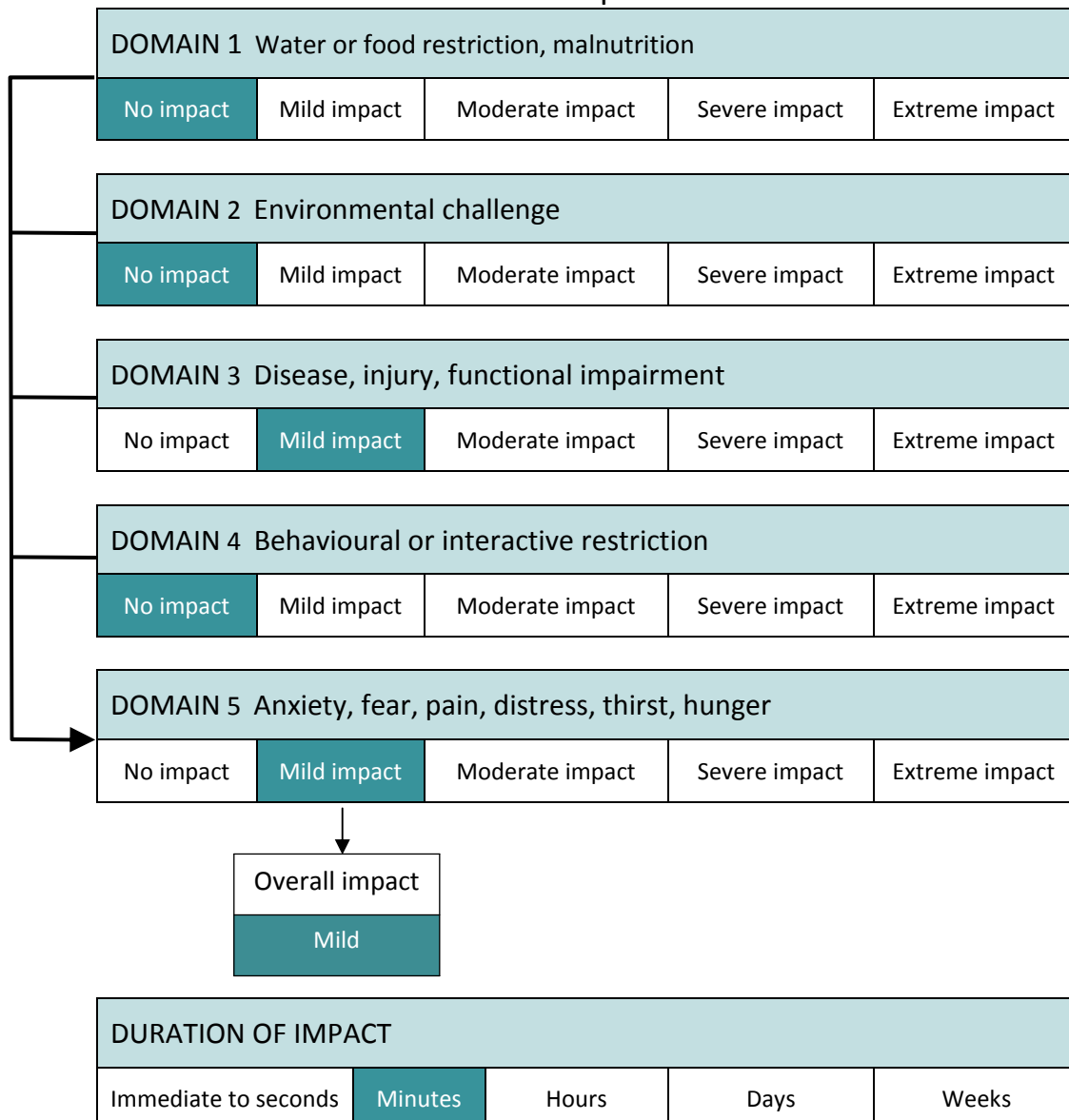


## Control method: Fumigation of fox dens with carbon monoxide (CO)

**Assumptions:**

- Best practice is followed in accordance with the standard operating procedure FOX004.
- This assessment applies to the use of DEN-CO-FUME cartridges and fumigators specifically prescribed for the generation of carbon monoxide (CO) as a fumigant for fox dens.
- Fumigation of fox dens is not carried out if the cubs are suspected to be less than four weeks old since neonates are more tolerant to hypoxia after CO exposure.

### PART A: assessment of overall welfare impact



<b>SCORE FOR PART A:</b>	<b>3</b>
Summary of evidence:	
Domain 1	No impact in this domain.
Domain 2	No impact in this domain.
Domain 3	If the cartridges are used without the portable fumigator there is a risk that foxes could be exposed to unacceptably high temperatures that cause burns to the skin or fur <sup>1,2</sup> .
Domain 4	There is no interference with behaviour, foxes are in the den and remain there during the fumigation process.
Domain 5	There may be some fear/anxiety due to the sound made when blocking the entrances and ignition of the cartridges.

### PART B: assessment of mode of death

Time to insensibility (minus any lag time)				
Very rapid	Minutes	Hours	Days	Weeks
Level of suffering (after application of the method that causes death but before insensibility)				
No suffering	Mild suffering	Moderate suffering	Severe suffering	Extreme suffering

<b>SCORE FOR PART B:</b>	<b>A-C</b>
Summary of evidence:	
Duration –	<p>When inhaled, carbon monoxide binds to haemoglobin in the red blood cells, with an affinity 250 times that of oxygen. This results in reduced oxygen-carrying capacity and altered delivery of oxygen to cells. Hypoxia - the reduction of oxygen supply to the tissues - eventually leads to unconsciousness and death.</p> <p>Death occurs rapidly at CO concentrations of 4 to 6%<sup>3</sup>. Carbon monoxide concentrations greater than 2% are sufficient to cause loss of consciousness within minutes. Failure of the respiratory centre then occurs followed by death from cardiac arrest.</p> <p>With den fumigation, the time to unconsciousness and death depends on factors such as CO concentration (influenced by size of den, porosity of the soil in the den, full or incomplete combustion of the cartridge) and animal age. Neonatal animals are relatively resistant to hypoxia. Physiological mechanisms exist to protect the animal from cerebral damage when oxygen is limited in the uterus and during birth<sup>4</sup>. Because inhalation of CO causes hypoxia, neonatal animals may therefore take longer to become unconscious and die than adult animals.</p>
Suffering –	<p>Hypoxia induced by CO is insidious and is reported to induce unconsciousness without pain or discomfort<sup>3</sup>. However there have been reports of short periods of anxiety followed by vocalisation and agitation in dogs<sup>5</sup> and severe excitation in pigs<sup>6</sup> that could occur prior to loss of consciousness. Muscular convulsions and spasms may be also observed but these are thought to occur after the animal has become unconscious<sup>6</sup>. During a study with rabbits, some animals showed signs of agitation and most exhibited lethargy, stupor, shallow breathing and uncoordinated</p>

movement prior to collapse<sup>7</sup>. In another study with rats, approach-avoidance testing showed that most animals find CO aversive<sup>8</sup>.

If animals are exposed to sub-lethal levels there may be neurological (e.g. reduced vision, blindness) or cardiac sequelae depending on the degree of anoxia experienced<sup>9, 10</sup>. Therefore it is essential to achieve lethal concentrations. To reduce suffering prior to death it is recommended that fumigation should seek to ensure exposure to concentrations greater than 1% and to gradually increase concentration to prevent the onset of convulsions<sup>10</sup>.

## Summary

CONTROL METHOD:	<b>Fumigation of fox dens with carbon monoxide (CO)</b>
OVERALL HUMANENESS SCORE:	<b>3A-C</b>
<p>Comments</p> <p>In people the most common initial symptoms of CO poisoning are headache, dizziness, weakness, headache, trouble in thinking, shortness of breath, visual problems and loss of consciousness. Diarrhoea can also occur<sup>11</sup>.</p>	

## Bibliography

- Hart, S., Marks, C.A. & Staples, L. (1996). Den-Co-Fume – humane control of foxes (*Vulpes vulpes*) in natal dens. *Humaneness and Vertebrate Pest Control* pp 58-61 (Ropet Printing: Tynong North).
- Anon (1995). *Evaluation of carbon monoxide cartridges for the fumigation of fox natal dens (final report)*. (Keith Turnbull Institute Research Institute and Applied Biotechnologies Ltd.: Frankston, Victoria).
- American Veterinary Medical Association (2001). 2000 Report of the AVMA Panel on Euthanasia. *Journal of the American Veterinary Medical Association* **218**, 669-696
- Singer, D. (1999). Neonatal tolerance to hypoxia: a comparative-physiological approach. *Comparative Biochemistry and Physiology - Part A: Molecular & Integrative Physiology* **123**, 221-234
- Chalifoux, A. & Dallaire, A. (1983). Physiologic and behavioral evaluation of CO euthanasia of adult dogs. *Am. J. Vet. Res* **44**, 2412-2417
- Lambooy, E. & Spanjaard, W. (1980). Euthanasia of young pigs with carbon monoxide. *Vet. Rec* **107**, 59-61
- Gigliotti, F., Marks, C.A. & Busana, F. (2009). Performance and humaneness of chloropicrin, phosphine and carbon monoxide as rabbit-warren fumigants. *Wildlife Research* **36**, 333-341
- Makowska, I.J. & Weary, D.M. (2009). Rat aversion to carbon monoxide. *Applied Animal Behaviour Science* **121**, 148-151
- Lorgue, G., Lechenet, J. & Rivière, A. (1996). *Clinical veterinary toxicology*. (Blackwell Science: Oxford).
- DEFRA (2005). *Review of effectiveness, environmental impact, humaneness and feasibility of lethal methods for badger control. A report to European Wildlife Division, DEFRA, 20 October 2005*. (Department for Environment, Food and Rural Affairs: London, UK).
- Dolan, M.C. (1985). Carbon monoxide poisoning. *Canadian Medical Association Journal* **133**, 392-399