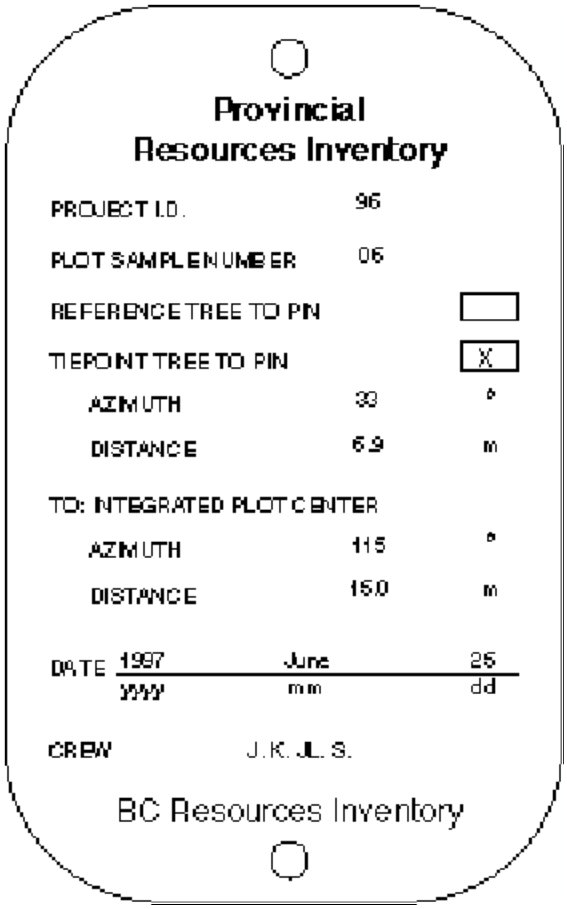

Figure Fr4-2, Tie Point Tree Tag

You will become familiar with this information during the practical exercises.

When you feel you are ready, complete the practical exercises

Practical Exercises

These self-paced exercises will help you get the practical hands-on experience you will need to become competent in this skill. Do not attempt these exercises until you have read the text for this section.

Do not attempt to do these exercises on your own. The field exercises in this Unit should be done in pairs. Your partner may be another participant, or it may be your Facilitator.

Classroom Exercises

1. This exercise is a review of skills you learned in Unit 3. Your Facilitator will provide a field map, stereo photo pair, stereoscope, protractor, and scale rule. The field map will have a sample point marked on it. Your task is to locate the sample point, as accurately as you can, on the photos. Mark the point with a grease pencil, not a pin prick, so the photo copies can be reused.

2. On the same photo pair, locate at least three possible tie points. Again, mark them with a grease pencil. Use the protractor and scale rule to find the bearing and distance from each of the tie points to the sample point. Record these measurements.

3. Repeat exercise number 2 with a second set of photos.

Field Exercises

The second set of photos you marked are from the field sampling location that you will travel to for doing the practical field exercises. You will do these exercises in a group.

1. Your facilitator will take the group to visit several of the tie points that were marked by the participants on their photos. How good a tie point did it turn out to be?

2. At each tie point, use a compass to take a bearing on the sample point. Use the measurement you made yourself on the photo in the classroom exercise. Is it correct? Would you want to travel on this route to the sample point?

3. At each tie point site, your group will practice flagging a tie point tree. To minimize damage to the trees, the Facilitator will help the group to state and point out how the tree would be marked. Then each participant will practice ribboninng and tagging the tree.

4. Examine the tie tree tag carefully. Discuss it with the Facilitator until you are clear about all the information that must go on the tag.

Measuring Distance And Slope

Using A Nylon Chain

A common device used for measuring distance is a nylon chain. Crews may use it to navigate to the sample location. It's easy to carry and use, and it's accurate enough for this work when carefully used.

Nylon chains come in standard lengths of 30, 50, 75, and 100 m. These chains are actually longer than their name says, because there's an extra length at each end so you can hold on when stretching it so it's straight. Some chains have a small pull handle at the zero end. A drawing of a nylon chain is shown in Figure FR4-3.

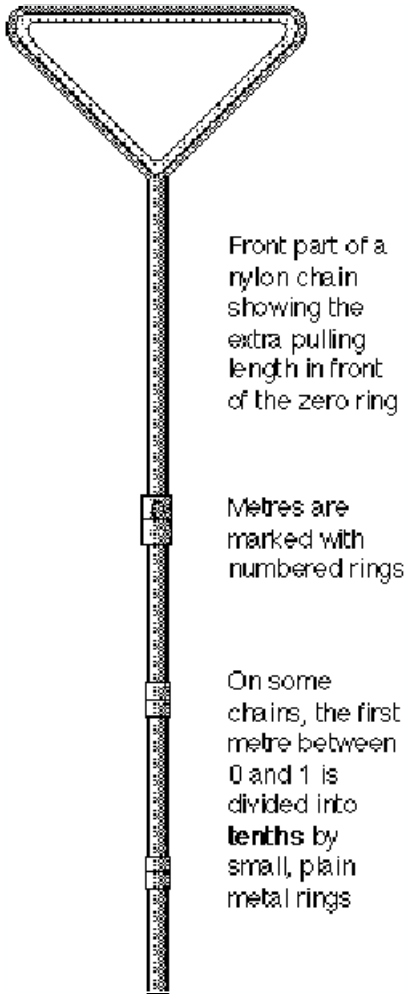

Figure Fr4-3 Nylon Chain

Why call it a chain when it's really a nylon rope? Good question. The answer is... tradition. Long ago, surveyors used actual chains. When surveyors started using steel tapes they still called them chains. Now there's nylon, and the nylon rope is the latest form of "chain."

Markings on the chain

Numbered metal rings are placed one metre apart along the chain. On a 50 m chain they're numbered 0 to 50. A groove in the middle of the ring shows the exact metre mark.

On many chains, the first metre is divided into tenths by smaller rings so you can measure to an accuracy of 1/10th of a metre. Some chains also show tenths in the last metre.

Pulling the chain straight

To measure, you have to pull the chain so that it's straight. Pull it with about four kilograms of force. It should sag just a little.

Folding and carrying the chain

There's a method of folding up the chain so that it's easy to carry in your vest, and so that it unwinds without problems. Words can't describe this well. Ask your Facilitator to show you how. Then practice it.

Chaining procedure

Measuring with a chain takes two people. The head chainperson is the one in front. The rear chainperson is the one who is behind.

Chaining procedures vary with the job, but generally you follow these steps:

1. The head chainperson takes the zero end of the chain and follows the compass bearing. If trees are in the way, the head chainperson goes to the right of one tree, then to the left of the next tree, and so on.

2. The rear chainperson feeds out the chain and watches for it to reach the desired metre mark. The rear chainperson also watches to make sure the head chainperson stays on course.

3. When the chain is nearly at the desired mark, the rear chainperson calls out "chain" and the head chainperson stops.

4. Between them, they make sure the chain is stretched in the right direction.

5. The rear chainperson locates the desired metre ring over the rear marker and yells something like “mark.”

6. The head chainperson then pulls the chain taut, marks a spot under the zero or tenths ring, then yells out “mark.”

7. The rear chainperson records the distance on the compass card.

Using A Hip Chain

A hip chain is a string that is measured out by a counting device as you walk. Only one crew person is needed.

Once the thread is tied to a branch and the counter dial is turned to zero, the counter will measure the distance you’ve travelled.

What Is An Offset?

An offset it what you do if there is a barrier that blocks you from measuring a straight line with your nylon chain or hip-chain. The barrier could be a cliff, a pond, or a thicket of dense bush.

To get around the barrier, the chaining crew has to measure new lines, and take new bearings at two turning points, to arrive back at the right point on the far side of the barrier. You could call it taking a “side step.”

Each line you measure is called a “leg,” a “run,” or a “course.”

Each turning point where measurements and bearings are made is called a “station.” Look at the figure below to see what the path looks like from above (Figure FR4-3b).

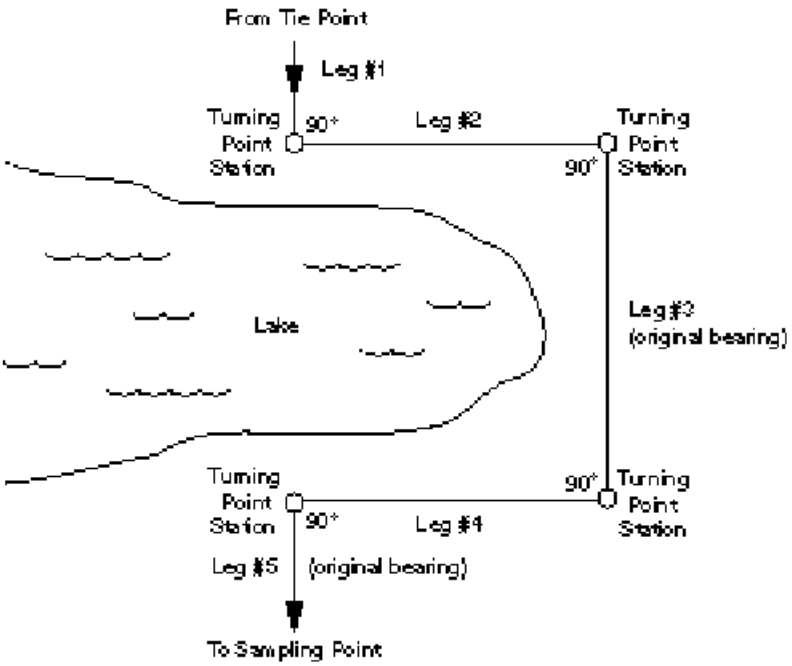

Figure FR4-3b An Offset (top view)

An offset is performed like this:

1. Take a bearing at 90 degrees from your true bearing.

2. Follow the bearing for this new leg and measure the distance with the chain, until you have gotten to a turning point station at the side of the barrier.

3. Find the original bearing again, turn and chain the next leg until you have passed the barrier.

4. Take a bearing 90 degrees back to measure the leg.

5. Turn and measure back the same distance you measured away. When you reach the station at the end of the leg, you're back to where you would have been if the barrier wasn't there.

6. Add together all of the legs of your chaining lines that are at the true bearing to the sample point.

You will become familiar with this practice in the field when you complete section 3, *Navigate to the Sample Location*.

What Is Slope?

Remember that map distance is horizontal distance. It's the distance you would travel if the land was flat. But you will often have to travel up hill and down valley.

When you measure distance on flat land, the answer you get from your chain is all you need.

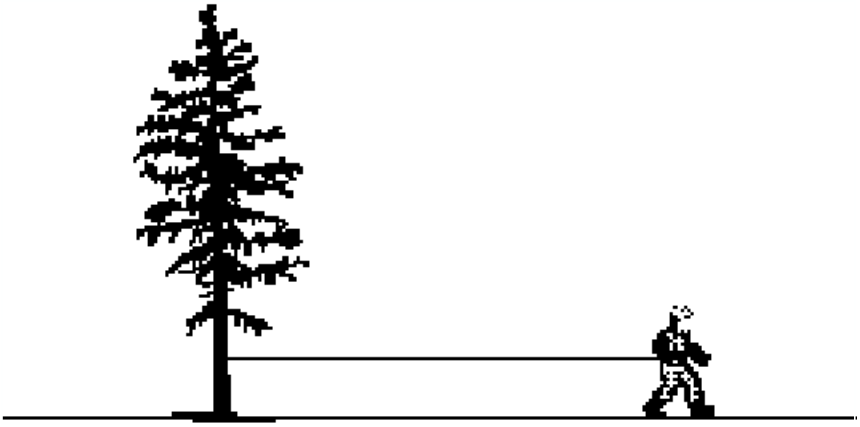

Figure Fr4-4, On Flat Land

But when you measure distance on land that is *not* flat, you need to make an "adjustment." Land that is not flat is called "sloped" land.

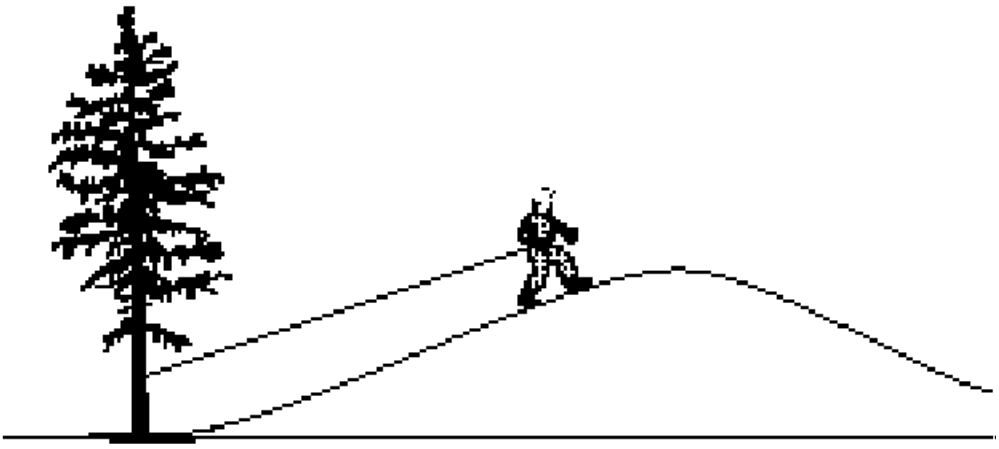

Figure Fr4-5, On Sloped Land

All distances are written down as *horizontal* distances. But when you measure up and down slopes, your chain is measuring the *slope* distance. Slope distance is always *more* than the horizontal distance because it includes some vertical distance in it.

The amount of slope is written as a *percentage*, as shown in Figure FR4-6 below.

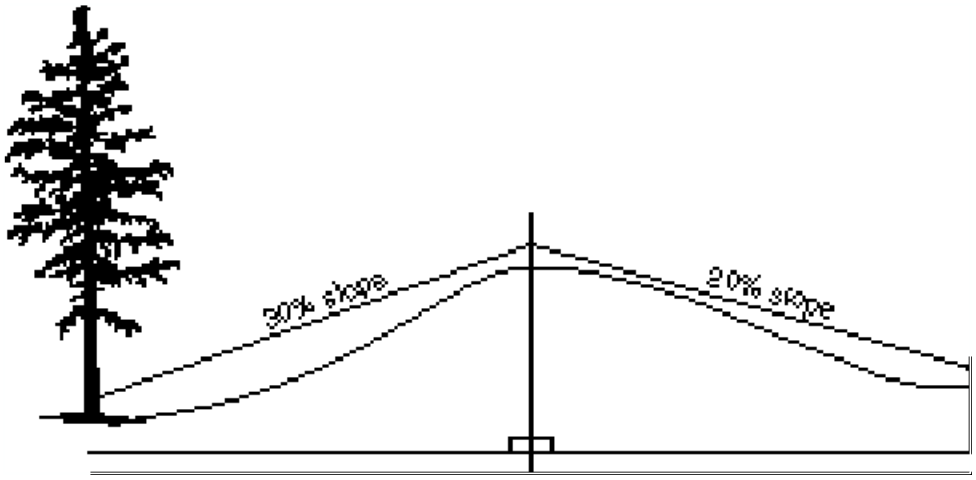

Figure Fr4-6, Slope As Percent

Figure FR4-7 below shows the same sloping ground with the slope distances your chain would measure.

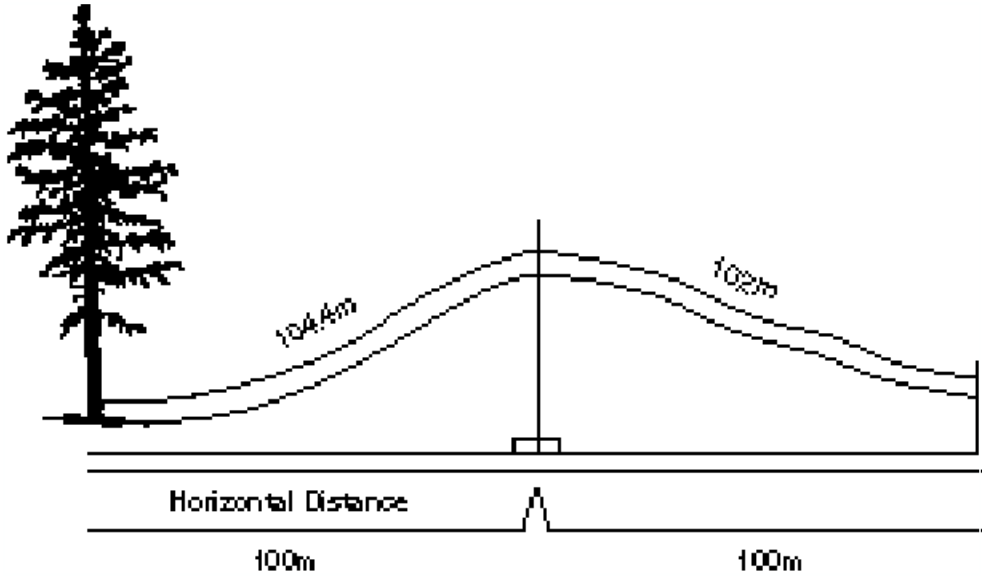

Figure Fr4-7, Slope As Distance

So, if you need to travel 100 m on a 30% slope, then you must actually walk and measure 104.5 m on your hip chain. You can see this by comparing Figures FR4-6 and FR4-7.

The steeper the slope is, the greater the slope distance must be to cover the same horizontal distance. This is shown in Figure FR4-8.

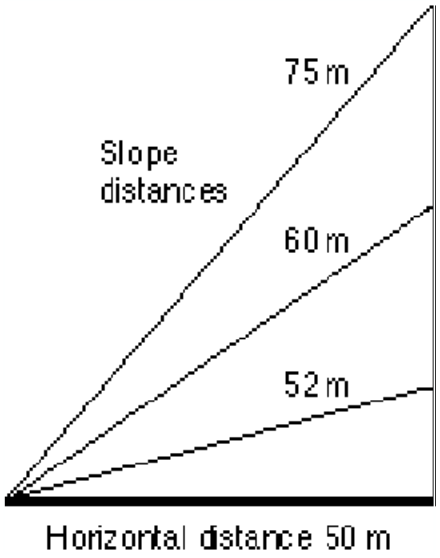

Figure Fr4-8 Diagram Of Different Slope Distances

The steeper the slope is, the more vertical distance is travelled. As the slope becomes less steep, the slope distance becomes more like horizontal distance.

When you measure distance on sloped land, you need to make an adjustment. You need to make this adjustment because you must travel farther on sloped land to cover the horizontal distance shown on the field map.

The adjustment is based on the slope of the land. You must be able to measure this slope.

Using A Clinometer To Measure Slope

There's an easy way to measure slope -- the *clinometer*. The "clin" comes from "incline," which is another word for slope.

Inside the clinometer is a wheel that turns freely. It's weighted at the bottom to keep it stable no matter whether the device is pointing up or down.

On the outer edge of the wheel is a dial marked in numbered scales which you can see through a small lens.

Reading the clinometer

Look at the sketch below of a person reading a clinometer.

FIGURE FR4-9, Man Reading Clinometer

As you look into the lens with one eye, keep your other eye open and look past the clinometer's side to the distant object you're sighting on.

Your brain mixes these two pictures together. By an optical illusion, you'll see the line on the distant object. You can read the slope value from the dial as you do so.

The scale on the *right* of the dial shows the slope as plus or minus *percent*. This is the scale you'll use to record slope.

The plus symbol (+) means uphill. The minus symbol (-) means downhill. It's written as +14%, +6%, -23%, and so on.

Sighting on a distant object

What distant object should you sight on? It depends on the situation. Usually you can sight on your crew partner. Before starting to navigate, stand facing each other and choose a target that's at the same level as your eyes. This is illustrated in Figure FR4-10.

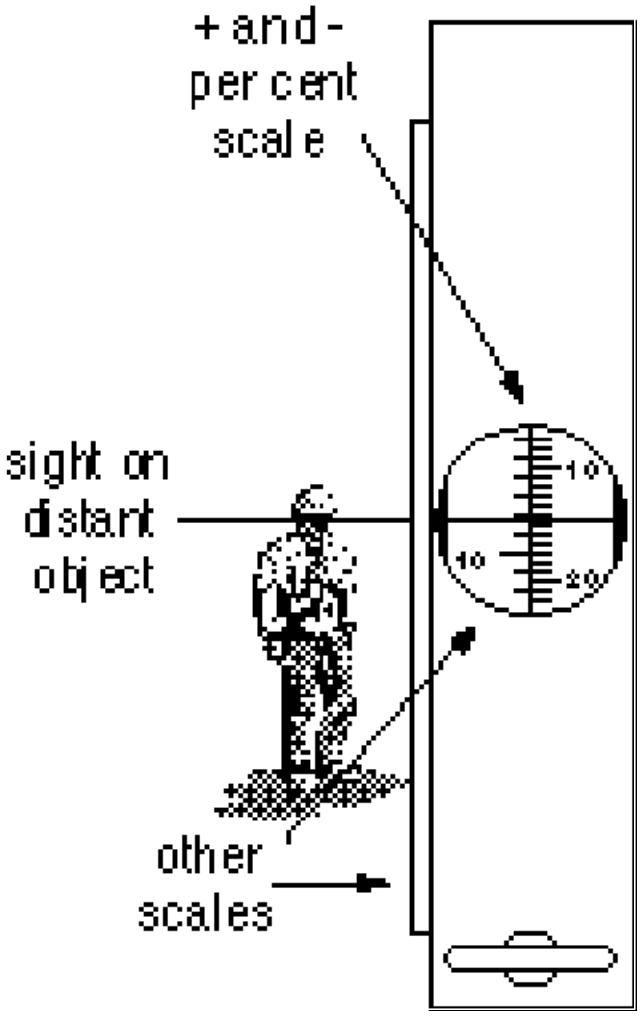

Figure Fr4-10, Sighting Distant Object

If both of you are the same height, sight on your partner's eyes.

Sometimes you'll also sight on treetops, etc.

Remember: you're sighting from eye level

When measuring slope, always sight on a target at your eye level. You're holding the clinometer above the ground, so your target must be just as high. Then your line of sight will have the same slope as the ground, as illustrated in the diagram below.

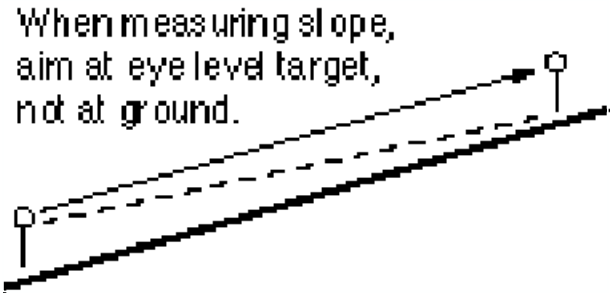

FIGURE FR4-11, Eye-Level Parallel Sighting

What exactly is a "percent" slope?

Percent slope is a different way of measuring angles. It's *not* the same thing as degrees of a 360 degree compass.

A percent slope tells you how many metres the slope would rise over 100 metres of horizontal distance.

For example, a +12% slope rises 12 m for every 100 m of horizontal distance, 12 cm for every 100 cm, and so on. This is illustrated in the diagram below.

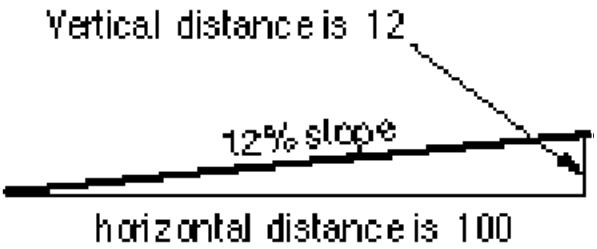

Figure Fr4-12, Slope Ratio Illustrated

Using A Slope Table To Adjust Horizontal Distance

Once you know the slope distance, you can look up the horizontal distance from slope tables carried in your field note book. Part of line from a slope table is shown here:

Part of a Slope Correction Table

SD	8	10	12	14	16	18	20	22	24	26	28	30
12%	7.9	9.9	11.9	13.9	15.9	17.9	19.9	21.8	23.8	25.8	27.8	29.8

Figure Fr3-13, Slope Table

Down the left side of the table is the slope percent. Only one line is shown in the figure.

Across the top is the distance measured. The “SD” stands for slope distance.

Let’s say you chained 30 m on a 12% slope. How would you find the correct horizontal distance?

Look down the left hand side until you find the row for 12% (as shown here). Look across the SD columns to the one for 30 m. The number listed there is the horizontal distance, 39.7 m.

For distances that aren’t shown, your crew leader will find the value between the two numbers given. Your Facilitator will

show you how this is done when you participate in the practical exercises.

Finding Horizontal Distance Across Sloping Ground

When using a clinometer to correct for slope, you should measure the slope *frequently*. You should take a new measurement every time the slope changes more than about five percent.

On each segment that is measured, the horizontal distance must be found with the slope table. Then add them together. This is necessary to accurately find the total horizontal distance.

For example, you might travel like this:

1. 100 m at +3 percent slope,

2. then 20 m at +35 percent slope,

3. then 40 m at +40 percent slope,

4. and finally 200 m at +11 percent slope.

That would mean four separate chain measurements, four separate slope measurements, and four separate slope corrections.

In the practical exercises you will practice finding horizontal distance in the field using the clinometer, hip chain, and slope table provided by your Facilitator.

When you feel you are ready, complete the practical exercises

Practical Exercises

These self-paced exercises will help you get the practical hands-on experience you will need to become competent in this skill. Do not attempt these exercises until you have read the text for this section.

The exercises in this section will not be performed in the classroom or at the field sampling location. They will all be done at a nearby "obstacle course" prepared by your Facilitator.

1. Use a hip chain to measure 5 different distances at different bearings, and from different starting points. The distances, bearings, and starting points will be given to you by your Facilitator.

2. Repeat exercise 1 with a partner, using a nylon chain.

3. Your Facilitator will demonstrate how to fold the nylon chain correctly. Practice it until you're good at it.

4. Your Facilitator will give you a distance to measure with a hip chain. You will measure it across and open field, using the *offset* method. Mark where you end up with a small spike in the ground.

5. Now measure the same distance again, using the regular, straight ahead method. Did you end up in the same place?

6. Use a clinometer to measure the slopes of various different objects pointed out by your Facilitator. Measure the slope distance from your position to the top of the object. The objects might include buildings and trees. Also use a partner to measure slope of the ground. (Remember -- you must sight at eye level.) Check all your answers with your Facilitator.

7. On sloping ground, measure several different slope distances with a hip chain. Measure the slope of the ground with a clinometer (sight on your partner). Then, for each distance, use a slope table to find the actual horizontal distance you travelled for each of the chaining distances you measured. When you're confident you can do this correctly, proceed to the next exercise.

8. Now you will do the reverse of what you just did. On the same sloping ground, measure out with your hip chain to a *horizontal* distance of 50 metres...

   This requires some figuring first! Use the slope table to calculate how far to measure across the ground to end up at a *horizontal* distance of 50 meters. Use the slope you have already measured with the clinometer. (Hint: the slope distance is always longer.)

   Your Facilitator knows this is a tough exercise, and will always be there to help you.

Navigating To a Sample Location

All of the learning in this section is done in the practical exercises. You will practice navigating to a bearing and horizontal distance given to you by your Facilitator. The topics below describe the activities you will learn to perform.

- navigating from a tie point to a sample point
- performing offsets in difficult terrain
- confirming that you're in the right polygon by comparing the aerial photos to the land around you

As you learned in Unit 2, the two most important things about the inventory sampling point are these:

- It's established in an unbiased way
- It's in the correct polygon

As long as the crew has followed all the procedures to get to the sample point, the most important thing is to make sure that you're in the right polygon. As you learned in Unit 3, that is why reading aerial photos in the field is so important. You should be able to say with confidence, "yes, I'm in the right polygon."

When you feel you are ready, complete the practical exercises

Practical Exercises

These self-paced exercises will help you get the practical hands-on experience you will need to become competent in this skill. Do not attempt these exercises until you have read the text for this section.

For these exercises, a group of participants will travel with the Facilitator to the field sampling site. Participants will take turns doing the exercises.

1. Start at a selected tie point and navigate to the sample point given on your field map and aerial photos. Your tools will include stereoscope, compass, clinometer, and hip chain. You will need to take bearings, correct for slope, perform offsets, and record everything along the way.

2. Confirm that you're in the correct polygon by reading your aerial photos and map.

3. Repeat this whole procedure, starting from a second tie point.

4. Repeat this whole procedure again, starting from a third tie point.

After you have completed the practical exercises, or have arranged for them to occur, continue on to the Skills Test for this unit.

Skills Test

Instructions

Now that you have studied and practiced navigating in the field, it's time to be tested on your performance.

The first part of this skills test will be done when you are ready to arrange it with the Facilitator, prior to going to the field location. You will use a map, photo, scale rule, protractor, and hammer.

For the second part of this skills test, you will travel as a group back to the field sampling location for a third time. Your ability to navigate accurately on your own will be evaluated by your Facilitator, who will travel with you as you demonstrate your new navigation skills.

In this Unit, performance will be evaluated by a point system. The quality and accuracy of activities will be rated by points. Some activities are worth more points than others.

Your tools will include stereoscope, compass, clinometer, hip chain, and nylon chain. You will be given the same map and aerial photo pair again, but this time marked with a *new sample point*.

Procedures

Before going to the field:

1. Your Facilitator will give you the aerial photo on which you originally located the sample point and tie points in the first exercise in Section 1. This time your Facilitator has marked a *new sample point* on the field map. Transfer the new map point to the photo, using the scale rule and protractor.

2. Your Facilitator has selected one of the possible tie points on the photo and map. Use the protractor and scale rule to find the bearing and distance from each of the tie points to the *new* sample point. Record these measurements.

3. Your Facilitator will give you a new aerial photo of an unknown area. Identify five possible tie points and explain why you have chosen them.

4. Your Facilitator will take you to a selected tree. Pretend this tree is a tie point tree. Describe the complete process of marking this particular tree. Finally, nail in the information tag.

5. Describe the information appearing on this information tag.

6. Explain the meaning of the term "slope."

At the field sampling site

1. Your Facilitator will take you to one of the tie points. Identify on the photo which tie point it is.

2. Navigate to the *new sample point* given on your field map and aerial photos. You will need to take bearings, correct for slope, perform offsets, and record everything along the way.

3. On the last leg of your navigation, use the nylon chain instead of the hip chain.

4. At the sample point, confirm that you're in the correct polygon by reading your aerial photos and map. Explain how you know. (Or if you're in the *wrong* polygon after all, how do you know *that*?)

Evaluation Checklist

Unit 4- Navigate in the Field Skills Evaluation Form

The participant:	**SCORE**	**Comment**
1. Used a scale rule and protractor to accurately locate the sample point on an aerial photo. (10 pts)		
2. Identified possible tie points on aerial photographs. (5 pts)		
3. Explained the reasons for choosing specific tie points well enough to show an understanding of what a tie point is for. (2 pts)		
4. In the field, standing next to a tie point, was able to correctly identify and accurately locate the tie point on the aerial photo. (5 pts)		
5. Explained how to correctly mark a tie point tree for referencing the tie point. (5 pts)		
6. Hammered in the tag correctly. (2 pts)		
7. Described correctly all of the information on the reference tree tag. (5 pts)		
8. Used a nylon chain to measure distance accurately. (10 pts)		
9. Folded and carried the nylon chain correctly. (5 pts)		

10. Used a hip chain to measure distance accurately. (10 pts)

11. Explained the meaning of the term “slope.” (5 pts)

12. Operated a clinometer to measure slope accurately. (5 pts)

13. Used a slope table to adjust horizontal distance accurately. (10 pts)

14. Accurately determined the horizontal distance across sloping ground, using a hip chain, a clinometer, and a slope table. (15 pts)

15. Used a hip chain to navigate in the field from a tie point to a sample point, given the bearing and the horizontal distance. (15 pts)

16. Performed offsets accurately. (15 pts)

17. Explained how they were able to confirm that the measured ground sample point was in the right polygon by reading the field map. (Or: explained how they knew they were not in the correct polygon.) (10 pts)