Toxicants and Contraceptives for Feral Swine in the US

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Know your adversary

Population Size =
Birth + Immigration - Death - Emigration

- Diet
- Behavior
- Habitat
- Range

- Timing
- Site selection
- Prebaiting

Strategies for Managing Feral Swine

- Non-Lethal
  - Fencing
  - Habitat management
  - Frightening/Hazing/Repelling
  - Trapping and Relocating
  - Contraception – none fully developed
- Lethal
  - Shooting (professional, recreational, aerial, bait, dogs)
  - Trapping/snaring with euthanasia
  - Toxicants – none registered in US

Key: Integrated Management Approaches

The ideal feeder

- Lightweight yet durable
- Portable
- Easy to deploy
- Large capacity
- Non-target proof
- Pig specific
- Weather resistant

Why toxicants for feral swine?

- 11x cheaper than shooting and 80X cheaper than trapping (Coblentz and Baber 1987)
- Will be more practical/feasible in some areas
- Will reduce evasive behaviors (e.g. trap shyness, shifts in movement or activity)
- Will increase reduction of populations
- Will complement other control strategies

The perfect toxicant:

- Fast acting
- Humane
- Cheap
- Species specific
- Void of non-target implications
- Palatable
- Concentrated (minimal dosage)
- Attractive odor or scent free
- Easily combined with bait matrix
- Registration potential
- Already "labeled" as "food" item
- Acceptable operator hazard, safe

Historical pig toxins:

- Warfarin, coumatetralyl, rotenone, and sodium fluoroacetate/1080 (Khan et al. 1990)
- Warfarin – 35 – 61% reductions (Choquenot et al. 1990)
- Warfarin – 98.9% reduction (Saunders et al. 1990)
- Warfarin – 94% reduction (McIlroy et al. 1990)

Historical pig toxins:

- Warfarin, brodifacoum, phosphorus (O'Brien and Lukins 1990)
- Yellow phosphorous, 1080, and warfarin were being used in Australia as recent as 2008 (Cowled et al. 2008)
- Only 1080 still considered humane, though variable, and has non-target risks (Cowled et al. 2008)
- Sodium nitrite (Lapidge et al. 2012, Cowled et al. 2008)

Historical pig-bait concoctions:

- **Molasses, brown sugar, and whole wheat** – Khan et al. 1990
- **Fishmeal variations** – Fletcher et al. 1990, Kavanaugh and Linhart 2000, Long et al. 2010, Campbell et al. 2011
- **Corn dog** – Kavanaugh and Linhart 2000
- **PIGOUT (fish or grain/vegetable)** – Campbell et al. 2006, Campbell and Long 2007
- **Soured Corn** – Campbell et al. 2011
- **HOGGONE (corn or fish)** – Lapidge et al. 2012, Campbell et al. 2013

Historical pig bait delivery methods:

- **Dough balls on ground, furrow baiting (whole grain and bagged), whole grain on ground, lidded feeders, parrafinized baits in furrows** - Khan et al. 1990
- **BOS** - Long et al. 2010, Campbell et al. 2011
- **Pig-specific lidded bins** - Khan et al. 1990, Long et al. 2010
- **On ground** - Fletcher et al. 1990, Kavanaugh and Linhart 2000, Campbell and Long 2007
- **HOGHOPPER** - Lapidge et al. 2012, Campbell et al. 2013

Current efforts: Genesis Labs, Scimetrics -Warfarin

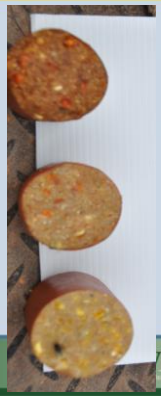
Sodium nitrite just registered in New Zealand

- Killed 11/12 pigs
- Pigs continued to consume after reaching lethal dose
- No evidence of taste aversion

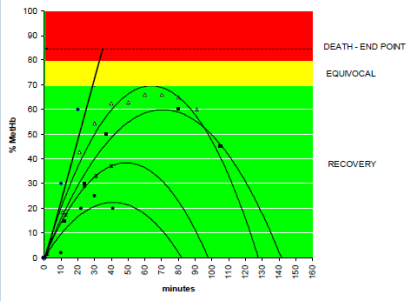
Current focus of USDA, TPW, AU and others

Why sodium nitrite?

- Safe for humans.
- Antidote - methlyn blue
- Toxic to pigs
- Cheap.
- Bait stable.
- Humane.
- Food product.
- Target specific
- Minimal residue
- Palatable
- Registration Studies



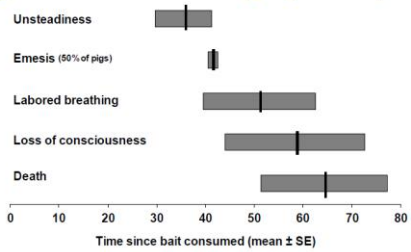
How does SN Work?



- Oxidizes hemoglobin to Methemoglobin
- Reduced O_2 Transport
- Swine sensitive
- Methemoglobin Reductase
- Low MR = high sensitivity
- Takes >400mg/kg
- 34 g SN

Invasive Animals CRC

Average nitrite toxicosis symptoms (n=4)



IMVS

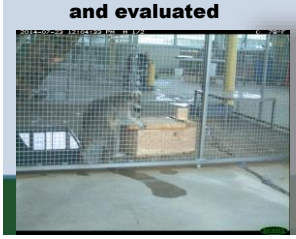
Independent humaneness review: *"In the opinion of the authors, the symptoms leading to death and duration of display of these symptoms would suggest that sodium nitrite satisfies a general understanding of what a humane poison would be."*

Invasive Animals Cooperative Research Centre

"Together, create and apply solutions"

Current Status of SN Research

- **3 formulations killing about 80% of swine in pen trials (huge progress!)**
- **Little evidence of taste aversion**
- **Importance of pre-feeding and creating "feeding frenzy"**
- **Prototype delivery devices being developed and evaluated**



Fertility Control Project - NWRC

Three main areas of research

1. **Vaccine development**
2. **Direct acting reagents**
3. **Delivery**

The Goal

To develop a reagent(s) that can be delivered, preferably as a bait, to cause permanent sterility of a target species, with an acceptable level of species-specificity.

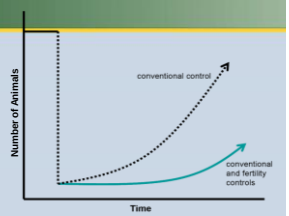
One hit, permanent sterility

Criteria for acceptable fertility control

- **Species-specific**
- **Effective – permanent sterility**
- **Humane**
- **Cost effective**
- **Acceptable environmentally**

Why Fertility Control?

- Reduced frequency and costs of control
- Reduced amount of toxins in the environment
- Reduced risk to non-target species
- Increased scale of management



- **Must be used as part of an integrated management strategy**
- **Will be many situations where use of fertility control not appropriate**
- **Valuable additional tool in environment of increasing political and social demands/expectations**

Vaccine development - Immunocontraception

Shown to be effective on individuals

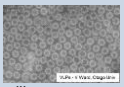
ORIGINAL RESEARCH PEER REVIEWED

Immunocontraception in male feral swine treated with a recombinant gonadotropin-releasing hormone vaccine

Tyler A. Campbell, PhD; Michelle R. Garcia, PhD; Lowell A. Miller, PhD; Martha A. Ramirez; David B. Long, MS; Jean-Baptiste Marchand, PhD; Fergal Hill, MB, BChir

Current vaccines

- Must be injected
- Duration of effect depends on maintenance of adequate antibody titers
- For long-lived species (e.g feral swine) booster vaccination(s) required
- Not permanent



New research

- Mucosal vaccines – for oral or intranasal route of delivery
- Identification of better antigens (i.e. target molecules) that will cause **permanent sterility**
- Dual vaccines - Brucellosis-GnRH, Rabies-GnRH

Direct acting agents - oocyte depletion

- Female mammals have only a finite supply of oocytes (eggs)
- If destroyed ➡ permanent sterility

New research

- Elucidate mechanisms for maintenance and survival of oocytes
- Identify and test 'ovotoxins' (chemosterilants) that will cause **permanent sterility**

Research focus for feral swine initiative

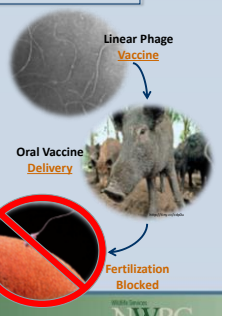
Eggs in ovary

Auburn University: contraceptive vaccine development

Elements of AU Technology

Vaccine Principles:
- Induction of antibodies against sperm.
- Block fertilization (sperm x egg interactions)
- Biotech based (phage display)

Optimum Characteristics:
- Species-specific (pigs only)
- Oral / Nasal delivery
- Humane
- Meets EPA requirements
- Consumable by humans without risk
- Cost effective



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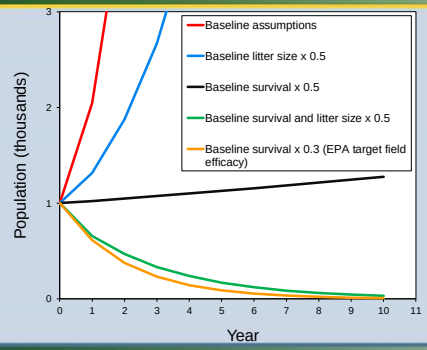
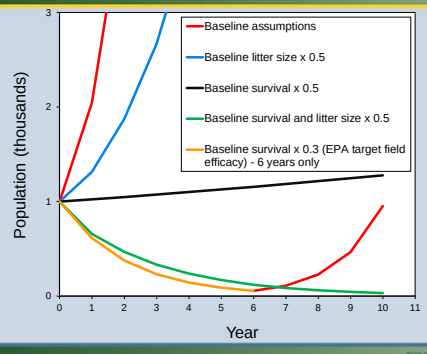
Management Interventions for Example Population Projections

- **Reduce baseline reproductive rate by 50%, e.g. successful contraceptive delivery to half of the adult females**
- **Reduce baseline survival rates by 50%, e.g. use of toxicant**
- **Reduce baseline survival rates by 70%, e.g. use of toxicant at level of efficacy required by EPA in field testing**
- **Reduce survival rates and reproductive rate by 50%, e.g. use of toxicant and contraceptive**

Hypothetical Population Projections



Hypothetical Population Projections



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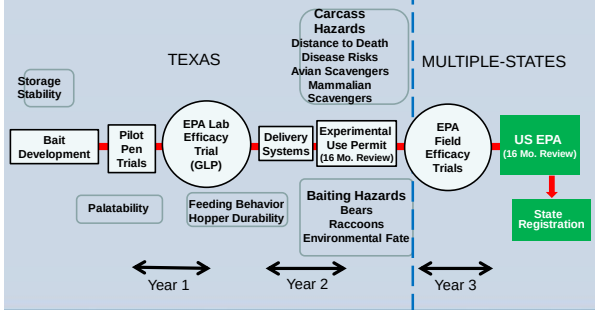
Timeline to Registration



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Questions and Discussion

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