KARRI SEED CROP ASSESSMENT & MONITORING

CONTENTS:

SILVICULTURE GUIDELINE 2/97

KARRI SEED CROP ASSESSMENT & MONITORING

1. INTRODUCTION

"The floral cycle of karri is complex with variation between trees and seasons, within crops on one tree and between stands within the forest. Main blossoming may be interrupted, advanced or delayed depending upon the interaction of genetic and environmental factors." Loneragan (1979).

The normal floral cycle of karri is 4 to 5 years. Although individual karri trees may flower annually, abundant seed crops on any one tree occur only infrequently at intervals of between 4 and 12 years.

Regeneration of harvested karri coupes can be achieved via natural seed fall through the implementation of seed tree harvesting systems. Due to the irregular availability of naturally occurring seed crops however, regeneration of harvested coupes must be augmented by artificial regeneration methods if an annual regeneration program is to be achieved. This mainly involves the planting of nursery raised seedlings. As artificial methods such as this are more expensive in application every effort needs to be made to utilise the naturally occurring availability of seed.

This specification provides a method by which naturally occurring seed crops can be assessed and monitored. Seed monitoring is needed for planning appropriate harvest and regeneration methods and for planning seed collection operations.

2. OBJECTIVE

The objective of karri seed crop assessment and monitoring is to provide for:

* mid term harvest planning through detailed forecasting of the stage of development of seed crops within coupes added to the 4 year logging plan.

* annual monitoring of coupes within the 4 year plan assessed as suitable and available for harvesting to seed trees.

* detailed pre-burn assessment of coupes harvested to seed trees.

3. MID TERM SEED FORECASTING

To provide for detailed assessment of seed crops within coupes added to the 4 year harvesting plan following annual revision, the objective being to determine the suitability of these coupes for regeneration by seed trees.
The following method will be adopted;

3.1 Suitability:

The suitability for seed tree regeneration should be assessed prior to assessment of seed crop potential. Sufficient medium to large crowned trees with primary or secondary crowns (degenerate crowns resulting from age or fire damage are not suitable) need to be present on an area for this method of regeneration to be considered. Part of an operation may be suitable and the area of this used as the basis of calculating further assessment requirements.

If all of a proposed coupe is unsuited to regeneration by seed trees no further assessment is required and the results and monitoring record sheet (Appendix 1) is to be completed accordingly and returned to the Southern Forests B.U. Silvicultural Officer.

This broad assessment of the coupe can be achieved from a review of aerial photography of the proposed coupe combined with a field inspection.

For those coupes or parts of coupes which appear suitable for consideration for seed tree regeneration detailed assessment is required. This will require Appendix 1 and the Karri Seed Forecasting Procedure Appendix 2 to be completed.

A map of the coupe must also be prepared showing the area of the coupe suitable for seed tree regeneration and the approximate position of potential seed trees assessed.

3.2 Number of Sample Trees:

For coupes less than 20 hectares in size, the minimum number of sample trees required is 4. This reflects at least a 5% sample of potential seed trees assuming 4 trees/hectare will be retained for this purpose. For every 5 hectares in excess of 20 hectares, 1 further sample tree is required. This maintains the sample at a minimum of 5%.

eg.	< 20 hectares	-	4 trees	
	20 - 24 hectares	-	5 trees	
	25 ≤ 29 hectares	-	6 trees	etc.

3.3 Selection of Sample Trees:

Sample trees need to be subjectively selected to ensure a representative sample of the range of sites within the coupe has been obtained, ie. ridge to valley.

The sample trees also need to be selected on the basis of being representative of the average floral cycle stage of potential trees within the coupe, eg. there is no point in selecting a tree to be included in the sample if it is carrying a heavy seed crop when the majority of trees are carrying a very poor seed crop.

Initial selection of sample trees may be achieved through the use of binoculars.

3.4 Viability Testing of Seed:

If as a result of the sampling process it is found that potential seed trees are currently carrying a sufficient seed crop to achieve regeneration, consideration needs to be given to bringing the coupe forward on the harvest plan for immediate cutting.

If it is possible to do this, confirmation of the seed crop will be required by testing the viability of seed in late stage 3 and stage 4 fruits.

To do this a representative sample of 100 capsules is to be collected, placed in a sealed, dry container and despatched to the Plant Propagation Centre (PPC), seed store without delay. Care must be taken to ensure this sample is not subjected to temperatures exceeding 40^{o}C as this will impair viability.

3.5 Timing of Assessment:

Assessment of coupes is to be completed during October/November each year with a copy of results (Appendix 1, 2 including recommendations on year of best cut for regeneration via seed trees), being forwarded to the Southern Forests B.U. Silvicultural Officer by 1st December annually.

3.6 Bee Introduction:

Research has shown bees can significantly improve seed yield per capsule and seed viability by improving the successful pollination of flowers. The introduction of bees to coupes to enhance potential seed crops should be seriously considered, particularly where seed assessment and monitoring suggests a marginally acceptable seed crop to be otherwise available.

Note: A coupe proposed to be harvested to seed trees will not have the dominant/co-dominant strata harvested until flowering has finished. Harvesting prior to or during flowering may result in reduced cross pollination and loss of flowers due to exposure.

4. ANNUAL MONITORING

Genetic and environmental factors combine in karri to make reliable forecasting from single assessment of early stages of the floral cycle impossible.

Some apparently good crops of buds abort, some develop slowly while others may develop more rapidly than expected.

Seeds/capsule and seed viability can vary greatly making ongoing monitoring essential. To take account of this, all coupes which have been harvested or are proposed to be harvested to seed trees within the 4 year plan but which are not proposed for regeneration burning in the current financial year will receive an annual seed monitoring assessment.

4.1 Method:

The procedure to use will be as per Appendix 2.

4.2 Timing:

The assessment of coupes is to be completed during October/November each year with a copy of the results (Appendix 2 including recommendations on year of best cut for regeneration by seed trees), being forwarded to the Southern Forests B.U. Silvicultural Officer by 1st December annually.

5. PRE-BURN ASSESSMENT

Seed forecasting and monitoring procedures detailed above provide a general estimate of available seed crop and its development.

For years of heavy seed crop availability, this process may be all that is required to achieve regeneration success. However, for marginal crops, crops that are highly variable or coupes in which regeneration burning has been delayed, further work is required to ensure regeneration success.

The uniformity or otherwise in the number of maturing capsules per twig between seed trees is crucial as is the range in sizes of tree crowns, the distribution of these crowns/ the number per hectare and the viability of available seed.

Successful regeneration is therefore not only dependent on the average seed crop per hectare on a coupe, but also on how it is distributed across the coupe.

Because our measure of success requires 85% of the area of the coupe to be adequately stocked, it is necessary that 85% of the surface of the coupe is exposed to the minimum recommended rates of seed fall. This needs to be evenly distributed across the coupe to ensure that no holes in the regeneration occur.

As a rule of thumb, 65% to 70% of seed trees must contribute at the minimum rate per hectare (eg. 30,000 viable seeds/tree for a spring burn for 4 seed trees per ha), with no more than 1 in any group/triangle of 3 contributing less than this.

5.1 Timing:

Pre-burn seed assessment is to be completed no more than 2 months prior to regeneration burning programmed for spring. For seed tree regeneration burning programmed for the remainder of summer/autumn assessment is to be completed no later than 15th January with results forwarded to the Southern Forests B.U. Silvicultural Officer by this date. This will allow all options for remedial action to improve potential regeneration stocking to be considered.

5.2 Method:

Subdivide the coupe into groups of 10 to 20 seed trees using photo’s or maps, on the basis of snig tracks, roads or other defined features. Choose 50% of these seed trees on an even spacing, i.e, 5-10 trees and assess the trees for crown size (large, medium or small), with a telescope or binoculars, the size of the capsule crop in the crown (heavy, medium, light or very light), and record these on the seed tree area assessment sheet (Appendix 3).

Following this, estimate the capsule crop on each tree, (Appendix 3).

5.3 Seed Viability Testing:

Sample capsules for viability testing at the rate of one tree per area. Follow the procedure as outlined in section 4.

Using the information gathered on viable seed/capsule complete the seed tree area assessment sheet (Appendix 4).

5.4 Mapping:

Map the positions of trees assessed and their contribution, i.e. (acceptable, not acceptable). Highlight any areas of the coupe which may have less than the acceptable stocking in future regeneration, i.e. 2 or more trees adjacent in any 6 assessed which have less than acceptable seed crops.

Any areas which are highlighted as being potentially understocked will require assessment of all trees to determine the exact boundaries and total area involved.

5.5 Remedial Action:

Having decided on the adequacy of each area to achieve regeneration, remedial action will need to be prescribed for areas which may result in gaps in regeneration. Remedial action may either be through planting the potential gap area or direct seeding of these areas to boost seed supply, following the regeneration burn.

6. SUMMARY OF ASSESSMENT AND MONITORING REQUIREMENTS

SUMMARY OF TIMETABLE FOR SAMPLING

TYPE OF SAMPLE	DATE	SEED VIABILITY TESTING
Coupes added to 4 year plan	October/November	Yes
Coupes or parts of coupes suitable for harvesting to seed trees	October/November Annually until harvested	Yes
Pre-burn assessment	No more than 2 months prior to proposed burn and no later than 15th January each year	Yes

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Hardwood Silviculturist S.F.R.B.U

APS:BB
February 12, 1997.

APPENDIX 1

KARRI SEED FORECASTING
RESULTS & MONITORING RECORD

OPERATION CODE (ex harvesting plan): _____

AMENDED OP CODE (amended plan): _____

PLAN YEAR: _____ BLOCK: _____

SUITABILITY FOR SEED TREE CUTTING

Area suited to seed trees (sufficient potential seed trees): **ha**

Area not suited to seed trees (poor stocking / poor trees): **ha**

TOTAL AREA **ha**

RESULTS OF ASSESSMENT

Date assessed: / / . Forecaster: _____

Sufficient seed potentially available: YES / NO Best Year: _____

Alternative Year: _____

Are best or alternative years based on good pin or fat bud crops: YES / NO

If yes, should Bee introduction be considered: YES / NO (Year:)

RECOMMENDATIONS and COMMENTS

ACTION on Recommendations

_____
Harvesting Planner
Dated: / / .

_____
Dated: / / . Silviculture Officer

CROP MONITORING RECORD

Date Checked	Comments on Seed Crop Development in Relation to Above	Forecaster Signature

APPENDIX 2

SEED FORECASTING PROCEDURES
(Extract from G. Ellis - March 1988)

1. Examine a number of trees within the coupe with binoculars/telescope to get an indication of what the "average" tree looks like in terms of fruit development. This will also give an idea of the variability or uniformity of the seed crop within the coupe.

2. Shoot down sample branches from at least 4 "average" trees (see section 3.2) for the purpose of counting floral components. See Appendix 4 for a guide to shooting. Trees chosen should be from hilltops to valleys. Sample branches should represent the "average" branch, i.e. there is no point shooting down a branch with a light amount of stage 4 capsules when the majority of branches are heavy in fat buds.

3. Select branchlets from the sample branch and count the number of floral components per twig. 4 branchlets from the sample branch should be chosen. A twig is defined as "one years growth".

4. Once 4 trees have been sampled, totals for each stage are tallied and entered into column (a) on the attached seed forecasting proforma. By dividing by the number of observations (4 x "t") , ("t" is the number of trees sampled and assuming 4 branchlet samples per branch) comprising each total the mean number of fruit components per branchlet is found (column b).

5. Working through the table will result in predictions for the number of capsules/ha from stage 1 and stage 2 buds (assume one viable seed per capsule) and estimated numbers of seed/ha from stage 3 and stage 4 capsules.

"Stages of Development"

Stage 1: Pin buds and cylindrical buds (small) less than one year old.

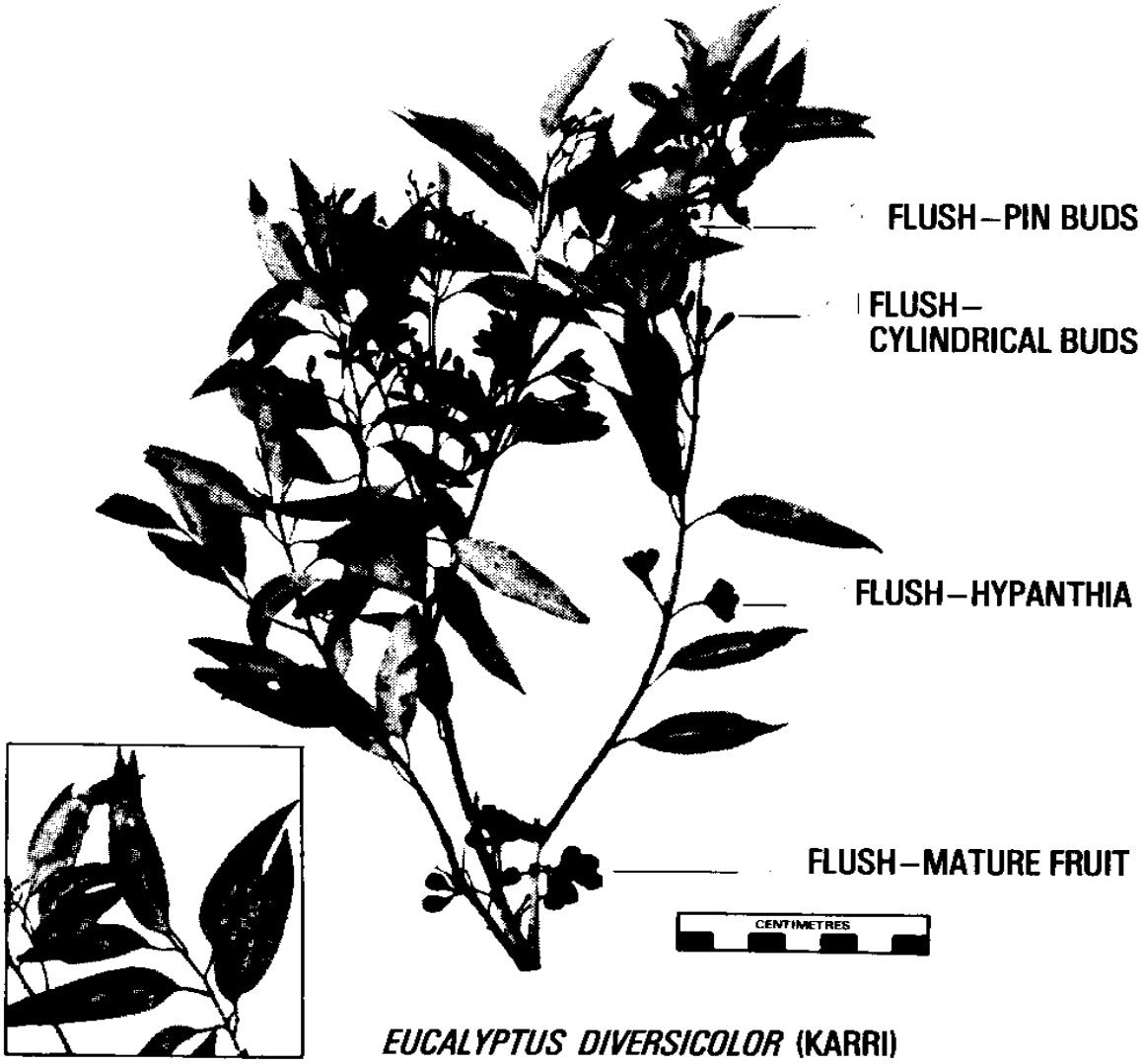
Stage 2: Cylindrical/fat buds likely to flower in the following autumn.

Stage 3: Flowers and immature capsules (green). Transition between stage 2 and stage 3 is the shedding of the operculum. Fat buds ready to flower are "late stage 2".

Stage 4: Mature capsules (grey), with seed.

Stage 5: Overmature capsules, seed already dropped.

DIAGRAM OF STAGES ADOPTED FROM LONERAGAN 1979



EUCALYPTUS DIVERSICOLOR (KARRI)
Collected from Gloucester Fire Look-out Tree
May 1961

KARRI SEED FORECASTING
PRE-HARVESTING FOR OPERATION SCHEDULING

PART A- SAMPLE SHEET

Forecaster: ______________________ **Date Assessed: ________________________**

Operation Code: _________________ **Block: _______________________________**
(Harvesting Plan)

Assessed Area: __________________ **Number of Trees to be Assessed: _________**

Tree #	Fruit Stage	Assessed Fruit Stages per Twig on Branchlet Number 1	2	3	4	Total by Stage
	1					
	2					
	3					
	4					
	1					
	2					
	3					
	4					
	1					
	2					
	3					
	4					
	1					
	2					
	3					
	4					
	1					
	2					
	3					
	4					
	1					
	2					
	3					
	4					
	1					
	2					
	3					
	4					

Tree #	Fruit Stage	Assessed Fruit Stages per Twig on Branchlet Number 1	2	3	4	Total by Stage
	1					
	2					
	3					
	4					
	1					
	2					
	3					
	4					
	1					
	2					
	3					
	4					
	1					
	2					
	3					
	4					

GRAND TOTAL (Total of all trees): ________

Number of trees "t" = _________ (used at [b]) of page 2

Transfer all to column (a) of page 2

Stage 1: ______
Stage 2: ______
Stage 3: ______
Stage 4:_______

POTENTIAL SEED CROP CALCULATION

KARRI SEED FORECASTING

PART B - POTENTIAL SEED CROP CALCULATIONS

Operation Code (Harvesting Plan) **Date Assessed: _____**

_____

	(a)	(b)	(c)	(d)	(e)	(f)
Fruit Stage	**Grand Total All Trees**	**Ave. Branchlet (a) / (4x't')**	**Total / Tree (b) x 10,000**	**Total / Ha (c) x 4**	**Capsules**	**Seed Estimate per Ha**
1					0.3 x (d)	0.8 x (e)
2					0.6 x (d)	0.8 x (e)
3					0.8 x (d)	viable x (e)
4					1.0 x (d)	viable x (e)

	YEAR AND SEASON								
Stage	**Spring**	**Autumn**	**Spring**	**Autumn**	**Spring**	**Autumn**	**Spring**	**Autumn**	**Spring**
1	0	0	0	0	0	0	(f)	0.6 x (f)	0.4 x (f)
2	0	0	0	0	(f)	0.6 x (f)	0.4 x (f)	0	0
3	0	0	(f)	0.6 x (f)	0.4 x (f)	0	0	0	0
4	(f)	0.6 x (f)	0.4 x (f)	0	0	0	0	0	0
Total Crop Estimate									

NOTES:

1. Grand total at (a) is from sample sheets.
2. "t" in the calc. for (b) is the total number of trees in the sample used to get (a).
3. Calculations at (c) assumes an average tree has a medium sized crown.
4. Calculation at (d) assumes 4 seed trees per ha (adjust if otherwise).
5. Use (f) in second table for respective stages.
6. Total crop available by year and season is obtained by totalling columns down the page, not across.
7. Compare to standards in Appendix 4 to select best or range of seasons for regen burning.

KARRI SEED FORECASTING
FIELD COPY

PART B - POTENTIAL SEED CROP CALCULATIONS

Operation Code (Harvesting Plan) **Date Assessed: _____**

_____

	(a)	(b)	(c)	(d)	(e)	(f)
Fruit Stage	**Grand Total All Trees**	**Ave. Branchlet (a) / (4x't')**	**Total / Tree (b) x 10,000**	**Total / Ha (c) x 4**	**Capsules**	**Seed Estimate per Ha**
1						
2						
3						
4						

	YEAR AND SEASON								
Stage	**Spring**	**Autumn**	**Spring**	**Autumn**	**Spring**	**Autumn**	**Spring**	**Autumn**	**Spring**
1									
2									
3									
4									
Total Crop Estimate									

NOTES:

1. Grand total at (a) is from sample sheets.
2. "t" in the calc. for (b) is the total number of trees in the sample used to get (a).
3. Calculations at (c) assumes an average tree has a medium sized crown.
4. Calculation at (d) assumes 4 seed trees per ha (adjust if otherwise).
5. Use (f) in second table for respective stages.
6. Total crop available by year and season is obtained by totalling columns down the page, not across.
7. Compare to standards in Appendix 4 to select best or range of seasons for regen burning.

APPENDIX 3
SEED TREE PRE-BURN AREA ASSESSMENT SHEET

AREA REFERENCE:

Tree #	Crown size (L,M,S) *	Capsule Crop (H,M,L,VL) *	# Capsules per Tree	# Seeds per Capsule	Viable Seed per Tree
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
Percent adequate =			Any gaps (ie. > 1 in any 3 poor)?		

AREA REFERENCE:

Tree #	Crown Size (L,M,S) *	Capsule Crop (H,M,L,VL) *	# Capsules per Tree	# Capsules per Hectare	Viable Seed per Hectare
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
Percent adequate =			Any gaps (ie. > 1 in any 3 poor)?		

*** Refer Appendix 4**

APPENDIX 4

CAPSULE CROP ESTIMATES FOR SEED TREES

Capsule Crop Size	TREE CROWN SIZE		
	Large (diam.> 27.5 m)	**Medium (27.5 > diam.> 22.5)**	**Small (22.5 m.> diam.)**
Heavy (8+ caps / twig)	G.T. 120,000 / tree (G.T. 480,000 / ha)	G.T. 80,000 / tree (G.T. 320,000 / ha)	G.T. 53,000 / tree (G.T. 210,000 / ha)
Medium (5 to 7 caps / twig)	90,000 / tree (360,000 / ha)	60,000 / tree (240,000 / ha)	30,000 / tree (120,000 / ha)
Light (2 to 4 caps / twig)	45,000 / Tree (180,000 / ha)	30,000 / tree (120,000 / ha)	20,000 / tree (80,000 / ha)
V Light (0 to 1 cap / twig)	L.T. 15,000 / tree (L.T. 60,000 / ha)	L.T. 10,000 / tree (L.T. 40,000 / ha)	L.T. 7,000 / tree (L.T. 30,000 / ha)

ASSUMPTIONS:

The table assumes: a large crowned tree of about 30 m diameter has 15,000 twigs;
a medium crowned tree of about 25 m diameter has 10,000 twigs;
and a small crowned tree of about 20 m diameter has 6,600 twigs.

The rates per hectare assume 4 seed trees per hectare, ie. the trees contribution to regeneration is (the rate per ha) x (the # viable seeds per capsule).

If less than (or more) the 4 trees per hectare, adjust accordingly.

MINIMUM SEED REQUIREMENTS:

At the time of burn, the rates in the table below are the minimums to be used to assess likely success or possible failure.

SOIL TYPE	MINIMUM VIABLE SEED RATES / ha at the time of the burn	
	SPRING BURN	**AUTUMN BURN**
Red “Karri” loams: (high quality ‘pure’ karri sites)	120,000	90,000
` Podsols: (generally the mixed karri, marri types)	180,000	135,000

APPENDIX 5

FIREARM USE

1. FIREARM SAFETY

Persons required to use firearms in the course of their work are required to complete the Departmental Firearms Safety and Maintenance Course and as a prerequisite to being registered on the Corporate Firearms License.

The Department has a duty of care responsibility to ensure its employees are adequately trained in the use of firearms and that the correct safety procedures are followed. It is also important that the Department firearms are properly maintained and utilised in a proficient and cost-effective way.

When planning a trip into the field a number of checks are required prior to heading out:

1.1 Notification: Check of any CALM, Timber Industry or other operations/activities that may exist within a 3 km radius of survey area. Notify these people/neighbours of your works program and nature of the job. Avoid discharging a rifle in the direction of these operations/activities.

1.2 As a courtesy, notify the local Police with information of job, time and area of work, then any reports to police by public of firearms being discharged are attended to at time of call and result in no unnecessary follow-up by Police.

1.3 Check the location of all private property within a 3 km radius of area and be familiar with its direction when in the field. Avoid discharging a rifle in the direction of the Private Property.

1.4 Ensure the firearm to be used is well maintained. Check that you have the correct bolt, magazine and ammunition for that firearm.

1.5 Complete the firearms/ammunition record sheets prior to and on completion of day's program.

1.6 Ensure all safety equipment is worn. Ear protection is compulsory and eye protection is recommended.

1.7 Check the accuracy of your rifle prior to commencing the job (may need sighter shots taken as scope may have been knocked prior to use).

1.8 When arriving in the field check to ensure that no public are in the area and all checks from the office are correct. Always bear in mind that other people may be using the area no matter how remote the site may be. Avoid using a rifle on State Forest during potentially high public visitation periods of the year, i.e. school holidays.

1.9 Assess the sample points required.

* Check the firing zone:
  - think what will happen to the bullet if the target is missed;
  - are there any people, property or stock in the firing zone.

* Identify the target absolutely:
  - never fire at a sound;
  - never fire at a movement;
  - never fire at a shape that cannot be identified.

2. BALLISTICS/TRAJECTORY

As explained in the Departmental firearms safety and maintenance course you require a basic understanding of this topic for safety in the use of firearms.

Interior ballistics - there are extreme internal pressures developed when the propellant inside the cartridge case is ignited, these can amount to 45,000 - 52,000 pounds per square inch in many centre fire rifles.

If this release in pressure is blocked by having excess oil or some other form of blockage, a serious accident could result. Breaches and barrels can and do give way under extreme pressure - this happening very close to the person involved.

Exterior ballistics - refers to what happens to a bullet once it leaves the barrel. Two factors operate on the bullet - gravity and drag. Wind also is a critical factor affecting the bullet, especially cross wind.

Once the bullet leaves the muzzle, we must be aware that it is going to end up somewhere for example, the .222/.223, if fired at a maximum angle of traverse, ie. 40 degrees it is calculated it will have a maximum range of approximately 3 kms.

It is therefore paramount you are aware of your firing range and what is beyond your target.

It is also possible if the target is incorrectly and even correctly hit the bullet may still travel beyond.

Causes for this may be ricochet - incorrect placement of shot, heavily constructed bullets - pass through a target, and density and structure of target.

3. A GUIDE TO THE SHOOTING DOWN OF KARRI BRANCHES

The choosing of which branches to shoot down will become easier with experience, but the following points should be noted. The number and citing of branches shot will depend on both the size of, and variation within, the coupe, but should be numerous and diverse enough to reflect any variation.

3.1 A reasonably ‘average’ branch should be chosen in each case, but the branch must offer a good target, contain enough ‘crown’ to give a good sample, and have a free fall, ie. in practice, branches must be near the edge of the tree crown.

3.2 The target area of the branch stem should not be too thick from 4 cm to 8 cm is a reasonable size.

3.3 Branches often hang after breaking. In this case, it is futile firing off a dozen or so shots in an attempt to free it. It is better to try another branch. However, it pays, particularly on a windy day, to check every area where branches are hanging before leaving the coupe. Often a branch will have freed itself by then, and is useful for a confirmatory check and another capsule sample.

3.4 Branches rising straight up, or at an acute angle, should be chosen for preference. This cuts down the number of ‘hang-ups’.

3.5 Shooting range is up to the individual. However, a distance of about 60-80 metres from the tree is about right. The most efficient way of obtaining the branch is to fire the first shot into the lower edge, second shot into the upper edge, then one or more shots into the centre. Precision comes with practice, and it is often possible to get a branch down with two shots - occasionally with one. About 5 to 8 shots is the most frequent number to bring down a branch.