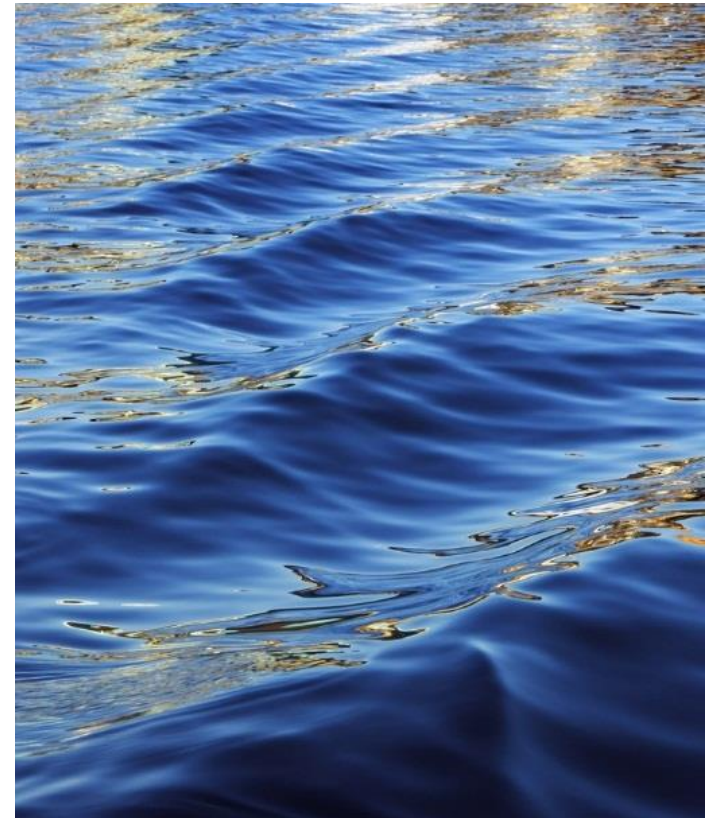


# Pindone and 1080 for rabbit control

Some of the science behind best practice

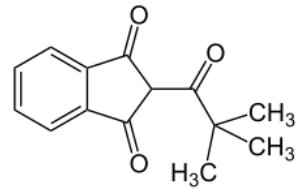


# A brief history



## Pindone

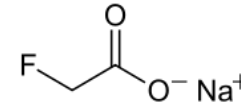
2-(2,2-Dimethylpropanoyl)-1H-indene-1,3(2H)-dione;  
2-pivalyl- 1,3-indandione



- Insecticidal properties identified in 1940s, rodenticidal properties in 1950s
- In Australia, registered for use against rabbits in 1984
- Currently in Australia, only used for rabbits (not rodents)
- Used for rabbits, brushtail possums and rats in New Zealand

## 1080

Sodium 2-fluoroacetate

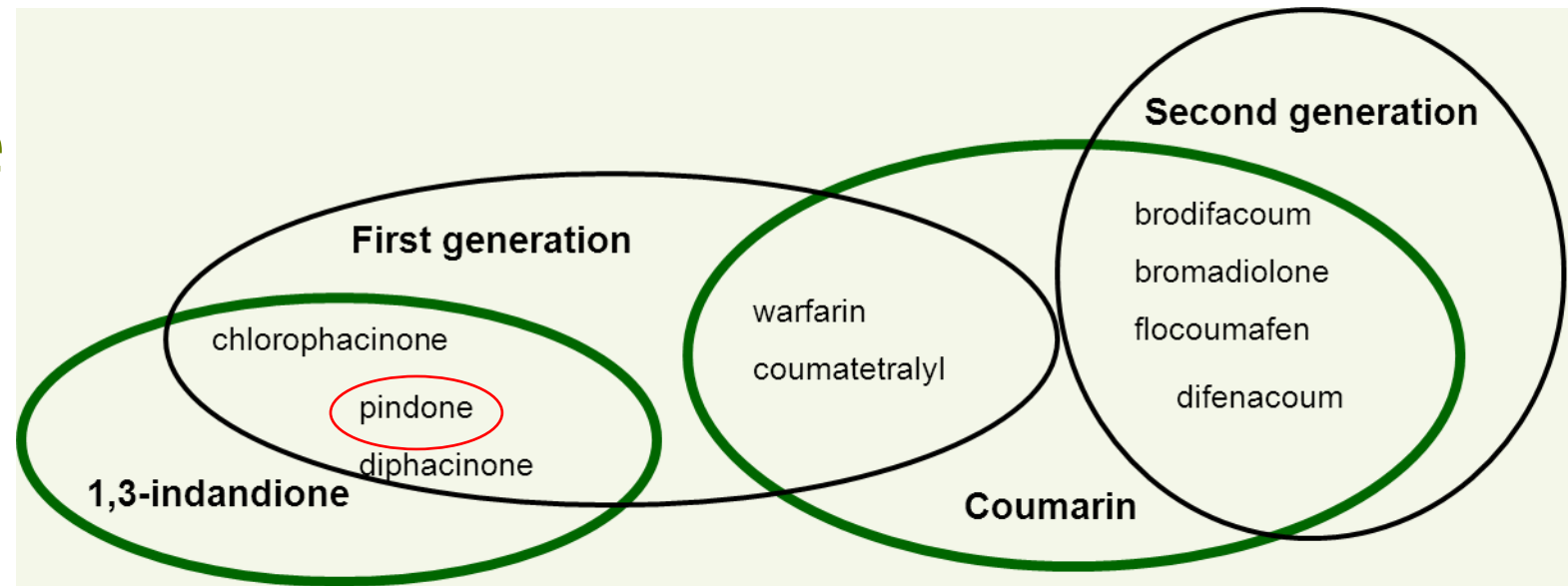


- In 1940s, fluoroacetate identified as a naturally-occurring toxin, produced by plants known to poison livestock
- Around the same time, 1080 (a salt form of fluoroacetate) developed in the USA as rodenticide
- In Australia, first used for rabbits in mid-1950s
- Now used for a range of established pest animal species in Australia & New Zealand

# Mode of action- pindone

Anticoagulants →

Most used as rodenticides

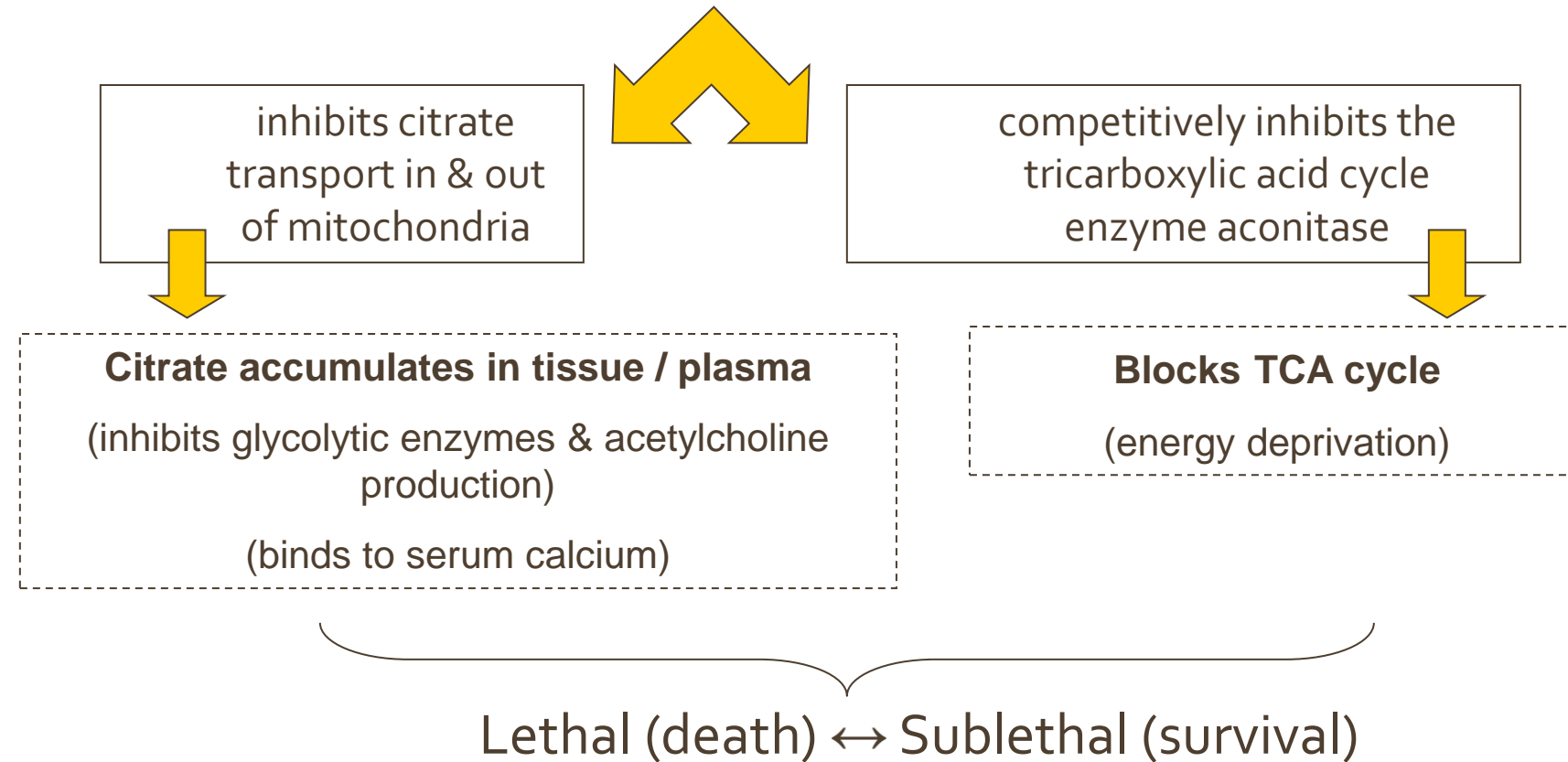


- Inhibit Vitamin-K metabolism in liver, prevent formation of blood clotting factors
- Clotting factors become depleted in blood, coagulation function compromised
- Haemorrhage becomes more likely to occur following movement or small injury
- Visible signs of poisoning become evident after a 'latent' period then progress to death through massive (usually internal) haemorrhage
- Caught early enough, poisoning can be treated with Vitamin K<sub>1</sub>






# Mode of action- 1080

- Acts to inhibit aerobic energy metabolism in cells & impair normal cell function in a range of tissues e.g. heart, lungs, brain
- Toxic effects & pathology variable between species – all relate to cellular energy deprivation
- No proven antidote to poisoning

Fluoroacetate eaten & absorbed:  
converted to ***fluorocitrate*** in cell mitochondria



# Comparative toxicity (examples)

	Oral lethal dose (LD50) milligrams poison per kilogram of bodyweight (mg/kg)	
	<b>Pindone</b>	<b>1080</b>
Rabbit 	13 mg/kg 0.52 mg/kg / day	0.34 - 0.8 mg/kg
Rat 	280 mg/kg 5 mg/kg / day	0.2 - 5.0 mg/kg
Possum 	>100 mg/kg 51 - 64 mg/kg / day	0.68 - >100* mg/kg <small>*possums co-evolved with fluoroacetate-producing plants</small>
Dog 	75-100 mg/kg	0.05 – 0.2 mg/kg
Chicken 	2.5 mg/kg / day (estimate)	5 – 10 mg/kg

- In general, 1080 is more toxic than pindone (single dose)
- Pindone is most toxic (effective) in multiple, consecutive intakes
- Rabbits are relatively sensitive to pindone (caecotrophy?)
- Extensive toxicity data for 1080 available across a wide range of species
- Far less toxicity data available for pindone, especially for birds & reptiles

# Poisoning - animal welfare impacts

## Pindone

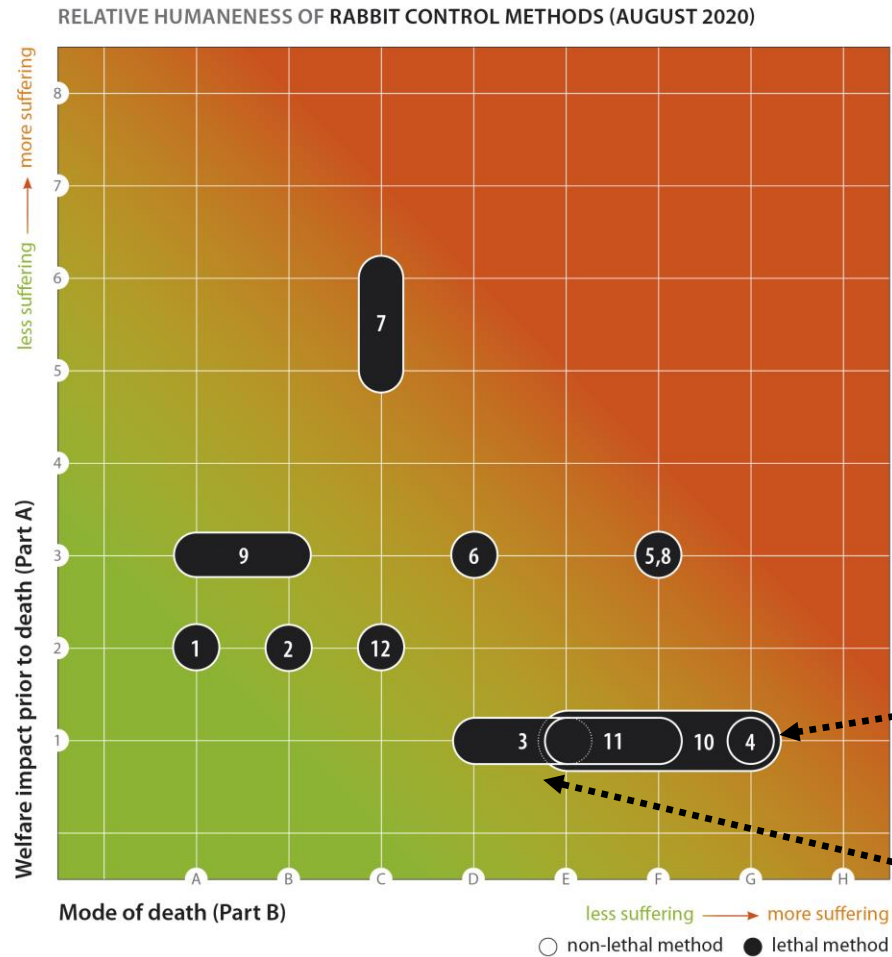
- Bait ingestion over a number of days + latent period with no visible signs:
  - typically over 3 - 7 days, but can be up to 11 days lag
  - in this time pindone is acting to deplete Vitamin K & coagulation factors
- Followed by visible signs associated with anaemia over 3-7 days:
  - stop feeding, lethargy, lack of grooming
  - pain / discomfort / reduced mobility from internal haemorrhages in multiple sites; organs, muscles & joints
  - rabbits typically conscious for duration of these effects
- Time to death 10 - 14 days after lethal exposure to bait
- Necropsy typically shows massive haemorrhage in cardiac cavity, leg muscles or abdominal cavity

## 1080

- Lethal amount of bait typically ingested within one feeding 'session' then latent period with no visible signs:
  - varies from 20 minutes - 10 hours, typically 0.5- 2 hours
- Followed by visible signs in general progression before death
  - stop feeding, weakness /immobility, lethargy
  - increasingly laboured respiration, increased sensitivity to noise/disturbance
  - convulsions, often with vocalisation. Unknown if rabbits are conscious during this phase
- Time to death is variable (probably depending on dose) typically 3 - 4 hours after bait ingestion, but can range up to 44 hours
- Necropsy pathology consistent with cardiac failure – cyanosis, severe venous congestion in heart & lungs, in some cases oedema (fluid) in lungs, localised pulmonary haemorrhage

# Assessing animal welfare impacts

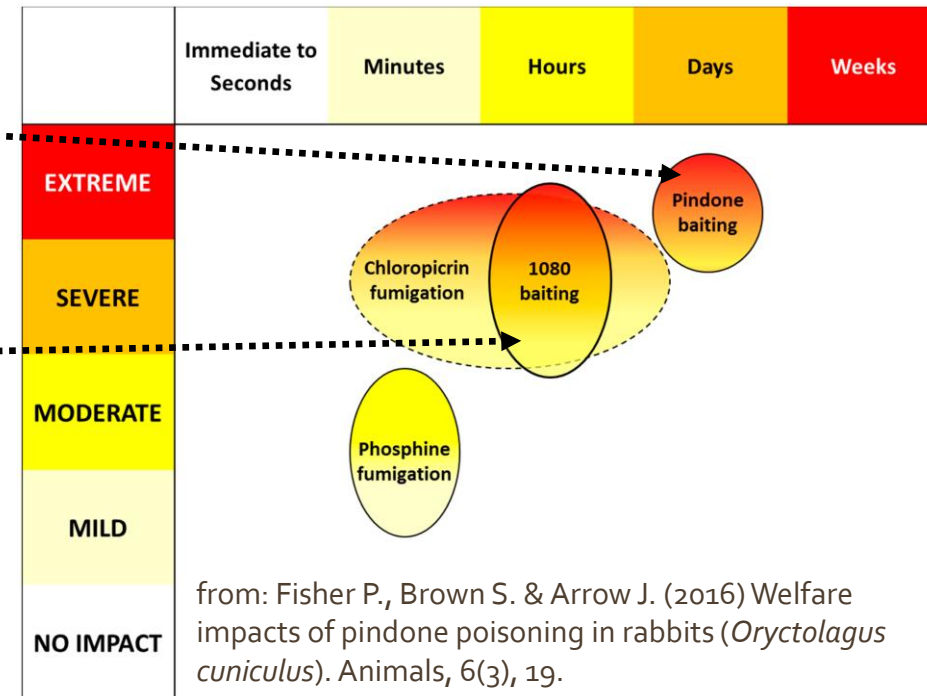
- Welfare impacts of rabbit management methods evaluated using relative humaneness assessment models based on those developed by Sharp & Saunders (2008, 2011).
- Models use scientific information & expert judgement to assess the negative impacts of a control/ killing method on target animal's welfare
- Score generated so that the relative humaneness of different methods can be compared



- KEY**
- 1 ground shooting – head [2A]
  - 2 ground shooting – chest [1A]
  - 3 1080 – [1D-1E]
  - 4 pindone – [1G]
  - 5 chloropicrin – [3F]
  - 6 phosphine – [3D]
  - 7 padded foot-hold trap – [5C-6C]
  - 8 warren ripping – [3F]
  - 9 warren blasting – [3A-3B]
  - 10 RHDV1 K5 – [1E-1G]
  - 11 RHDV2 – [1E-1F]
  - 12 Rodentator® with adequate blast pressure – [3D]

pindone

1080



# Rabbit baits

- Palatable food, mixed with toxic solution to nominal concentration of pindone or 1080
  - fresh chopped carrot (to be applied ASAP after preparation), or
  - oats (shelf-stable, can be stored before use)
- Toxic bait dyed green or blue
  - visually indicates toxicity to people e.g. pest control operators, public
  - reduces bait uptake by birds?
    - less attractive food colour to some birds on first exposure, but
    - not a fail-safe deterrent - evidence that birds can learn that dyed bait is palatable over time



## Pindone products

- liquid (sodium salt) or powder (free acid) pindone concentrates for use only by authorised personnel in preparation of bait, or
- ready-to-use oat baits available 'over the counter' from retailers or licensed pest control agencies – no authorisation required

## 1080 products

- all restricted products that can only be supplied to / used by authorised persons
- Shelf-stable, ready to use 1080 oat baits can be purchased from licensed re-sellers
- Chopped carrot 1080 bait must be used soon after preparation so use requires planning to co-ordinate bait supply and application



# Baiting practice

## Pindone

- Used in situations where 1080 is unsuitable due to distance restrictions & domestic animal risk e.g. peri-urban
- Multiple / repeated applications of toxic bait to facilitate uptake by rabbits – 'knockdown' takes longer
- Pre-feeding with non-toxic bait is optional as per label
- Application of bait in furrows/ trails – broadcast or scatter of bait not recommended
- Neighbour notification required in some jurisdictions

## 1080

- Less expensive than pindone bait
- Label stipulates pre-feeds with non-toxic bait before single application of toxic bait – often more rapid knockdown than pindone
- Label requirements for neighbour notification, signage and distance restrictions for laying bait away from residences, roads, fences and waterways
- Application of bait in furrows/trails, swathes or by aerial broadcast



Both methods have potential risk to non-target animals

Primary exposure: birds, mammals or reptiles that eat oat or carrot bait

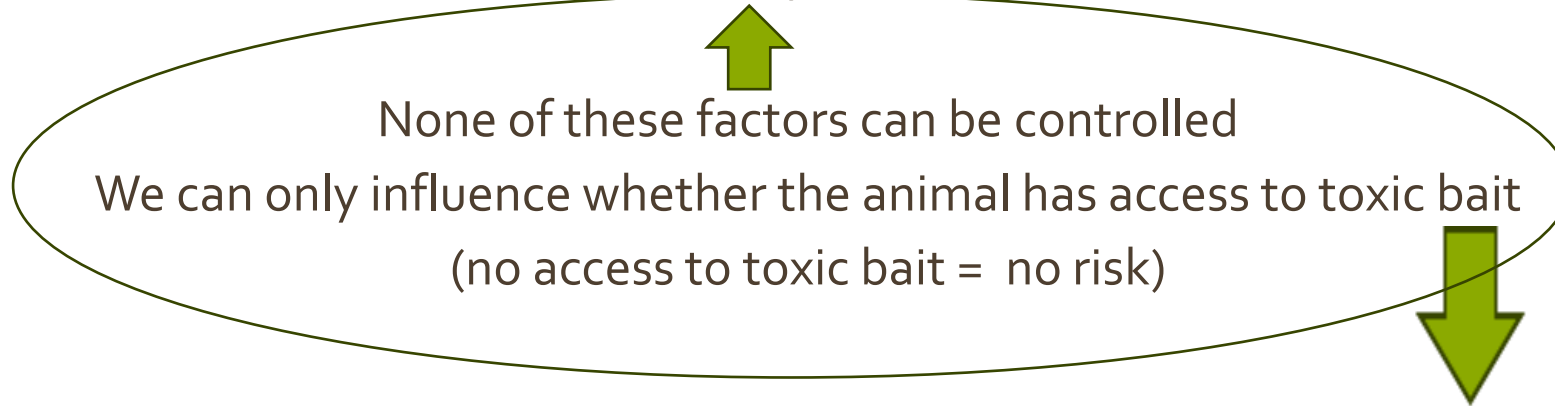
Secondary exposure: rabbit predators or carcass/carrion scavengers

# Reducing primary non-target risk from rabbit baiting



Ingestion of toxic bait may be lethal or sublethal, depending on;

- Species & bodyweight of the animal
- Susceptibility of the animal to the toxicant (pindone or 1080)
- How much toxic bait the animal consumes, over what period



- Apply rabbit bait in evenings to reduce availability to diurnal non-targets
- Pre-feeding 'teaches' rabbits location of palatable food, can also encourage non-target uptake
- Use non-toxic pre-feeding to monitor uptake & identify non-targets present, particularly nocturnal feeders / species that take oats or carrot
  - Larger non-targets e.g. macropods, livestock, can be excluded by bait stations
  - Smaller non-targets can access bait stations – depending on the species & numbers observed, decision on whether to apply toxic bait
- Remove uneaten bait / delay restocking baited areas

# Residual concentrations in rabbits after sublethal bait uptake

## Pindone

- Haemorrhage points cease bleeding / heal as coagulation recovers
- Normal movement & behaviour / feeding can take some days to resume, depending on degree of effects
- \*As yet unmeasured in rabbits - based on other mammals, residual pindone cleared from blood/ muscle within hours but eliminated more slowly from liver and fat
- Expected to be metabolised & excreted over ~2 weeks – but could be 'topped up' in liver with repeated exposure to pindone during this time

## 1080

- Recover from lethargy to normal behaviour/ feeding in 5-24 hours
- Residual fluoroacetate mostly in muscle tissue, metabolised & excreted over ~ 7 days
- Not considered bioaccumulative

- Poisoned rabbits represent the highest secondary exposure hazards;
- to their predators, in the period between (lethal) bait intake and death
  - to scavengers, once they have died of poisoning



# Residual concentrations in rabbit carcasses

## Pindone

- Residual pindone most concentrated in liver, followed by fat, less concentrated in muscle
- \* Fisher, P., Brown, S., & Arrow, J. (2015). Pindone residues in rabbit tissues: implications for secondary hazard and risk to non-target wildlife. *Wildlife Research*, 42(4), 362-370.
- Unlikely to be residues in gut / intestines
  - Rate of degradation / decline of pindone residues in rabbit carcasses has not been measured - likely influenced by temperature, moisture & biotic activity

## 1080

- Residual fluoroacetate most concentrated in muscle tissue
- Potential for partially digested bait to be present in gut/intestines with rapid time to death
- Decline of residual concentrations in carcasses over time studied – linked to biodegradation, most rapid under warm, wet conditions can take weeks under dry, cold conditions

- Concentrations in carcasses influenced by how much toxic bait the rabbit ate before death
- Some (most?) poisoned rabbits will retreat to / die in warrens, reducing availability to some predators / scavengers
- Search for / removal of rabbit carcasses recommended on pindone & 1080 product labels
- But – difficult to prevent all predation or scavenging of rabbits following baiting >>> secondary exposure of non-target wildlife

# Secondary non-target risk

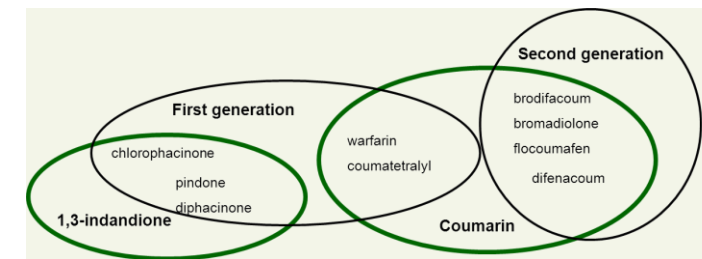
Ingestion of rabbit tissue may be lethal or sublethal, depending on;

- Species & bodyweight of the predator/scavenger
- The residual concentration of the toxicant (pindone or 1080) in rabbit tissues
- Susceptibility of the predator/scavenger to the toxicant (pindone or 1080)
- How much rabbit tissue the animal consumes, over what period



## A note about anticoagulants & secondary risk

- Wide use of anticoagulants for household rodent control, available over-the-counter
- Some anticoagulants (SGAR) are highly persistent in liver tissue – bioaccumulative
- Growing evidence of anticoagulant residue burdens /harms to non-target wildlife has triggered regulatory review
- Pindone among the least toxic & persistent of anticoagulants & is not used for rodent control in Australia
- Many rabbit predators / scavengers also have exposure pathways to the anticoagulant rodenticides



Thank you - Questions?