

Part 1: Barrow Island environment

1. The major challenge for plants and animals living on Barrow Island is lack of water. The average annual rainfall of 320 mm is much less than that of Perth, 867 mm, although high relative humidity leads to the regular formation of dew.

Investigate the landscapes, water sources and climate of Barrow Island, and describe what strategies plants and animals might adopt to acquire and conserve water.

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Part 2: Meet the Marsupials

2. Read the information about each marsupial and watch each animation, record your observations about their behaviour in the table below.

	WATER ACQUISITION (freshwater, dew, food)	DIET	TYPE OF SHELTER	ACTIVE TIMES (day, night, dawn, dusk)
burrowing bettong				
spectacled hare-wallaby				
black-flanked rock wallaby				
euro				

3. During the dry season temperatures on Barrow Island can reach 45°C. What behavioural adaptations of the featured marsupials that would help them avoid high temperatures and water loss, did you observe?

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4. Consider weather data provided in the tables below. What do you notice about temperature and humidity in caves and warrens compared to external air temperature and humidity? What advantages would this provide black-flanked rock wallabies and burrowing bettongs?

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	AIR TEMPERATURE OUTSIDE CAVE °C	AIR TEMPERATURE INSIDE CAVE °C	AIR HUMIDITY OUTSIDE CAVE %	AIR HUMIDITY INSIDE CAVE %
mean	27	24	69	90
maximum	37	25	92	97
minimum	21	22	22	65
	AIR TEMPERATURE OUTSIDE BURROW °C	AIR TEMPERATURE INSIDE BURROW °C	AIR HUMIDITY OUTSIDE BURROW %	AIR HUMIDITY INSIDE BURROW %
mean	30	29	51	69
maximum	47	34	95	84
minimum	20	25	13	45

Part 3: Water balance in Barrow Island marsupials

Water influx and body water

5. Water balance, or homeostasis, is essential for life. It is important levels of water within the body are regulated to maintain optimal functioning. In humans, even a loss of 2 % total body water can lead to serious symptoms and compromising of function.

Without adaptations to regulate body water what do you think might happen to marsupials living on Barrow Island?

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6. Record water influx and total body water content, for each marsupial, in the table below.

	WATER INFLUX mL kg ^{-0.82} d ⁻¹		TOTAL BODY WATER %	
	Wet	Dry	Wet	Dry
burrowing bettong				
spectacled hare-wallaby				
black-flanked rock wallaby				
euro				

7. Water influx refers to water inputs per day. For Barrow Island marsupials water is available through food, metabolic water, drinking (if free water is available), and water vapour in the air. Total body water refers to the volume of water in the body as a percentage of body weight.

Compare water influx and total body water in wet and dry seasons for each marsupial. Explain any trends.

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8. To maintain water balance all mammals must take in enough water to replace what they lose; otherwise dehydration has serious consequences. The amount of water an animal takes in each day (water influx) depends on how much water they lose to their environment through faeces, urine, and evaporation (water efflux).

A low water influx means an animal is very efficient at regulating body water. Which marsupial has the highest water influx during the dry season, and which has the lowest? If water influx is low what does this suggest about water losses?

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9. Another way to consider water regulation is to express an animal's water use as a percentage of water in the body. The rate of water use (turnover) reflects losses that must be replaced in order to maintain water balance. The lower the water turnover rate the less water an animal is losing to the environment, and the less it has to replace.

Record water turnover rates, for each marsupial, in the table below.

	DAILY WATER TURNOVER % (Dry season only)
burrowing bettong	
spectacled hare-wallaby	
black-flanked rock wallaby	
euro	

10. Most mammals, living in mild climates, have average water turnover rates of around 20-25% per day. This means around 20% of body water is used for daily activities, which needs to be replaced (via food, water, metabolic water production, water vapour) to ensure the body remains in water balance.

Which marsupial species have very low water turnover rates, and what does this suggest about their ability to regulate body water?

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11. Burrowing bettongs' water turnover is average for mammals and higher than other marsupials on Barrow Island. How is the diet of burrowing bettongs different to other marsupials on the island? How might this assist them in acquiring water? What strategies do they use to prevent excessive water loss?

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Anti-diuretic hormone and water balance

ADH (anti-diuretic hormone), also known as vasopressin, is a hormone that regulates water retention in the body. The hormone impacts on kidney function, increasing the amount of water reabsorbed and reducing urine volume; thus playing an important role in water balance.

ADH is found in most mammals, including humans. For example, while you are sleeping the levels of ADH in your body increase, resulting in more water being retained in the body and less urine produced. This is great as it means you don't have to wake up, get up and go to the toilet.

12. Record ADH levels for each marsupial, in the table below.

	ANTI-DIURETIC HORMONE pg mL ⁻¹ (Dry season only)
burrowing bettong	
spectacled hare- wallaby	
black-flanked rock wallaby	
euro	

13. Spectacled hare-wallabies have the lowest water influx ($28 \text{ mL kg}^{-0.82} \text{ d}^{-1}$ in dry season) of any recorded mammal worldwide. They lose so little water to the environment they require very little to replace it. Consider ADH levels and comment on how spectacled hare-wallabies conserve body water.

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14. The ADH level of the burrowing bettong and black-flanked rock wallaby is very low, almost zero. These animals have the hormone but it is not functioning to regulate water balance. How are they conserving body water?

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15. The black-flanked rock wallaby has low ADH levels but water turnover is also very low. This animal is conserving body water but not by the function of ADH. Instead they reduce flow of blood through the kidney, which results in production of less urine, limiting water loss.

However, there is another very important strategy that also helps the black-flanked rock wallaby conserve body water and maintain water balance. What is this strategy?

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16. The euro also displays elevated ADH levels. Do you think ADH levels would be higher or lower in the wet season for both the euro and spectacled hare-wallaby? Explain your answer.

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17. Each marsupial species has different adaptations to survive in an arid environment. List the major adaptations for each species, their function, and their type (physiological, behavioural).

	ADAPTATION(S)	FUNCTION	TYPE OF ADAPTATION
burrowing bettong			
spectacled hare-wallaby			
black-flanked rock wallaby			
euro			

- Conservation status refers to the likelihood of species survival, present and future. Federal and state legislation categorises plants and animals based on their risk of extinction. Threatened/vulnerable species are considered at high risk of extinction in the future.

18. Revisit the map of Barrow Island and record information on distribution, population, and conservation status for each marsupial species, in the table below.

	DISTRIBUTION	POPULATION	CONSERVATION STATUS
burrowing bettong			
spectacled hare-wallaby			
black-flanked rock wallaby			
euro			

19. Based on this information, and all other data collected, which marsupial might be most at risk of extinction? Explain why.

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