BIG PICTURE BIOLOGY

Teaching and Learning Resource

VCE Biology unit 1 & 2

Introduction

Big Picture Biology provides students with a unique insight into how the concepts they are learning in VCE biology are being used in real life by Zoos Victoria to save endangered species. The program is designed to apply key scientific skills through active student investigation and data collection.

Students will be posed with the big question,

'What do we need to know about an endangered species in order to save it?'

The species investigated in the program include:

- Philippines Crocodile
- Southern Corroboree Frog
- Asian Elephant
- Helmeted Honeyeater

Curriculum Links

VCE Biology Unit 1: How do living things stay alive?

- *Area of study 1*: How do organisms function?
- *Area of study 2*: How do living things sustain life?
- *Area of study* 3: Practical investigation

VCE Biology Unit 2: How is continuity of life maintained?

- *Area of study 1*: How does reproduction maintain the continuity of life?

The program consists of both zoo educator-led and self-directed activities. A zoo-educator will lead activities and discussion at two locations; DigestEd and the Elephant Barn.
Students will need to visit World of Frogs and the Helmeted Honeyeater aviary independently to collect information.

The Melbourne Zoo Learning Experiences Team, respectfully acknowledges the Wurundjeri People, the Traditional Custodians of the land on which we work, live and learn. We recognise their continuing connection to land, water and wildlife and pay respect to Elders past, present and emerging.

Student Booklet

The student booklet consists of four short scientific posters and one data collection activity. Please note that unlike past Zoo programs, students will not complete their booklet during the educator-led session. Students will need to bring their **logbook** (pracbook) to record information that will enable them to complete the student booklet post-excursion; students may refer to the booklet while onsite to determine the type of information they need to collect. It is strongly advised teachers do not require students to complete the booklet onsite.

Assessment Opportunities

As a result of the excursion there are two potential assessments that can be undertaken. One being the completion of the scientific posters, based upon the information collected on the day. The other being the production of their own scientific poster based upon the data collection activity.

Onsite Activities

The program consists of both Zoo Educator led and self-directed activities. A Zoo Educator will lead activities and discussion at two locations – Digest Ed and the Elephant Barn. Students will need to visit World of Frogs and the Helmeted Honeyeater aviary to collect information independently.

Pre-Excursion

It is recommended that students have some familiarity with the focus species prior to their visit. (The species common name, where it is found and what it looks like is sufficient.) To help with this we recommend students view the following online videos prior to their visit. Each video is very short (less than 4 minutes).

Helmeted Honeyeaters:
http://www.zoo.org.au/news/stranger-danger-training-for-helmeted-honeyeaters
Philippines Crocodile:
https://vimeo.com/90936453
Southern Corroboree Frog:
https://vimeo.com/45547747
Asian Elephant:
https://vimeo.com/81684319

Excursion Checklist

- Read Teacher Notes so you are clear about the activities and expectations of the day.
- Print copies of the Student Workbook for all students (map included)
- Watch the recommended videos and ensure that students have seen them too.
- Ensure that students are aware they will need to bring their Biology log book.
- Explain to students that during their visit they should use their student workbook as a prompt for recording notes and data in their logbook. Make sure students know they are not expected to complete their workbook during their visit; instead they will use their logbook as a resource to complete it post excursion.

Post-Excursion

Scientific posters: Students can use the information collected in their log book to complete the four scientific posters.
Data collection: Students can be asked to analyse the elephant behaviour data they collected in various ways. For example:

- Grouping behaviours into different categories, such as social, independent, feeding, behaviour for homeostasis, etc.
- Collate the data collected as a class.
- Students could be given the question – why is it important to monitor the behaviour of captive elephants?

Further big questions: After investigating the big question, '*What do we need to know about an endangered species in order to save it?*' students could be challenged with the following:

- What is the importance of conserving keystone species?
- Were any of the four species you investigated during your Zoo visit a keystone species?
- There are thousands of species around the world that are under threat of extinction. With limited time and resources to help them, it is unrealistic to think they can all be saved. How do we chose which species we should try to save?

Additional Species Information

Included below is additional information on the species covered that you may choose to use to as additional support. This information will aid you in linking the Biology course to the species.
It is not essential for students to cover this content prior to their session.

Asian Elephant

Class:	Mammalia
Order:	Proboscidae
Family:	Elephantidae
Genus:	*Elphas*
Species:	*E. maximus*
Status:	Endangered
Distribution:	Found in South and Southeast Asia

The Asian Elephant was once widespread throughout Asia. However, loss of habitat and poaching has forced remaining populations into heavily forested, inaccessible regions in South and South-East Asia. Countries where the Asian Elephant may be found include Sri Lanka, Laos, Thailand, Burma, China, Malaysia, India, Indonesia (on the island of Sumatra) and Cambodia.
There may be fewer than 53,000 animals remaining throughout Asia and the wild population is decreasing.

Five pregnancies have been achieved since Melbourne Zoo established the *Cooperative Conservation Breeding Program,* upon the arrival of three young elephant cows from Thailand in November 2006. The aim of the breeding program is to create an insurance population of this endangered species.

Diet - In the wild the Asian Elephant eats leaves, flowers, fruits, shrubs, grasses and roots. Elephants are inefficient digesters, with much of what they eat passing through relatively unchanged, meaning they play an important role in seed dispersal in their habitat. An adult elephant may eat up to 170kg of food and produce up to 75kg of faeces per day.

Reproduction – Elephants typically have a 14 to 16 week oestrous cycle. Once they fall pregnant, this cycle is halted for approximately 22 months, plus another two to four years during lactation. Once their calf is completely weaned, in the wild they would typically be expected to fall pregnant again within the next year. Female elephants must become pregnant within approximately 5 years of becoming sexually mature to maintain their fertility. If a female does not fall pregnant she will continue to cycle and go through the hormone fluctuations caused by the menstrual cycle. These fluctuations typically cause uterine cysts in the long term. The cysts reduce the chance of the blastocyst implanting, which in turn means the elephants will continue cycling, in turn causing even more cysts. Typically captive elephants enter puberty early, the reason for this is unknown but suggestions include; optimal nutrition provided in captivity means elephants develop quicker, and/or the mature female members of wild herds produce hormonal cues that delay puberty in the younger members.

Thermoregulation – Elephants are a relatively large animal for a hot habitat. As well as having large ears and loose, wrinkly skin for increased surface area to dissipate heat, behaviour plays a huge role in thermoregulation. Elephants will swim, squirt water on themselves, wallow in mud, throw dirt on themselves, and move in or out of the sun or cluster together to maintain optimal body temperature.

Elephants may also be seen to insert their trunks into their mouths and withdraw water from their throats. They are able to store several litres of water in a pharyngeal pouch, a structure unique to elephants located at the base of the tongue. In the wild herds of elephants have been recorded specifically spraying this water onto their ear that was facing the wind, but not the other ear which was protected from the wind.

Helmeted Honeyeater

Class:	Aves
Order:	Passeriformes
Family:	Meliphagidae
Genus:	*Lichenostomus*
Species:	*L. melanops*
Subspecies:	*L. m. cassidix*
Status:	Critically Endangered
Distribution:	Found in Bunyip State Park and Yellingbo Nature reserve, Victoria

The Helmeted Honeyeater, *Lichenostomus melanops cassidix*, is Critically Endangered. There are currently three small semi-wild populations established in remnant streamside swamp forest to the east of Melbourne. The Helmeted Honeyeater Recovery Program focuses on increasing the number of Helmeted Honeyeaters in the wild and reducing potential threats, with the aim of establishing a stable wild population with at least ten distinct but inter-connected colonies.

Zoos Victoria has been involved in the captive breeding of Helmeted Honeyeaters since the Recovery Program began in 1989. This commitment continues today. Zoos Victoria's key roles in the recovery of the Helmeted Honeyeater are to:

- Supplement wild populations through captive breeding for reintroduction
- Maintain an insurance population in captivity

Zoos Victoria staff are also involved in the translocation and reintroduction of captive-bred birds to the wild and monitoring their survival after release.

Diet – Honeyeaters are unique to Australasia with around 170 species recorded. Nearly all have a relatively long tongue, the tip of which is shaped like a brush. Their tongue can be moved in and out of their mouth too fast for the human eye to see – upwards of 10 times per second. Despite their title honeyeaters are not totally dependent on nectar. For some, such as the Helmeted Honeyeater, nectar only forms around 25% of their diet.

Part of the Helmeted Honeyeaters diet is made up of **lerp**. Lerp is a structure of crystallized honeydew produced by larvae of psyllid bugs as a protective cover. Helmeted Honeyeaters eat both the lerp and the bug. Another species of native bird that eats lerp is the Bell Miner, which is unusual in that it consumes only the lerp, not the psyllid below. Bell Miners are highly territorial and aggressive so repel other birds, which otherwise would eat the psyllids. As a result, these bugs reach such high densities that the trees sicken and often die (Bell Miner dieback). In 1995 it was identified that Bell Miners were driving Helmeted Honeyeaters out of their last remaining territory, and possibly having a negative effect on the remaining trees there too. A Bell Miner removal program was put in place and is still running today.

Reproduction – At one year of age, Helmeted Honeyeaters are considered to be sexually mature. The breeding season runs from early August through to early February. Usually two eggs are laid per **clutch**, very occasionally three, with three or four clutches per season. The female a further two weeks by both parents and sometimes related birds, known as **cooperative breeding**. While the young will fledge after the two weeks, they will remain with their parents for several months while they learn to fend for themselves. At 40 days they are considered adults. Each pair of Helmeted Honeyeaters may repeat this process four times over the course of a breeding season.

Thermoregulation – Like most birds, Helmeted Honeyeaters have high energy requirements. Endotherms consistently have a high energy requirement when compared with ectotherms, however, some birds, such as the Helmeted Honeyeater, have high energy requirements when compared to a mammal of a comparative size. This is due to several factors. Both their metabolism is faster than that of a mammal and their behaviors tend to be more energy costly. For example, most they will perch in a branch at night, leaving themselves relatively exposed to the changing ambient temperature, while many mammals may use a burrow. They tend not to build up large fat stores as this will hinder flight. Females also have to incubate eggs outside their body, requiring additional heat.

Philippines Crocodile

Class:	Reptilia
Order:	Crocodylia
Family:	Crocodylidae
Genus:	*Crocodylus*
Species:	*C. mindorensis*
Status:	Critically Endangered
Distribution:	Found in the Philippines

Crocodiles are the largest members of the reptile family. The Crocodylia in the form we know them today have been around for 65 million years and no (classified) species of alligator or crocodile has become extinct despite extensive hunting and loss of habitat. Zoos Victoria is working with the Mabuwaya Foundation to strengthen recovery of the Philippines Crocodile in the northern Philippines.

Diet – It is fairly well known that a large part of the crocodile's secret to success as an Order is their slow metabolisms and 'cast iron' stomachs. Crocodiles are ectotherms and while they prefer to eat at least weekly, can survive up to 12 months without food. As well as being able to survive long periods without food, crocodiles are described as being 'generalist carnivores'. They prey on whatever meat they can find – from large birds and mammals to small molluscs. Their stomachs are highly acidic and can digest hard items such as horns, bones, hooves and shells.

Reproduction – Philippines Crocodile have **temperature-dependant sex determination** (TSD). This is a type of environmental sex determination in which the temperatures experienced during embryonic development determine the sex of the offspring. In TSD eggs are affected by the temperature they are incubated at during the middle one-third of embryonic development. This critical period of incubation is known as the **thermosensitive period** (TSP).

The enzyme **aromatase** is largely responsible for allowing the process of TSD. During TSP, aromatase helps to convert sex steroids, a group of hormones that influence sex development and reproduction, from male sex hormones (androgens) to female sex hormones (estrogens). Therefore, individuals with **low levels of aromatase** during TSP will develop **male characteristics** and individuals with **high levels of aromatase** develop **female characteristics**.

This process isn't understood completely, however it is known that it varies from species to species. In some species the aromatase protein itself has a different activity level at different temperatures. In other cases transcription of the aromatase gene is the temperature-sensitive part.

It is also uncertain of the evolutionary advantages of TSD – study has been difficult mainly due to the long lifespan and late maturation of most of the species that exhibit it. One theory, named the Charnov-Bull model, it states for TSD to evolve, the same environmental conditions must influence male and female reproductive success differently. For example, warmer developmental temperature causes clutches to hatch earlier in the season. Crocodiles that hatch earlier have more time to eat and grow. Young females who are larger than normal at the end of their first reproductive season may be able to lay eggs in their first year of life, increasing their reproductive potential compared to the females who are too small to. Young males that are larger than normal may still not be large enough to compete against other males, so the increased temperature of development would not alter their reproductive success.

Thermoregulation – Being reptiles, the Philippines Crocodiles are **ectothermic**, requiring individuals to utilise the external environment to regulate their internal temperature. Behavioural adaptations such as; basking on the river banks, gaping for cool down and seeking out warmer bodies of water, assist with temperature regulation. Physical adaptations include darker scales on the back to facilitate absorption of heat and fat storage in the tail.

Southern Corroboree Frog

Class: Amphibia
Order: Anura
Family: Myobatrachidae
Genus: *Pseudophryne*
Species: *P. corroboree*
Status: Critically Endangered
Distribution: Found in Mt Kosciuszko National Park

Because of its bright yellow and black stripes, the Critically Endangered Southern Corroboree Frog, *Pseudophryne corroboree*, is one of Australia's best known frog species. It is at risk of extinction in the wild because of Chytridiomycosis – a disease caused by infection with Amphibian Chytrid Fungus. Zoos Victoria has been involved with the captive breeding of the Southern Corroboree Frog since 1991.

Diet - Corroboree Frogs possess two types of toxin. They obtain **pumiliotoxins** from their diet of ants and other invertebrates, and also produce their own poisonous alkaloids, **pseudophrynamines**. Corroboree frogs were the first vertebrate to be identified to produce their own toxins and have no known predators. The frogs advertise their toxicity with their bright colouration.

Reproduction - While Corroboree Frogs have a typical amphibian life-cycle with an aquatic tadpole stage and terrestrial frog stage, the life cycle has been modified to fit the pressures of their alpine habitat.

During early to late summer, mature males call from small chambers in damp moss at the edges of a sphagnum bog, which are usually dry at this time of year. Attracted females will lay their eggs in his nest and then leave. The male stays in his nest for the breeding season and will mate with several females. The eggs found in a typical nest are often at different stages of development, indicating they were laid at different times. Clutch size for Corroboree Frogs is small compared to most other frog species, with a maximum of 38 eggs.

Within the eggs, the tadpoles develop to an advanced stage, and then enter **diapause** (suspended development). When the nest floods due to the autumn or winter rains the eggs will swell and hatch now there is enough free water for the tadpoles to swim.

Over winter they will remain in the pool, surviving in the water below the ice layer, at temperatures that are just a few degrees above freezing. Over winter adults will move away from the exposed breeding pools into the relatively sheltered forested areas, where they will **hibernate**. As the frogs are so small they can work their way into small spaces (called a **hibernaculum**) under fallen bark or within piles of fallen leaves that, while frozen on the outside, remain above freezing inside. During this time, both larvae and adults will barely grow at all. The tadpoles begin feeding and growing again in spring, then **metamorphose** in early summer. Due to the harsh conditions for a large portion of the year, metamorphs will not reach sexual maturity until four years of age

Tadpoles have a long spiral gut, typical of a herbivore, which during metamorphosis shrinks to the short gut of a predator. Contrary to popular belief, tadpoles develop their lungs prior to metamorphosis and use them as an **accessory breathing organ**. The tail has a very fragile fin and tip – tearing easily to allow the tadpole to escape the grasp of predators. The tail does not have bones throughout, instead it is stiffened by a

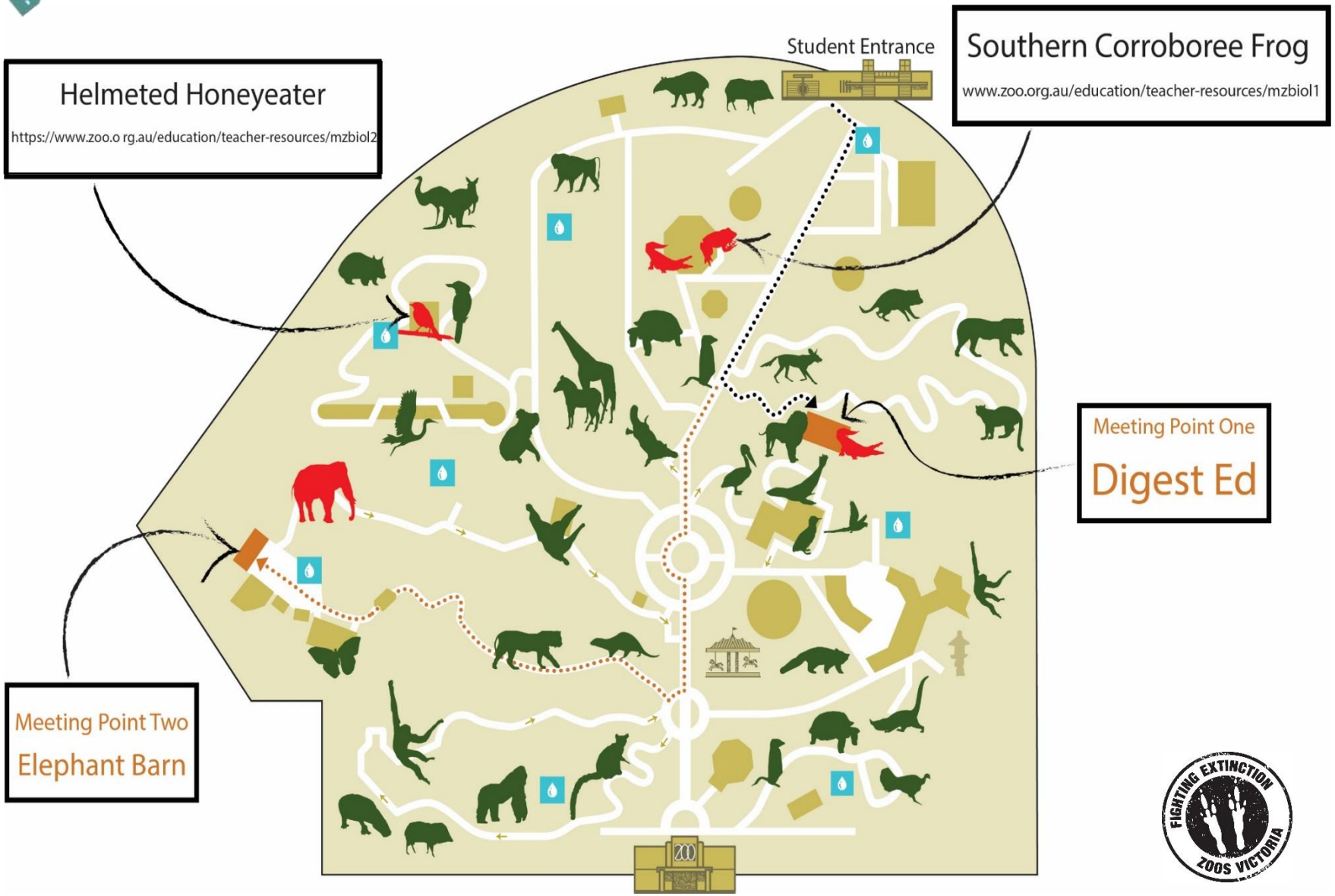
notochord and has only a few cartilaginous vertebrate at the base. It is thought that this is an adaption that allows metamorphosis to happen quickly – a tail made from soft tissue can be broken down and absorbed much faster than one made of bone and/or cartilage. Minimising this intermediate stage where a frog is losing its tail and growing its legs is an advantage as this is when the froglet is least mobile and theoretically most susceptible to predators.

Osmoregulation – Frogs have a similar excretory system to mammals, with two kidneys to remove nitrogenous waste. In the larval stage, where much free water is available, this waste is excreted as **ammonia**. Aquatic frogs also produce ammonia, while most terrestrial frogs produce **urea**. However, there are a limited number of frogs, including the Corroboree Frog, that produce **uric acid** as a response the limited amount of free water available to them.

The term Keratin refers to a family of fibrous structural proteins. Keratin is found in many animal structures, such as our hair, skin and nails, rhino horn, and horse's hooves. In the case of amphibians, frogs have keratin in their skin – it is the protein that protects epithelial (skin) cells from damage or stress. Tadpoles have no keratin except for in their mouth, they have **kerodonts** – teeth made from keratin. The reason keratin is so important is that it is this protein that is affected by the chytrid fungus that has devastated global amphibian populations.

Melbourne Zoo map

Use the map to help you explore Melbourne Zoo and find your meeting points. When students visit the **Southern Corroboree Frog** and **Helmeted Honeyeater,** they should visit the provided web pages to access additional information.


Student Entrance
Southern Corroboree Frog
www.zoo.org.au/education/teacher-resources/mzbiol1
Helmeted Honeyeater
https://www.zoo.o rg.au/education/teacher-resources/mzbiol2
Meeting Point One
Digest Ed
Meeting Point Two
Elephant Barn