

# Welcome to the seminar

“The length of a film should be directly related to the endurance of the human bladder”

- Alfred Hitchcock

May not apply to scientific presentations!

# Welfare, Economics and Practical Implications of Stunning and Slaughter of Poultry

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# Humane slaughter: whom should it concern?

## Stakeholders

government

industry

advocacy groups

scientists

consumer

# Humane slaughter – what is it?

One that occurs without causing animals avoidable fear, anxiety, pain, suffering and distress

# Stunning – what is it?

Procedure that induces unequivocal pathological brain state

which is incompatible with the persistence of consciousness and sensibility

in order to perform slaughter without causing avoidable fear, anxiety, pain, suffering and distress

# Humane stunning methods (1)

Should induce **immediate** loss of consciousness and sensibility in animals without causing avoidable, pain, anxiety, distress and suffering

# Humane stunning methods (2)

When induction of unconsciousness and insensibility **is not immediate**, it should occur **without causing** avoidable, pain, anxiety, distress and suffering

# Humane stunning methods (3)

The duration of unconsciousness induced by stunning method should be longer than the sum of

time interval between the end of stun and neck cutting (stun-to-stick interval)

time it takes for blood loss to cause death or bleeding to cease

40s of unconsciousness, irrespective of stunning method and species of animal



# Electrical water bath stunning known welfare concerns (1)

**Inevitable pain** associated with

tipping

shackling

pre-stun shocks

miss-stun / neck cut in conscious birds

inadequate stun / recovery during bleeding

live birds entering scald tanks

# Electrical water bath stunning known welfare concerns (2)

## **Tipping**

Poultry are the only species of sentient farm animals that could be treated this way

No sound scientific evidence has been presented so far to suggest it is not a welfare problem

# Electrical water bath stunning known welfare concerns (3)

## **Shackling**

Force of 180N applied over 1 cm<sup>2</sup> bone surface  
enriched with pain receptors

Over 90% of birds flap their wings due to pain

Enough scientific evidence to suggest it increases  
the prevalence of dislocated joints, broken  
bones and muscle bruising in conscious poultry

# Electrical water bath stunning known welfare concerns (4)

## **Painful pre-stun electric shocks**

Predisposes birds to miss the bath

Leads to ineffective stunning

Increasing lengths of water baths could be an indicator of severity of the problem

Preventive measures not widely implemented

# Electrical water bath stunning known welfare concerns (5)

## **Miss-stunning**

Birds miss water bath stunners (e.g. wing flapping, small size)

Yet, they are physically in contact with adjacent birds being stunned

Could receive potentially painful electric shocks

Preventive measures are not implemented

# Electrical water bath stunning known welfare concerns (6)

## **Electrical impedance varies**

1000 to 2600 Ohms in broilers

1900 to 7000 Ohms in layers

1200 to 2300 ohms in turkey

Amount of current received is inversely proportional to electrical impedance of individual birds in a multiple bird stunner

Constant current stunners not implemented yet

# Electrical water bath stunning known welfare concerns (7)

## **Effectiveness of stunning**

Low amount of applied current (<20%) may flow through the brain and the majority flows through carcass

No apparent solutions?

# Overall perception

The complexity of multiple bird water bath stunning is not conducive to maintaining good welfare

Widely practiced on economic and practical grounds

Fact or fiction?



# Effective electrical stunning criteria

Must induce **epileptiform** activity in the EEG

Followed by **spreading depression** - profoundly suppressed EEG

Indicative of generalised epilepsy

Raj, A. B. M. (2003) A critical appraisal of electrical stunning in chickens. *World's Poultry Science Journal*, 59: 89-98.

# Potential problem with monitoring physical signs of stunning

Both effectively and ineffectively stunned broilers exhibit seizures and apnoea

- not good indicators of unconsciousness and insensibility following electrical stunning

In the absence of profound EEG suppression following epileptiform activity, a potentially painful arousal could not be excluded

# Impact of electrical stunning parameters

Impact of waveform

sine wave AC, pulsed DC, pulse width of a DC

Impact of frequency (Hz)

Impact of amount of current (mA) or voltage (V)

# Impact of constant current electrical water bath stunning in broilers

Impact of sine wave AC

Impact of pulsed DC with 1:1 mark:space

Impact of pulse width of 200Hz DC

Variable voltage constant current stunner was used in all

# Impact of AC

Frequency

200, 400, 600, 800, 1000, 1200 **or**  
1400Hz

Amount of RMS current

100, 150 **or** 200mA

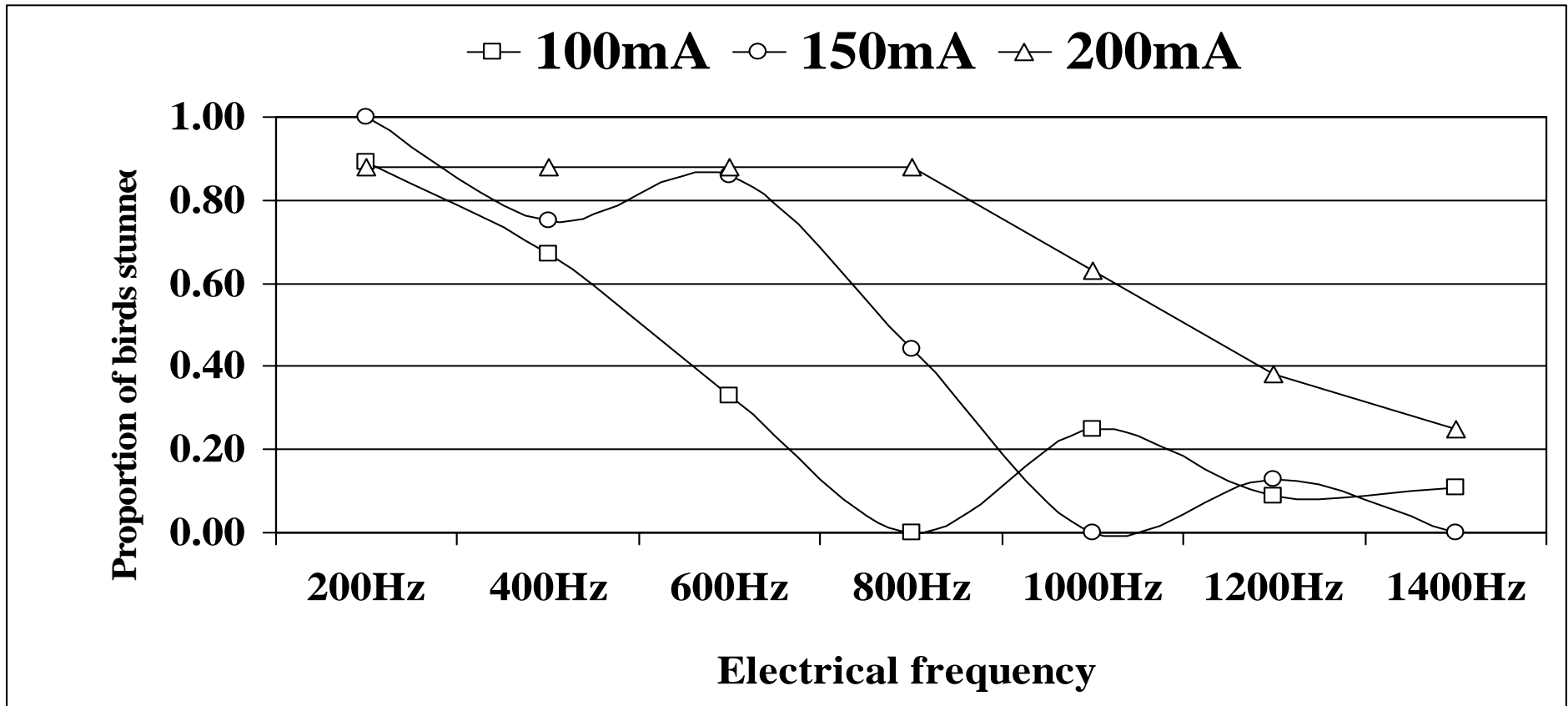
# Results (AC)

Electrical stunning frequency and amount of RMS current determines the effectiveness of stunning

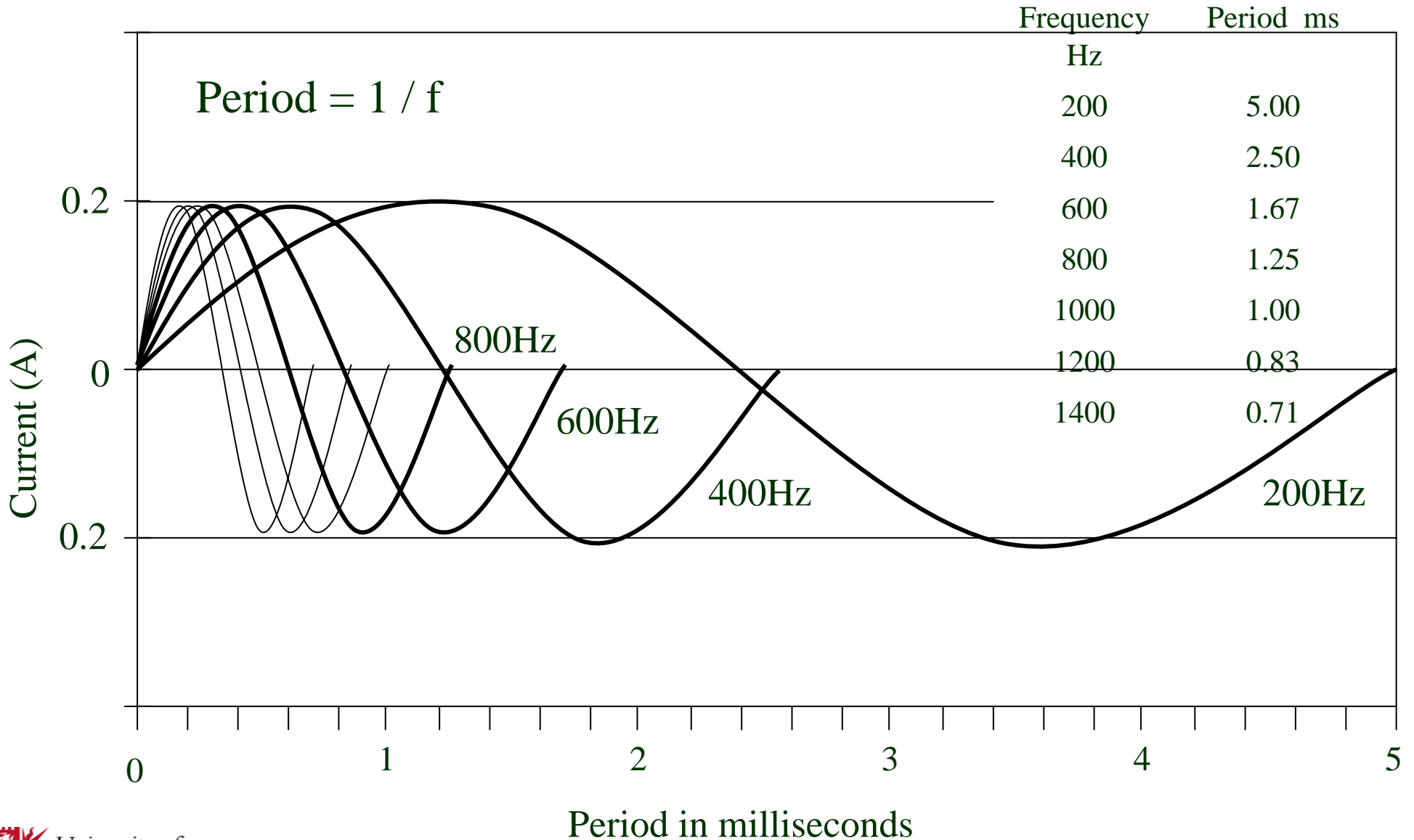
At a chosen current level, the proportion of broilers with epileptiform EEG decreases as the frequency is increased

Effectiveness is limited to a range of electrical frequencies

# Effectiveness of stunning with AC



# Period of current frequencies (AC)





# Conclusions (AC)

200Hz sine wave AC has a slower rate of voltage change and longer excursion distance than the others

Therefore, most effective in disrupting neuronal function even at 100mA RMS

Frequencies above 800Hz sine wave AC are least effective even at 200mA RMS

# Recommendation (AC)

| Frequency<br>(Hz) | RMS current<br>(mA) | RMS volt<br>(V) |
|-------------------|---------------------|-----------------|
| Up to 200         | 100                 | 151             |
| >200 to 600       | 150                 | 216             |
| >600 to 800       | 200                 | 273             |
| >800              | Not known           | Not known       |

# Impact of pulsed DC with 1:1 mark:space

Frequency

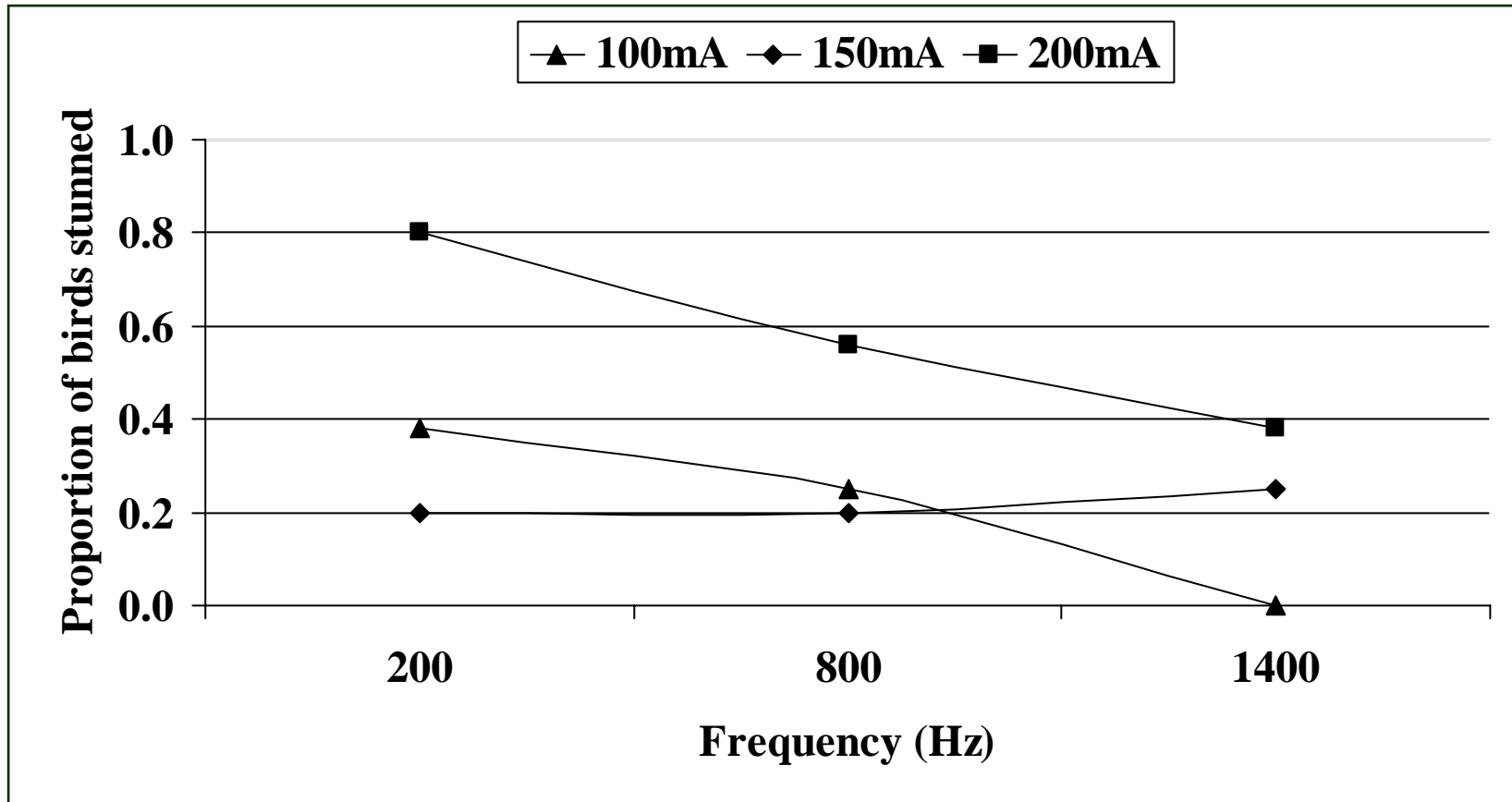
200, 800 **or** 1400Hz

Amount of average current

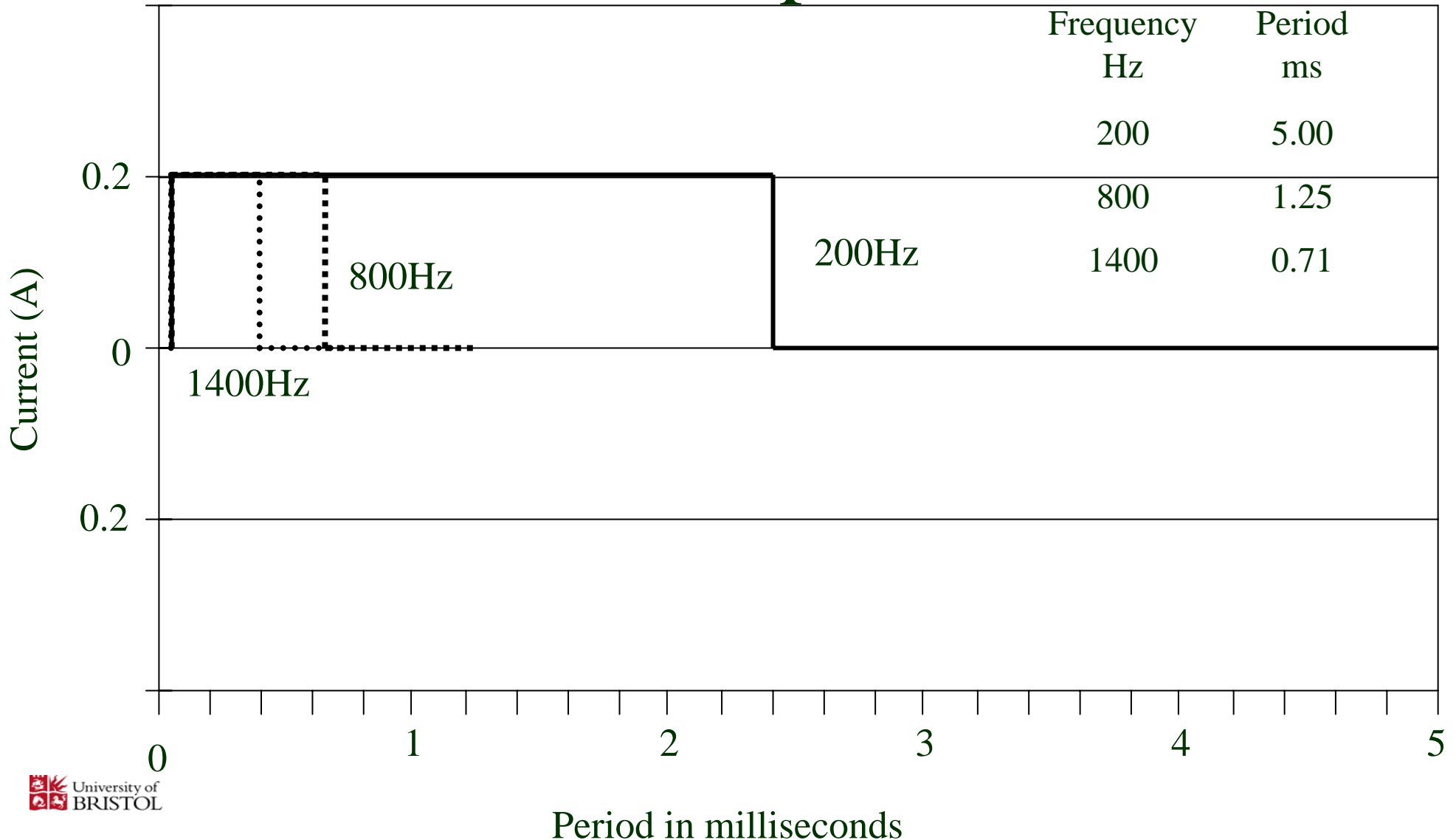
100, 150 **or** 200mA

(Peak = 200, 300 and 400mA)

# Effectiveness of stunning with DC



# Period of pulsed DC with 1:1 mark:space



# Conclusions (DC)

200mA average current (400mA peak) delivered using 200Hz pulsed DC is less effective than sine wave AC

Induces cardiac arrest without the EEG evidence of effective stunning in a considerable proportion (about 20%) of birds

This would compromise bird welfare

# Recommendation - pulsed DC with 1:1 mark:space

200mA average current (400mA peak) or 275V  
average (550V peak) delivered using 200Hz or  
less

Induces cardiac arrest without the EEG evidence of  
effective stunning in a considerable proportion  
(20%) of birds

The use of pulsed DC should be discouraged

# Impact of pulse width of a DC

Selected frequency = 200Hz

(period = 5 milliseconds)

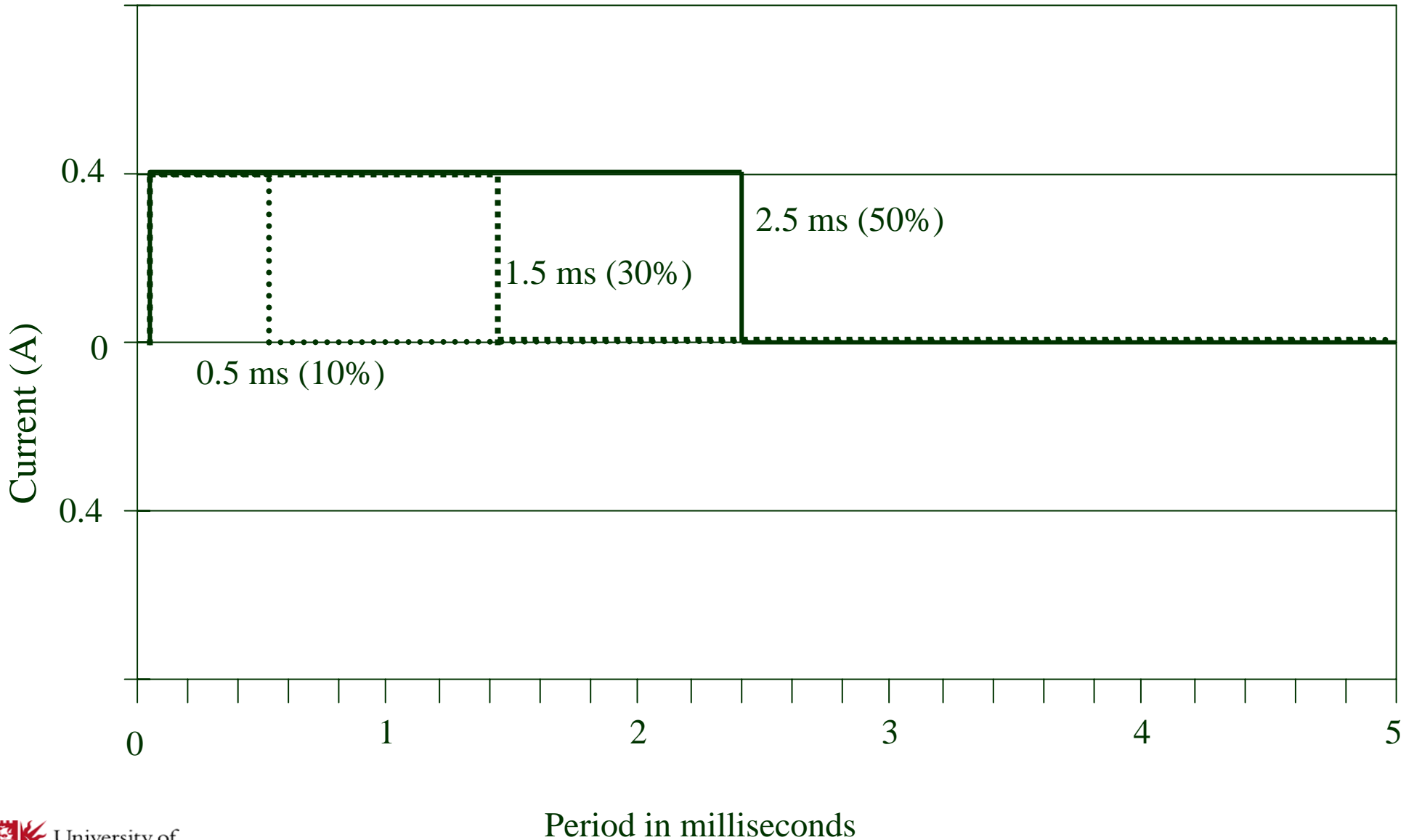
Amount of peak current = 400mA constant

Pulse widths = 0.5, 1.5 or 2.5 milliseconds

(10, 30 and 50% of current cycle, respectively)



# Pulse width of 200Hz DC



# Pulse width - jargons

|                             |            |            |            |
|-----------------------------|------------|------------|------------|
| Frequency<br>(Hz)           | 200        | 200        | 200        |
| <b>Pulse width<br/>(ms)</b> | <b>2.5</b> | <b>1.5</b> | <b>0.5</b> |
| <b>Duty cycle<br/>(%)</b>   | <b>50</b>  | <b>30</b>  | <b>10</b>  |
| Peak current<br>(mA)        | 400        | 400        | 400        |
| <b>Avg. volts</b>           | <b>200</b> | <b>120</b> | <b>40</b>  |

# Impact of pulse width of a 200Hz DC

| Pulse width<br>milliseconds | N  | Epileptiform<br>EEG |
|-----------------------------|----|---------------------|
| 0.5 (10%)                   | 8  | 1                   |
| 1.5 (30%)                   | 11 | 8                   |
| 2.5 (50%)                   | 10 | 8                   |

# Conclusions (PW-1)

At 400mA peak delivered with 200Hz, minimum pulse width of 30% of current cycle is essential to inducing epileptiform activity in majority of the birds

Induces cardiac arrest at stunning without epileptiform EEG in some birds

Does not induce quiescent EEG following epileptiform activity

# Conclusions (PW-2)

Reduced pulse widths of DC seriously compromises bird welfare

Increasing the frequency of this wave form to above 200Hz makes it worse

Therefore, not recommended

# What can be done to improve welfare?

Implement minimum currents appropriate to electrical waveform and frequency

Implement constant current, rather than constant voltage, stunning

Implement measures to prevent live birds entering scald tanks

# What would be the total cost?

Electrically isolate individual birds in water bath to facilitate constant current stunning = ?

Prevent live birds entering scald tanks = ?

Effects on carcass and meat quality = ?

# Any questions?

“Investing is not as tough as being a top-notch bridge player. All it takes is the ability to see things as they really are”

Warren Buffet

American investment broker



# Gaseous stunning

## Intention and purpose

Eliminate uncrating, hence avoid anxiety, pain, distress and suffering in conscious birds

Eliminate problems inherent to multiple bird water bath electrical stunning

# What are the welfare criteria?

Induction of unconsciousness should be non-aversive

Induction of death should be rapid

Birds should be killed, rather than stunned, in transport crates

# Aversion to gas mixture

birds do not avoid anoxia created using argon or nitrogen

birds avoid high concentration (40% by volume or more) of carbon dioxide

# Scientific bases (1)

UK: Bristol - Chickens and turkeys

Edinburgh (Roslin) – chickens

USA: Webster and Fletcher (2004)

Laying hens

‘Fewest stops and retreats occurred in air or argon’

‘Increased tendency to stop when carbon dioxide was present’

# Why do they do that?

Birds have chemical receptors in their lungs  
(Intrapulmonary chemoreceptors, IPCs)

That are

acutely sensitive to carbon dioxide but  
insensitive to hypoxia / anoxia

# Welfare significance (1)

Stimulation of IPC depresses respiration and the rate and extent depends upon the inhaled concentration of carbon dioxide

Gasping and head shaking could be due to stimulation of IPC – needs further investigation

# Welfare significance (2)

Like in mammals, inhalation of carbon dioxide leads to stimulation of central (brain) and arterial chemoreceptors

The effect of carbon dioxide on IPC is independent of the effects on central and arterial chemoreceptors, and pH of blood

# Welfare significance (3)

IPC stimulation



Depression of breathing



Apnoea in birds = breathlessness / suffocation in humans?



# Welfare significance (4)

Dyspnoea or breathlessness in humans  
activates brain regions associated with pain  
– one of many similarities

- American Pain Society

# Welfare significance (5)

Hypoxia or anoxia (nitrogen or argon)

There are no specific

Intrapulmonary chemoreceptors

Central receptors (brain)

# Inference

induction of unconsciousness with anoxia is non-aversive and rapid

Carbon dioxide induces breathlessness

Activates brain regions involved in perception of pain

Inhalation of carbon dioxide is distressing and may be painful

# Conclusions (1)

Use of anoxia is far more humane than the other gas mixtures containing carbon dioxide

A mixture containing low concentrations ( $< 30\%$ ) of carbon dioxide and an anoxic gas is probably better than using high concentrations of carbon dioxide in air

# Conclusions (2)

Slaughter without stunning induces unconsciousness quicker than carbon dioxide (14 Vs 30s)

Both are painful and distressing, could be avoided

Humanitarian intentions of eliminating avoidable pain and suffering during water bath stunning could be seriously compromised by carbon dioxide stunning

# Economics of gas stunning

Capital cost = ?

Running cost = Predominantly nitrogen is used in the UK; 0.50 to 0.75 US Cents per bird has been cited.

Payback:

- Consumers' confidence

- Improved bird welfare, environment, carcass and meat quality

- Opportunity for early filleting

- Sustainable industry

# Practical aspect

Bird welfare is maximised by stunning /  
killing in crates

Shackling of freshly killed birds improves  
operators' health and safety also

# Blood volume in chicken

| Body weight (kg) | Blood volume (% Bwt) |
|------------------|----------------------|
| 1.0              | 11.6                 |
| 1.5              | 8.9                  |
| 2.0              | 7.3                  |
| 2.5              | 7.3                  |
| 3.0              | 7.4                  |

Kotula and Helbacka, 1966



# Bleed-out (1)

Slaughter without stun      45% total blood volume

Destruction of brain      43% total blood volume

Decapitation      39% total blood volume

Newell and Shaffer (1950)

# Bleed-out (2)

| Method                    | Chicken | Turkeys |
|---------------------------|---------|---------|
| Electrical<br>(stun/kill) | 3.3%    | 2.5%    |
| CO2                       | 3.1%    | 2.5%    |
| Anoxia                    | 3.1%    | 2.5%    |

Blood content in organs not established

# Human hazards?

Very low

**gases already used for modified atmosphere packaging of food  
(e.g. meat, fruits, vegetables)**

**Like electrical water bath stunners, CAS systems are secured  
(caged)**

Duration of exposure Vs concentration of gas

Gas suppliers perform thorough risk assessment and ensure health and safety of operators

Environmental and personal gas monitoring systems are commercially available

# Proof of the pudding!

Owing to the complexity, constant current electrical water bath stunning is not practiced

Many gas stunning / killing systems involving inert gas mixtures are being used

# The way forward

Stunning methods should be selected based on sound science

Stun or stun / kill devices should have a quality control standard (kite mark) based on sound scientific evidence

Processors, who need licence to slaughter animals for food, should also obtain a licence to use stun / kill devices

Equipment manufacturer should share the corporate responsibility for ensuring welfare

# Acknowledgements

HFAC

HSUS

USDA

DEFRA, UK

# Further information

<https://www.efsa.europa.eu>

<http://www.ampainsoc.org/pub/bulletin/mar01/upda1.htm>

# Leadership

“Leadership is the capacity to  
translate vision into reality”

Warren G Bennis  
American Business Writer

The end!