Warning

This document contains graphic images of animals that have been attacked by predators, and graphic pictures of animal autopsies.

Please be aware that these images may cause distress to some people.

NSW Agriculture

SHEEPCRC

Lamb Autopsy

Notes on a procedure for determining cause of death

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Disclaimer
The information contained in this publication is based on knowledge and understanding at the time of writing (May 2004). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of New South Wales Department of Agriculture or the user's independent adviser.

Contents

Lamb autopsy

The causes of perinatal lamb deaths are well recognised but their extent and importance will vary between flocks, years and seasons, and from the start to the end of lambing. To establish causes of lamb deaths on a flock basis it is necessary to autopsy most of the dead lambs and over the full lambing period. It is also helpful to have:

Fig 1. Lamb data collection in field.

- flock management records
- lambs tagged at birth
- field notes such as whether the lamb was assisted and why (see figure 2), time of birth and death, accidents and birth type
- weather data.

The autopsy procedure should provide sufficient evidence to nominate causes of lamb death at that lambing. The next step is to consider all the information and attempt to identify the *predisposing factors* contributing to lamb mortality. Since flock management is a major contributor, consultants and producers who have attended the EDGE network workshop 'Wean More Lambs' will recognise deficiencies in their management that contributed to lamb mortality.

The publication *Wean More Lambs* brings together a set of best practice management guidelines for improving sheep reproduction. It is available from Meat and Livestock Australia.

In most commercial flocks, the autopsy procedure will provide sufficient evidence to nominate the causes of lamb death at that lambing. However, there are exceptions and the investigator should respond. For example, congenital goitre (iodine deficiency) and white muscle disease (selenium deficiency) are usually endemic to particular districts and may occur sporadically in those districts. Again, congenital infections usually have a low prevalence but if suspected to be a current problem then appropriate microbiological and histopathological examination needs to be undertaken. A suitable guide for the submission of samples is Eamens, G.J. (1985). *Laboratory Specimen Submission Manual – A guide for the submission of samples for laboratory examination and interpretation of results.* 8th Edition. NSW Agriculture, Orange.

TYPES OF ASSISTED BIRTH

1. Normal presentation, legs not extended, large lamb, easy to withdraw
2. One or both legs back; twisted head
3. Breech – rear presentation
4. Normal presentation, big lamb, head swollen
5. Dead 'in utero'; most likely dead if born naturally
6. Other difficulty, e.g. two lambs together; bad head presentation etc.
7. Passive twin to one of (6) above would have lived if born naturally.

Fig 2. Types of assisted birth

Fig 3. Autopsy equipment.

Fig 5. Dead lamb awaiting autopsy to determine cause of death.

EQUIPMENT

- Knife (approx, 15 cm blade, 1/4 curve to straight)
- sharpening stone
- steel
- secateurs (footrot)
- 10 cm scissors
- apron
- bucket
- paper towelling
- garbage containers
- gloves
- data sheet (figure 4)
- field sheet (figure 2)
- CNS and cranial scores (figure 30 and 33).

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DATA SHEET

DATE:	**DAM NO.:**	**BIRTH TYPE:**
LAMB NO.:	**ASSESSOR:**	**BIRTH WEIGHT (kg):**
SEX :	**AGE AT DEATH (d):**	
ASSISTED:	**TYPE:**	

CLEANED:	**WALKED:**	**EXTERNAL ABNORMALITIES:**
PREDATION:	**SITES:**	**BIRD / FOX / OTHER**

OEDEMA:	**HEAD / NECK / EXTREMITIES**
LIVER DAMAGE:	
BREATHED:	
PETECHIATION:	**HEART / LUNGS**
FED:	
FAT METABOLISED:	

CRANIAL HAEMORRHAGE:	**1**(nil) **2** **3** **4** **5** (severe)
CNS HAEMORRHAGE:	**1** **2** **3** **4** **5**

DEATH CATEGORIES:

1. **Dystocia** (a) Oedema, some (2) cranial and CNS, not walked, not breathed, ± cleaned, ± assisted.
2. **Dystocia** (b) Significant cranial and CNS, fat not metabolised, ± breathed, ± assisted.
3. **Dystocia** (c) Significant cranial and CNS, fat metabolised.
4. **Starvation / mismothering** (includes where CNS and cranial scores < 2 and fat metabolised)
5. **Primary predation**
6. **Premature or dead 'in utero'**
7. **Primary exposure**
8. **Infection**
9. **Undiagnosed**
10. **Misadventure**

Fig 4. Data sheet.

Fig 6. Lamb not cleaned by ewe – note meconium staining.

Fig 7. Lamb dead prepartum.

Fig 8. Hooves lack of wear indicates lamb has not walked.

PROCEDURES

Record (figure 4) date, lamb number, time, operator, sex and, if known, birth type, birth weight, assistance and category (figure 2), age at death.

The autopsy starts, for a right-handed operator, with the lamb placed on its right (off) side with the central abdomen and feet toward the operator. A general examination of the unopened lamb follows:

- lamb cleaned or not cleaned (showing maternal behaviour)
- presence of meconium staining (foetal faeces may indicate foetal distress during parturition)
- decomposition
- congenital abnormalities (particularly of the buccal and perineal regions)
- membranes of hooves (wear may indicate walking or bird pick)
- predation – location, severity, species
- subcutaneous oedema of head or shoulders (showing physical trauma during birth).

Fig 9. Hooves wear indicates lamb has walked.

Fig 10. Predation by fox and bird but autopsy needed to determine if primary or secondary.

Fig 11. Dead lamb with bird predation.

The skin on each side of the neck is incised and reflected and the skin and neck examined for:

- punctures consistent with fox or dog predation (can also check thoracic vertebra)
- subcutaneous oedema
- haemorrhage.

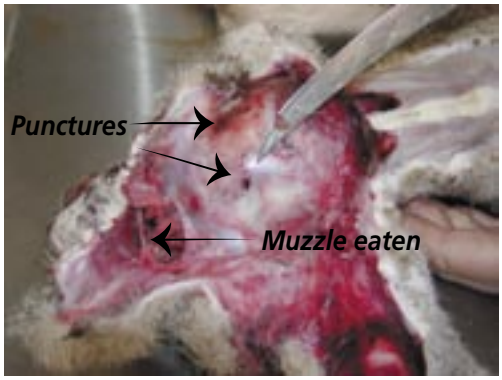

Fig 12. Punctures on skull (and muzzle damage) indicate fox predation.

Fig 13. Subcutaneous oedema of neck.

Fig 14. Oedema of neck and cranium.

If hypothermia is suspected as a result of cold, wet, windy weather in the preceding 30 hours, skin from the medial to lateral aspect of the hind legs should be reflected.

The presence of yellow subcutaneous oedema signifies possible cold exposure (this may be primary or secondary).

The lamb is then placed on its back and the hind and fore limbs spread laterally to give balance. The skin 5 cm caudal to the navel is grasped in the left hand to use the weight of the lamb to put strain on it. Make an incision so as to begin an anterior movement that removes a broad flap of skin, muscle and peritoneum (and sternum) exposing the abdominal and thoracic cavities. By maintaining upward traction of the flap it can be removed without injuring the abdominal viscera.

Fig 15. Hind leg exposed to ascertain if lamb exposed to cold. Absence of yellow oedema indicates no hypothermia.

Fig 16. Lamb balanced for incision.

Fig 17. Lamb opened for internal examination.

Examine the abdominal cavity for:

- infection (excessive yellowish fluid - if lamb is <48 hours this is usually due to navel infection)
- presence of blood and, if so, check liver for punctures/tears (showing a difficult birth)
- loss of organs resulting from predation
- presence of a white milk clot in abomasum (evidence of suckling)
- presence of scattered white substance in the supporting membrane of the intestines containing the lymphatic system (indicates the lamb has fed and digested milk)
- size and firmness of liver
- kidneys – amount, colour and firmness of the surrounding fat as a measure of whether metabolised (normal is firm, white, nonvascular; metabolised is soft, gelatinous, pink to red).

Fig 18. Milk in abomasum.

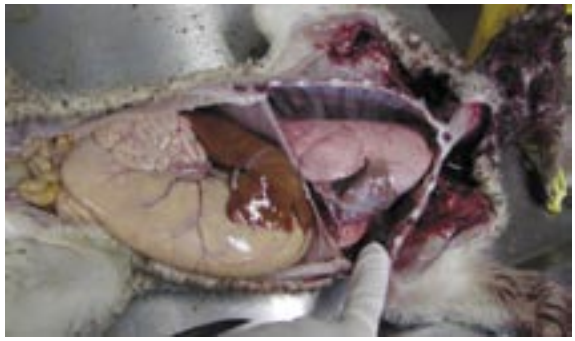

Fig 19. Milk in abomasum. In this case a considerable amount.

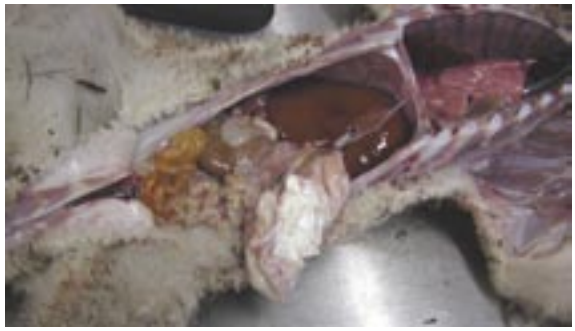

Fig 20. Abomasum opened to show consistency of milk.

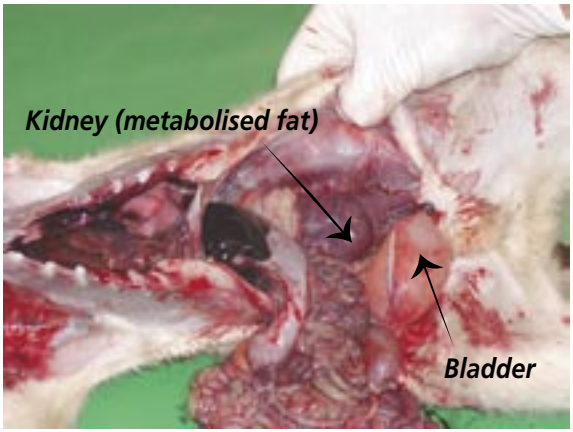

Fig 21. Not fed, starving, fat metabolised.

Fig 22. Metabolised fat on kidney, lamb starving.

Fig 23. Kidney with good fat cover.

Examine the thoracic cavity.

- lungs – evidence of aeration or abnormalities
  – petechiation (small dark-red spots caused by bleeding, possibly as a result of anoxia)
- heart – metabolic state of the pericardial fat
  – petechiation

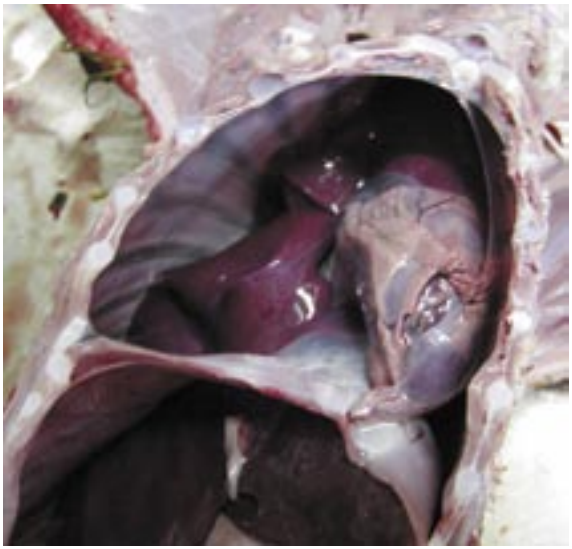

Fig 24. Uninflated lung, non-metabolised fat on heart.

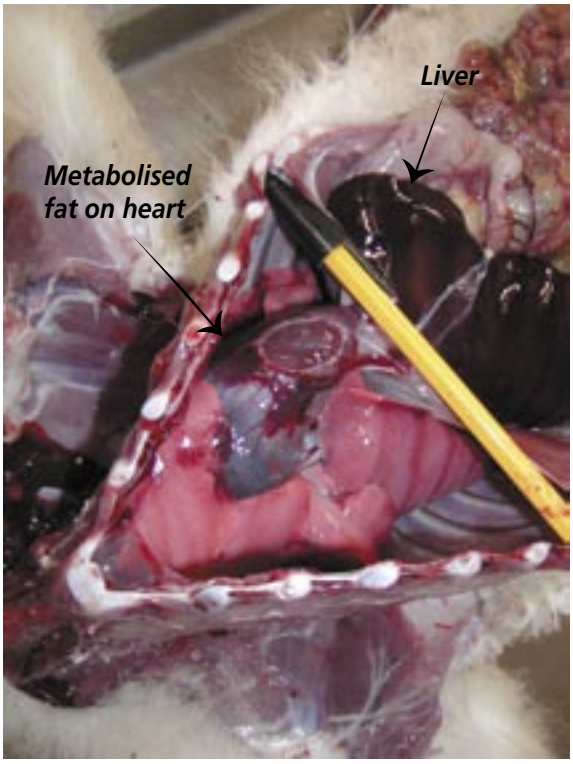

Fig 25. Red, gelatinous fat indicating metabolism and starvation.

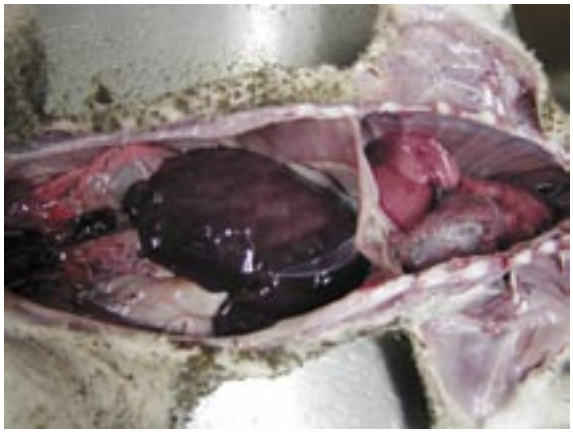

Fig 26. Non-metabolised fat, lamb breathed, liver damage.

Rotate the lamb to gain access to the top of the head and neck; remove the skin. Using secateurs, expose the brain by removing a circular plate from the roof of the cranial cavity.

Examine the brain and the associated cavities for abnormalities, congestion, and haemorrhage in the meninges (investing membranes). These abnormalities, congestion and haemorrhage are referred to collectively as vascular abnormalities.

Fig 27. Preparation of lamb for examination of brain and CNS.

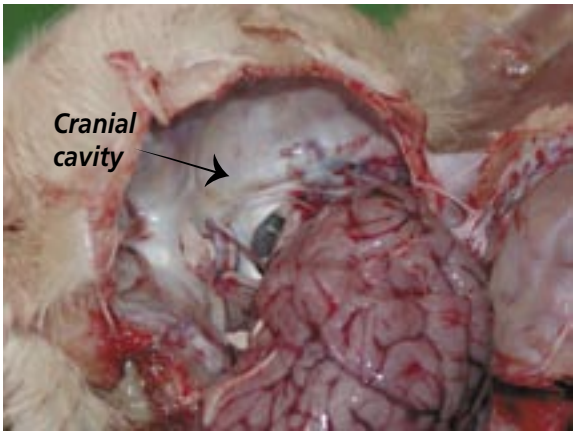

Fig 28. Brain and cranial cavity of normal lamb (score 1).

Fig 29. Meningeal haemorrhage on surface of brain; minor clots (score 4).

SCORES ASSOCIATED WITH SEVERITY OF CRANIAL LESIONS

Score 1 – nil

Score 2 – minor petechiation on brain surface

Score 3 – meningeal haemorrhage on surface of brain

Score 4 – meningeal haemorrhage on surface of brain
– congestion of cranial cavity (slight)
– minor clots

Score 5 – meningeal haemorrhage on surface of brain (severe)
– subdural clots obvious
– congestion of cranial cavity (severe).

Fig 30. Scores associated with severity of cranial lesions.

With the secateurs, sever the neck in the region of the axis vertebra. To expose the vertebral canal insert a point of the secateurs into the vertebral foramen and cut dorsal and lateral to the spinal cord as far as the shoulder region. Repeat on the other side.

Examine the spinal cord and vertebral canal for vascular abnormalities. Score (figure 33).

On the data sheet (figure 4) assign a death category. Figures 36-39 provide some examples.

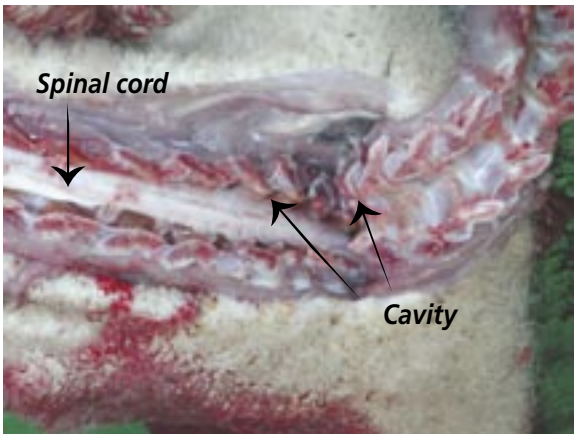

Fig 31. Spinal cord and vertebral canal of lamb with no lesions (score 1).

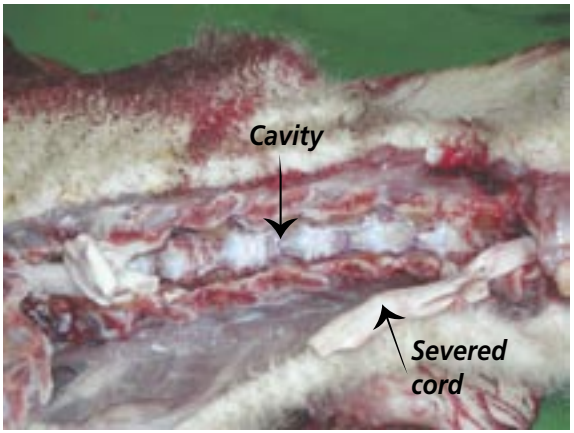

Fig 32. Spinal cord and vertebral canal of lamb with no lesions (score 1).

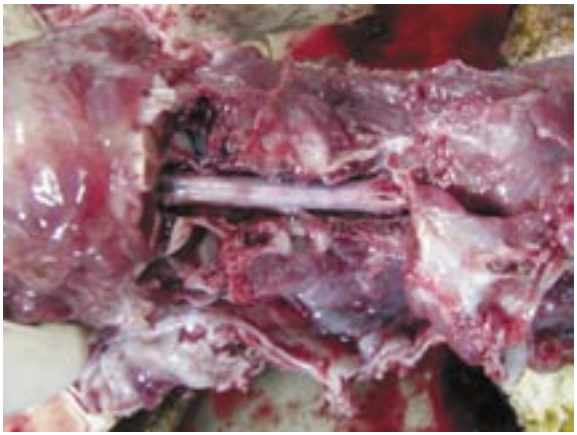

Fig 34. Spinal cord exposed to indicate light banding (score 4).

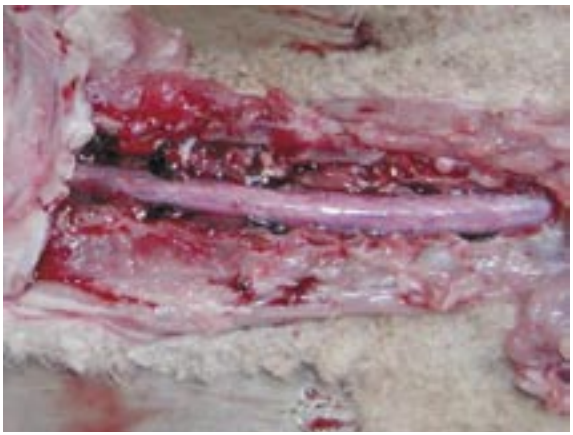

Fig 35. Haemorrhage along spinal cord and vertebral canal (score 5).

SCORES ASSOCIATED WITH SEVERITY OF SPINAL MENINGEAL LESIONS

Score 1 – nil

Score 2 – minor epidural haemorrhage of vertebral canal

Score 3 – obvious epidural haemorrhage of vertebral canal
– no banding of spinal cord (bloodstained cerebrospinal fluid in spinal cord)

Score 4 – haemorrhage along spinal cord
– haemorrhage along vertebral canal
– light banding of spinal cord

Score 5 – blood stained cerebrospinal fluid in spinal cord seen as severe banding of spinal cord
– severe epidural haemorrhage in vertebral canal.

Fig 33. Scores associated with severity of spinal meningeal lesions

DATA SHEET

DATE: 1/9/04	**DAM NO.:** R11	**BIRTH TYPE:** 1
LAMB NO.: 401	**ASSESSOR:** P	**BIRTH WEIGHT (kg):** 2.8
SEX : R	**AGE AT DEATH (d):** 0	
ASSISTED: ✓	**TYPE:** 6	

CLEANED: X	**WALKED:** X	**EXTERNAL ABNORMALITIES:** X
PREDATION: ✓	**SITES:**	**BIRD / FOX / OTHER**

OEDEMA: ✓	**HEAD:** ✓ **NECK:** ✓ **EXTREMITIES:** ✓
LIVER DAMAGE: ✓	
BREATHED: X	
PETECHIATION: ✓	**HEART:** ✓ **LUNGS:** ✓
FED: X	
FAT METABOLISED: X	

CRANIAL HAEMORRHAGE:	**1**(nil) **2** **3** **4** **5**(severe)
CNS HAEMORRHAGE:	**1** **2** **3** **4** **5**

DEATH CATEGORIES:

1. **Dystocia** (a) Oedema, some (2) cranial and CNS, not walked, not breathed, ± cleaned, ± assisted.
2. **Dystocia** (b) Significant cranial and CNS, fat not metabolised, ± breathed, ± assisted.
3. **Dystocia** (c) Significant cranial and CNS, fat metabolised.
4. **Starvation / mismothering** (includes where CNS and cranial scores < 2 and fat metabolised)
5. **Primary predation**
6. **Premature or dead 'in utero'**
7. **Primary exposure**
8. **Infection**
9. **Undiagnosed**
10. **Misadventure**

Fig 36. Example of assigning death category.

DATA SHEET

DATE: 1/9/04	**DAM NO.:** R10	**BIRTH TYPE:** 1
LAMB NO.: 400	**ASSESSOR:** P	**BIRTH WEIGHT (kg):** 3.8
SEX : R	**AGE AT DEATH (d):** 3	
ASSISTED:	**TYPE:**	

CLEANED: ✓	**WALKED:** ✓	**EXTERNAL ABNORMALITIES:**
PREDATION: ✓	**SITES:** 1. neck puncture, bruising 2. navel entry, abdomnal contents missing	**BIRD / (FOX) / OTHER**

OEDEMA:	**HEAD: NECK: EXTREMITIES:**
LIVER DAMAGE:	
BREATHED: ✓	
PETECHIATION:	**HEART: LUNGS:**
FED:	
FAT METABOLISED: X	

CRANIAL HAEMORRHAGE:	**1**(nil) (**2**) **3** **4** **5** (severe)
CNS HAEMORRHAGE:	**1** **2** **3** **4** **5**

DEATH CATEGORIES:

1. **Dystocia** (a) Oedema, some (2) cranial and CNS, not walked, not breathed, ± cleaned, ± assisted.
2. **Dystocia** (b) Significant cranial and CNS, fat not metabolised, ± breathed, ± assisted.
3. **Dystocia** (c) Significant cranial and CNS, fat metabolised.
4. **Starvation / mismothering** (includes where CNS and cranial scores < 2 and fat metabolised)
5. **Primary predation**
6. **Premature or dead 'in utero'**
7. **Primary exposure**
8. **Infection**
9. **Undiagnosed**
10. **Misadventure**

Fig 37. Example of assigning death category.

DATA SHEET

DATE: 1/9/04	**DAM NO.:** R12	**BIRTH TYPE:** 3
LAMB NO.: 402	**ASSESSOR:** P	**BIRTH WEIGHT (kg):** 3.0
SEX : E	**AGE AT DEATH (d):** 2	
ASSISTED: X	**TYPE:**	

CLEANED: ✓	**WALKED:** ✓	**EXTERNAL ABNORMALITIES:**
PREDATION: ✓	**SITES:** Eyes, anus	(BIRD) / FOX / OTHER

OEDEMA: X	**HEAD:**	**NECK:** **EXTREMITIES:**
LIVER DAMAGE: X		
BREATHED: ✓		
PETECHIATION: X	**HEART:**	**LUNGS:**
FED: X		
FAT METABOLISED: ✓		

CRANIAL HAEMORRHAGE:	(1) (nil)	**2**	**3**	**4**	**5** (severe)	
CNS HAEMORRHAGE:	(1)	**2**	**3**	**4**	**5**	

DEATH CATEGORIES:

1. **Dystocia** (a) Oedema, some (2) cranial and CNS, not walked, not breathed, ± cleaned, ± assisted.
2. **Dystocia** (b) Significant cranial and CNS, fat not metabolised, ± breathed, ± assisted.
3. **Dystocia** (c) Significant cranial and CNS, fat metabolised.
4. **Starvation / mismothering** (includes where CNS and cranial scores < 2 and fat metabolised)
5. **Primary predation**
6. **Premature or dead 'in utero'**
7. **Primary exposure**
8. **Infection**
9. **Undiagnosed**
10. **Misadventure**

Fig 38. Example of assigning death category.

DATA SHEET

DATE: 1/9/04	**DAM NO.:** R13	**BIRTH TYPE:** 2
LAMB NO.: 403	**ASSESSOR:** P	**BIRTH WEIGHT (kg):** 4.8
SEX : M	**AGE AT DEATH (d):** 2	
ASSISTED: X	**TYPE:**	

CLEANED: ✓	**WALKED:** ✓	**EXTERNAL ABNORMALITIES:**
PREDATION: ✓	**SITES:** Tongue, eye, anus	(BIRD) / FOX / OTHER

OEDEMA: X	**HEAD:**	**NECK:** **EXTREMITIES:**
LIVER DAMAGE: X		
BREATHED: ✓		
PETECHIATION: ✓	**HEART:**	**LUNGS:** ✓
FED: X		
FAT METABOLISED: ✓		

CRANIAL HAEMORRHAGE:	**1**(nil)	**2**	**3**	(**4**)	**5** (severe)
CNS HAEMORRHAGE:	**1**	**2**	(**3**)	**4**	**5**

DEATH CATEGORIES:

1. **Dystocia** (a) Oedema, some (2) cranial and CNS, not walked, not breathed, ± cleaned, ± assisted.
2. **Dystocia** (b) Significant cranial and CNS, fat not metabolised, ± breathed, ± assisted.
3. **Dystocia** (c) Significant cranial and CNS, fat metabolised.
4. **Starvation / mismothering** (includes where CNS and cranial scores < 2 and fat metabolised)
5. **Primary predation**
6. **Premature or dead 'in utero'**
7. **Primary exposure**
8. **Infection**
9. **Undiagnosed**
10. **Misadventure**

Fig 39. Example of assigning death category.

PREDATION

Primary predation is where the lamb is apparently normal (and should have survived) but shows signs of fatal injury from a predator.

Secondary predation is where lamb is abnormal or injured at birth, starved etc., with signs of fatal injury by predators.

Note: deaths from cold injury can also be primary or secondary.

Fig 40. Fox skull.

Fig 41. Slink skin of lamb showing punctures possibly caused by fox rearranging carrying position.

PREDATORS

Fox (*Vulpes vulpes*). (Similar wounds can be caused by domestic dogs and dingoes but they differ in puncture marks and size of bite.) Live lambs killed by frontal attack e.g. muzzle, or spinal attack either at the neck or further back across the thoracic area, or both. Carcasses need to be skinned to exhibit punctures or haemorrhage. Foxes prefer the heart, lungs, liver and kidneys followed by the viscera and finally the large muscles.

It is thought that some individual foxes kill for 'sport'. The dead lambs are characterised by distinctive (repeatable) mutilation but with little eaten.

Crow (*Corvus*). Crows usually penetrate through anus, navel (umbilicus), eyes or tongue; foxes sometimes eat tongue.

Wedge-tailed eagle (*Aquila audax*). Usually leaves small punctures on skull caused by talons, and follows with a large opening usually through rib cage or abdomen.

Pig (*Sus scrofa*). Associated with extensive damage to the carcass, decapitation and generally little residue.

Fig 42. Muzzle eaten by fox.

Fig 45. Haemorrhage on surface of brain (Score 3).

Fig 43. Lamb opened to show the effects of crow predation.

Fig 46. Haemorrhage of verebral canal (Score 3).

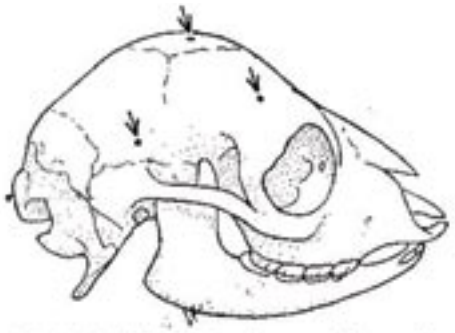

Fig 44. Skull of lamb showing wounds made by eagle talons (from I. Rowley 1970).

Fig 47. Merino ewe with quins – lambs perished next morning from cold exposure.

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