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AS GCE/Level 3 Certificate

QUANTITATIVE METHODS (MEI)

G244/01 Introduction to Quantitative Methods (IQM)

Insert

Duration: 1 hour 30 minutes

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INFORMATION FOR CANDIDATES

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1 Hedgehogs and badgers

An extract from

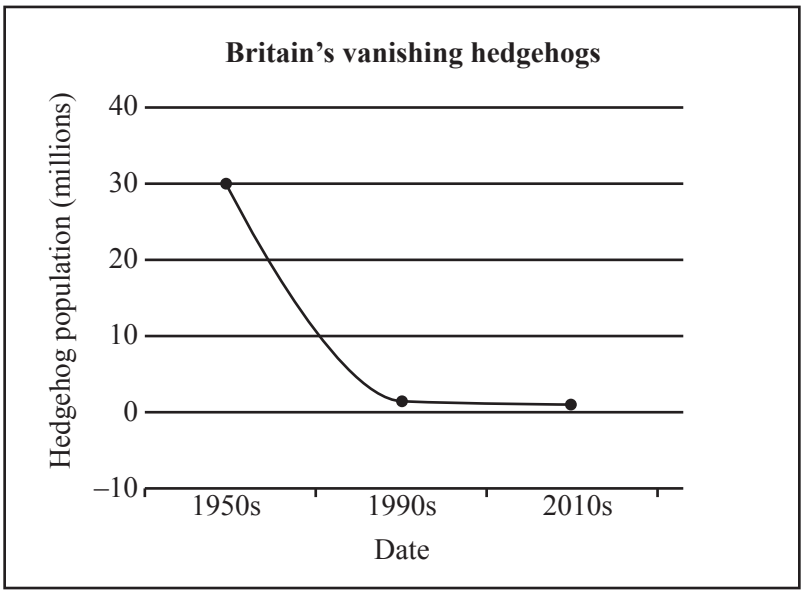
'Our humble hedgehog is disappearing fast'

Geoffrey Lean 5/3/2015

Source http://www.telegraph.co.uk/news/earth/wildlife/11449901/Our-humble-hedgehog-is-disappearing-fast.html

They've been around for 15 million years; hedgehogs roamed Britain with mammoths and sabre-toothed tigers. But in a single lifetime the much-loved mammals have been driven towards extinction, their national population apparently plummeting more than thirtyfold.

As Philip Larkin wrote in The Mower – a poem composed after he killed a hedgehog while cutting long grass – we have "mauled" their "unobtrusive world". And their decline is all the more significant since – like butterflies – they are known to be an "indicator species", whose fate mirrors what is happening to the natural world as a whole.



There has never been a full national census of hedgehogs in Britain but, back in the Fifties – extrapolating from limited data – it was estimated that there were 36.5 million of them. In 1995 a better, but still incomplete, survey put their numbers at just 1.55 million.

And there is good evidence that they have continued to disappear since. Three more recent surveys suggest that we lost another third between 2002 and 2012, and sightings fell by 4 per cent last year alone. Now a fifth of Britons say they never see the prickly creatures at all.

Badgers, another iconic species, have lately been getting much of the blame. And it is true that they are the nocturnal animal's main predator – nothing else is strong enough to overcome its defences. More important, though, the two mammals compete for the same prey, such as worms and slugs.

Brock's population has been booming, as TB-hit dairy farmers know all too well, and where they are most plentiful, hedgehogs tend to be scarce. There are also some signs that their numbers have sharply increased in areas where badgers have been culled.

But it is an oversimplification to indict badgers alone. Hedgehogs have also declined sharply in areas where the bigger beasts are scarce. And, of course, the two species long coexisted. The problem is that habitats have been shrinking, leaving hedgehogs without ecosystems to sustain them – and places to hide from predators.

The clue is in their name. Since the Second World War we have grubbed up 200,000 miles of hedges in Britain, enough to encircle the world eight times over, as intensive farming has advanced. This no longer happens on anything like the same scale, but ecologists say that even the remaining hedgerows are less rich in wildlife than they used to be because they are less well maintained.

As development spreads, this and other hedgehog habitat becomes more and more fragmented: garden walls and fences add to the problem by blocking the way for the animals, which can roam for up to two miles a night. And there are other hazards too. Many take refuge in bonfires, only to be burned alive when they are lit. Unknown numbers perished in last year's floods. Pesticides kill their prey. And tens of thousands are squashed every year by their second greatest predator – the car.

Badger numbers

In the past badgers were persecuted in the UK. They were hunted and, alongside cock fighting, badger baiting was considered a sport.

However, their relationship with humans changed in 1973 when they became a protected species and so killing them was a crime. It would not be surprising if the effect of this change in status led to an increase in their numbers and to their becoming less reclusive.

It is not possible to count the number of badgers at any time. Instead estimates have to be made on the basis of the numbers and sizes of social groups.

Badgers form social groups of size varying from 2 adults upwards; groups of 6 are not uncommon. They live in underground burrows called setts. There are several connected chambers in a sett and a number of different entrances from the outside. A typical social group has more than one sett and sometimes the group will be split between different setts. That makes it very difficult to estimate the number of badgers in a social group. Observing those coming out of one entrance of a sett does not guarantee that all the badgers have been counted.

Many individual farmers can say how many setts there are on their land, and in many cases how many social groups (but usually not their size). However, the density of social groups varies according to the type of land and also from one region to another. Estimates of the overall number of social groups are inevitably based on sample data from a number of locations, and so are unlikely to be very accurate.

So neither of the inputs into any calculation of badger numbers is particularly reliable. However, there have been a number of attempts to estimate them.

- In 1985, it was suggested that there were 42 000 social groups in England, with an average size of 2 to 3 adult badgers.

- A study 10 years later, in 1995, came up with figures of 50 000 social groups of average size 5 to 6 adults.

Taken together these two studies seemed to indicate a large increase in the badger population. However another possibility is that since different methodologies were used, the results were not comparable.

In 2001 a study by Natural England suggested a figure of 220 000 adult badgers in England.

There are two sites, at Woodchester Park in Gloucestershire and at Wytham Woods in Oxfordshire, where particular badger populations have been monitored over a long period. An overall conclusion from these two studies is that it is in the nature of badger populations that their numbers fluctuate strongly.

2 Hearing sounds

Pitch

Any note has a certain pitch, or frequency, measured in cycles per second, or hertz.

The band of frequencies that you can hear varies from person to person but is usually somewhere within the range of 20 to 16 000 hertz.

In music, particular sequences of notes are called scales. These consist of consecutive sets of 8 notes, called octaves. The notes in each octave are given the same names and in the simplest scale these are the letters from A to G.

In this basic scale the frequencies of the 8 notes in the middle octave are as follows, rounded to the nearest 0.1 hertz.

A 220.0 B 246.9 C 261.6 D 293.7 E 329.6 F 349.2 G 392.0

In the next octave up, the frequencies of the notes are exactly twice those given above. (Any variation from this pattern in the final digits is due to rounding.)

A 440.0 B 493.9 C 523.2 D 587.3 E 659.3 F 698.5 G 784.0

The same pattern of multiplying by 2 continues for higher octaves. Similarly, dividing by 2 gives the frequencies for the notes in lower octaves.

So the frequencies of musical notes in hertz are embedded in a logarithmic scale. (Notice this is a different use of the word “scale” from that in a musical scale.)

Another measure for the pitch of a note is its wavelength, λ. This is related to the frequency, f, by the equation

$$\lambda \times f = \text{The speed of sound.}$$

The speed of sound in still air is $340.29\,\text{m}\,\text{s}^{-1}$.

Loudness

The loudness of a sound is usually measured in decibels. This is actually a measure of the pressure of the sound wave.

This table gives some reference points.

Loudness (decibels)	Description
0	The softest a human can hear
15	A soft whisper
40	Rainfall
65	A typical speaking voice
85	Permanent ear damage in about 8 hours
100	Permanent ear damage in about 15 minutes
120	A loud rock concert

To understand the meaning of the decibel it is helpful to start with its parent unit, the bel, even though it is rarely used in its own right.

$$1 \text{ decibel} = \frac{1}{10} \text{ of } 1 \text{ bel}$$

Any increase in loudness of 1 bel means that the sound has become 10 times louder. So the bel and the decibel are units on a logarithmic scale.

An increase in loudness of 1 decibel corresponds to an increase by a multiple m where

$$m^{10} = 10$$

and so

$$m = 1.2589\ldots$$

Thus an increase of 1 decibel corresponds to an increase in loudness of 25.89… % or about 26% .

This multiple m is the same whether the increase is from 35 decibels to 36 decibels or from 110 to 111.

Similarly an increase in, for example, 7 decibels corresponds to a multiple of m^7.
Since $1.2587\ldots^7 = 5.0118\ldots$, this is a percentage increase of 401% to the nearest whole number.

3 Fuel efficiency

An extract from

'Speed Kills MPG'

This article was written in the United States.
Source http://www.mpgforspeed.com/

Unfortunately, it's true. Your car's gas mileage decreases once it gets past its optimal speed. For most cars, this is around 55–60 mph. This means that every time you go over this speed, you're essentially wasting gas and money – and creating unnecessary greenhouse gases.

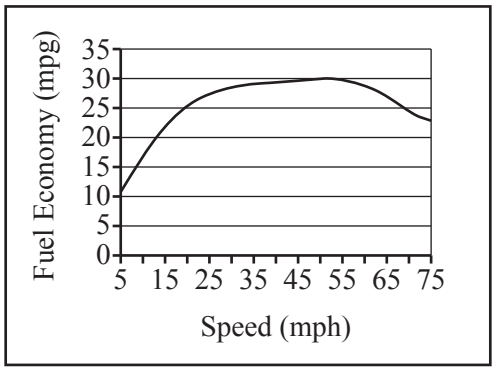
You'd be surprised to learn that a slight decrease in your highway driving speed can significantly reduce your gas consumption, while only adding a few minutes to your travel time.

How much?

According to studies backed by the department of energy, the average car will be at its advertised MPG at 55 mph. But as the speed increases:

–3% less efficient at 60 mph
–8% less efficient at 65 mph
–17% less efficient at 70 mph
–23% less efficient at 75 mph
–28% less efficient at 80 mph

See the graph below (from fueleconomy.gov):



Which cars?

Regardless of your vehicle, engine, or size, the numbers hold true.

Why?

This effect happens for two reasons:

1 Increasing air resistance. According to CNN, "Pushing air around actually takes up about 40% of a car's energy at highway speeds. Traveling faster makes the job even harder … The increase is actually exponential, meaning wind resistance rises much more steeply between 70 and 80 mph than it does between 50 and 60."

2 Engines are designed for specific speed, temperature, and rpm ranges. Driving out of these ranges goes against the fundamental design of the engine.

Interesting Facts

If the national speed limit were reset to 55, it would save 1 billion barrels of oil per year.

The old national speed limit of 55 mph was created to address the energy crisis in the early 1970's – not safety purposes (although it did help safety).