BATS IN RAIN FORESTS
Notes for facilitators

Suitable for
Ages 10 – 14

Main message
The diversity and abundance of bats in rain forests.

Answers

1. 620 square km x 1700 bats in each km = 1,054,000 bats.

2. 4 x 1700 = 6800 bats
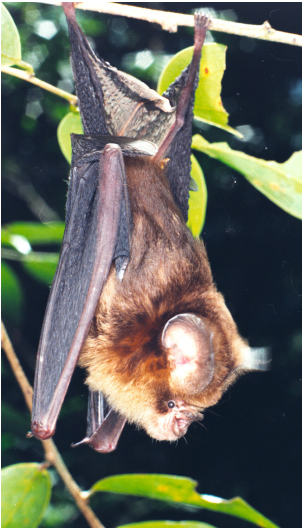
3. 1,054,000 bats x 4 (or 6800 bats x 620 km) = 4,216,000 bats
    WOW! MORE THAN 4 MILLION BATS!!!

4. 8 g x 6800 bats = 54400g or 54.4 kg per square km, and 8 g x 4,216,000 = 33728000g = 33728 kg = 33.73 metric tonnes (or 54.5 kg x 620 square km) in the whole reserve.

5. 33.728/3 = just over 11 elephants.

BATS IN RAIN FORESTS

Rain forests are a critical habitat for many bat species. Approximately half of all the mammal species that live in rain forests are bats and in numbers of individuals, they often outnumber all other mammals combined.

Scientists from the Malaysian Bat Conservation Research Unit have been surveying the bat populations at Krau Wildlife Reserve in Pahang. In a two month period in 2002 they captured 1700 individual insect-eating bats in an area of forest just 1 square km in size.

1.   If the total area of Krau Wildlife Reserve is 620 square km, how many bats might be in the Reserve?

2.   The trapping techniques used by the MBCRU team certainly did not capture every bat in the 1 square km study site. They were not targeting fruit bats and caught only a sample of the insectivorous bats. If they caught 25% of all the bats in the area, how many bats would there be in the 1 km study site?

3.   How many would there be in the whole 620 square km reserve?

4.   If the average body weight for a bat is 8 g, what is the bat biomass --the weight of all the bats put together -- for 1 square km? For the whole reserve?

5.   If an average elephant weighs 3 tonnes, how many elephants would give you the same biomass in the reserve?

Sadly, there are no elephants left in Krau Wildlife Reserve, but the Reserve does support more insectivorous bat species (55 species) than any other forest in the Old World. When the fruit bats are included the species list runs to 66 species.

(Tip: there are 1000 g in a kg; and 1000 kg in a metric tonne).

LIFE STATISTICS

How many pups do you think a bat usually has in a year?

Are they like rats and mice that can have more than 10 babies in a litter, or more like us with single pups and occasionally twins?

Can you guess how many times a year they breed?

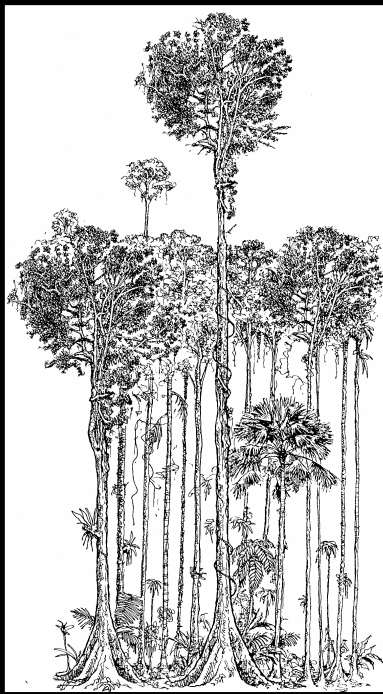**Kerivoula pellucida**

Hipposideros cervinus

Find out about bats and their pups and discover how we compare to bats by filling in the blanks.

	Me/My mother	Fawn Roundleaf Bat (*Hipposideros cervinus*)	Common rat (*Rattus norvegicus*)
Gestation, pregnancy		40-50 days	21-26 days
Adult weight		8 g	200 g
Birth weight		2g	6g
Litter size		1	8
Time to reach adult size		25 days	150 days
Time to weaning		45-60 days	22 days
Lifespan		Up to 20 years	3 years
Number of litters per year		1	1–12; average 6

Use the table above to answer the following questions:

1. For each species, what percentage of the adult weight is the weight of the pup at birth?

2. a) How much would you have had to weigh at birth to be like a bat baby? b)As a percentage of the lifespan, how long does it take reach adult size?

3. How many offspring could a female rat produce in her lifetime?

4. How many offspring could a female bat produce in her lifetime?

Now that you know how often bats reproduce work out what could happen in the following scenario.

In a forest there was a population of 1000 rats and 100 bats. One year ¾ of the forest was cleared for a large oil palm plantation. Without a home the populations fell to 450 rats and 45 bats.

As the plantation grew the owners used large amounts of pesticide to stop pests from destroying their crops. The pesticide poisoned the insects but when the bats ate the insects it poisoned them as well. It also entered the water supply and killed many rats. The populations quickly declined again leaving only 2 rats and 2 bats. The survivors were made up of one male and one female in each population.

5. a. If the bats and rats were able to recover, how many offspring would the survivors produce after 1 year?

b. If all the young born in the first year are able to breed in the second year, how many bats/rats will there be after 2 years? (Assuming half the young are male and half are female)

c. Which species do you think would be most likely to survive and why?

LIFE STATISTICS
Notes for facilitators

Suitable for
Ages 12-16

Main message
Bats are slow to recover after disturbance, especially compared to rats.
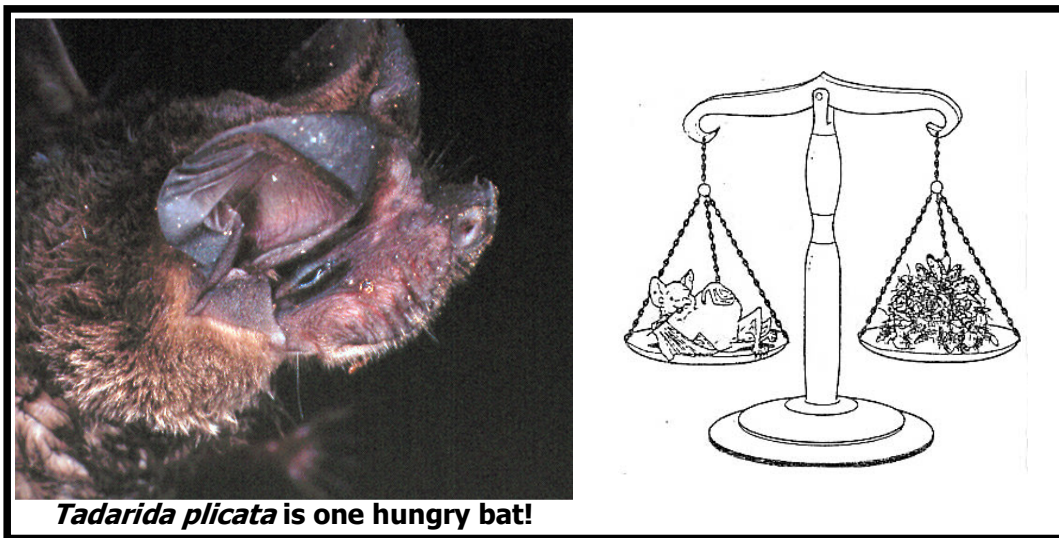
Answers

1. birth weight ÷ adult weight x 100 = % birth weight of adult weight

2. a. adult weight x 0.25 = 25% of adult weight (1/4)

   b. time to reach adult size (in days) ÷ lifespan (in days) x 100 = % of lifespan reaching adult size

3. lifespan in years x number of pups per litter x number of litters per year = 3 years x 6 litters x 8 pups = 144 rats

4. 20 years x 1 litter x 1 pup = 20 bats

5. a. Rats: average 6 litters per year x 8 pups in each litter= 48 rats
   Bats: 1 litter per year x 1 pup per litter = 1 bat

   b. Rats: 24 young females + original female = 25 females
   25 females x 48 pups = 1200
   1200 young from year 2 + 48 young from year 1 + 2 survivors = 1250 rats

   Bats: if first year pup is male, only the original female can breed and has 1 pup per year, giving a total of 4 bats at the end of 2 years. If the first year pup is female she will also breed in the second year, giving a total of 5 bats after 2 years.

   c. Rats, because they can recover their population much faster.

A NATURAL PESTICIDE

The wrinkled-lipped bat is one of the free-tailed bats that live in colonies in caves that can number over a million individuals. There are over 1.8 million in Deer Cave at Mulu, Sarawak and it can take hours for them all to leave at night.

They have long-narrow wings and heavy bodies so they fly very fast like little jet planes and can go tens of kilometres in a night in pursuit of their prey. They may even track the movements of pest insects over the seasons. Their cousins in the USA, the Mexican free-tailed bats (*Tadarida brasiliensis*), fly up to 3 km high into the night sky to intercept moth migrations – they eat about 120 tonnes of moths a night, which has a huge impact on pest populations.

***Tadarida plicata* is one hungry bat!**

The wrinkle-lipped bat (*Tadarida plicata*) is one hungry bat! Each bat weighs about 16 g and must eat at least half of its own body weight every night. To find out more, answer the questions below (Tip: there are 1000 g in a kg; and 1000 kg in a metric tonne).

1. How many grammes of insects does one individual eat in a night?

2. How many kilogrammes does a colony of a million bats eat in a night?

3. How many tonnes in a year?

4. The wrinkle-lipped bat's favourite food is moths, which weigh about 0.25 g each. How many moths could the colony eat in a year?

5. If they switch to small insects, which weigh only 0.10 g each, how many small insects could the colony eat in a year?

6. How many litres of pesticides do you think you would need to replace this colony if it disappeared? What impact would the loss of the colony have on local farmers?

A NATURAL PESTICIDE
Notes for facilitators

Suitable for
Ages 10-14 years

Main message
Insectivorous bats are important as they eat many insects, including some that are pests.

Answers
1. Body weight ÷ 2 = 16 ÷ 2 = <u>8 g</u>
2. Number in colony x number grammes eaten per individual per night = 8 x 1,000,000 = 8,000,000

   To convert to kg ÷ by 1,000 = <u>8,000 kg</u>

3. Number of kg per night x 365 = 8,000 x 365 = 2,920,000 kg

   To convert to tonnes ÷ by 1,000 = <u>2,920 tonnes</u>

4. To convert to grammes x by 1,000,000 (1 million) = <u>2,920,000,000 g</u>

   Total year weight ÷ 1 insect weight = 2,920,000,000g ÷0.25 = <u>11,680,000,000 insects</u>

5. Total year weight ÷ 1 insect weight = 2,920,000,000g ÷ 0.10 = <u>29,200,000,000 insects</u>

6. You would need many litres of pesticide to replace the colony: enough to control the insects the bats would otherwise be eating. An increase in pest numbers would result in local farmers losing their crops or increasing their pesticide use to keep numbers under control. This would have a knock-on effect on the surrounding environment and health of other animal populations.

TONNES OF FOOD

Many insect-eating bats eat almost half their own weight in insects each night.

For example, *Hipposideros cervinus*, which weighs 10 g, might eat 5 g of tiny insects in one night's hunting.

Hipposideros cervinus

1. If *Hipposideros cervinus* hunts for 200 nights in 1 year, what weight of insects would it eat? (For the other 165 nights it stays at home because of storms, rain or because there are not enough insects around worth chasing.)

2. How many times its own weight would *Hipposideros cervinus* eat in 1 year?

3. You probably eat less than 2 kg of food each day. What is this as a fraction of your own weight? (E.g. If you weigh 45 kg, this would be 1/22 or 4.5% of your weight.)

4. a. How many times your own weight would you eat in one year?

    b. If you ate as much of your own weight as *Hipposideros cervinus*, how much would you have to eat each day?

5. Why is it so important *Hipposideros cervinus* eats so much more than you do?

6. How could *Hipposideros cervinus* be useful to people?

TONNES OF FOOD
Notes for facilitators

Suitable for
Ages 9-12

Main message
Relative to their size, insectivorous bats eat much more in comparison to humans. They are important as they eat many insects, including some that are pests. This activity can be followed up by *A Natural Pesticide*.

Answers
1. ½ bat weight x number of hunting nights in year = 200 days x 5 g = <u>1000 g per year</u>

2. weight of insects per year ÷ bat weight = <u>1,000 ÷ 10 = 100 times body weight</u>

3. your body weight ÷ 2 kg x 100 % (or put into a fraction)

4. a. food weight per year = 2 kg x 365 = <u>730 kg</u> (food weight x number of days). weight of food ÷ own weight = how many times your own body weight

5. They use a lot of energy for such a small animal, so they need to eat to replace the energy lost.

6. As a natural pesticide

Discussion points
Problems with pesticides
One of the problems with using pesticides is that they can also kill other animals as well as pests, particularly animals that eat the pests - predators. i.e. the pesticide enters the food chain.

Pesticides are sprayed into the air, which can result in a concentration of perhaps 1 ml of pesticide for every 1,000,000 ml of air (i.e. 1 part per million). The poisoned air is absorbed by the insect. If the dose is high enough it will die. If it is a tough insect and can cope with 1 part per million, then it flies around with this pesticide within its body.

The pesticide becomes concentrated in the insect's body, so perhaps 20 parts per million of its body are made up of the chemical. If a bat eats the insect the chemical becomes further concentrated. If an owl eats the bat, then inside the owl's body the chemical becomes even more concentrated. Sometimes the chemical can harm an animal several further steps up a "food chain".