Conserving PLATYPUS and Water-Rats

INFORMATION and GUIDELINES

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CONSERVING PLATYPUS AND WATER-RATS

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1.1. EVOLUTION, NAMING, DISTRIBUTION AND STATUS

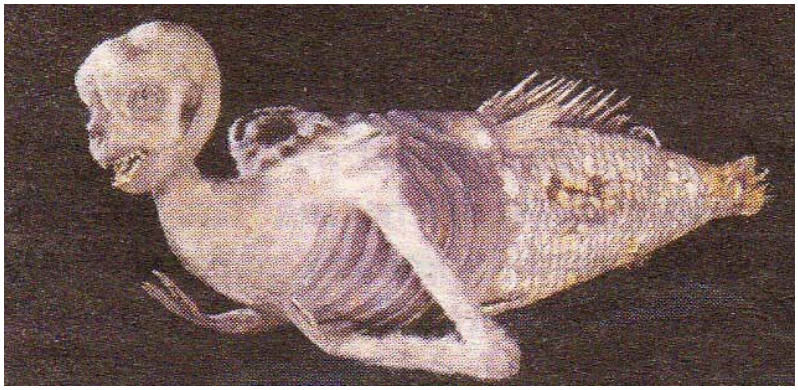
1.1.1. History of discovery and naming

According to Aboriginal Dreamtime legend, the first platypus were born after an attractive young female duck mated with a lonely and persuasive water-rat. The duck's offspring had their mother's bill and webbed feet and their father's legs and handsome brown fur.

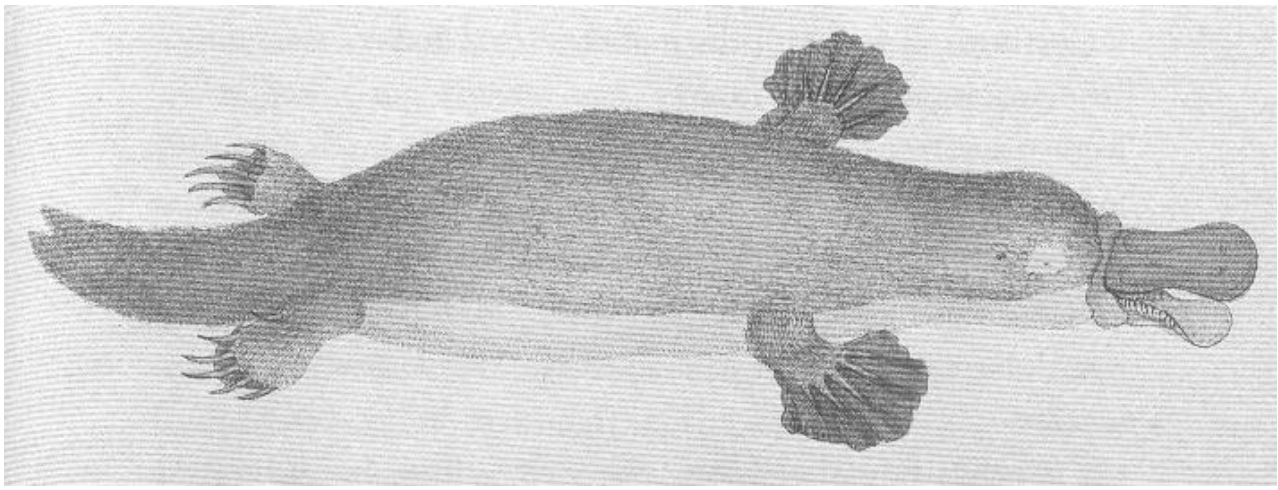
Early written records suggest that indigenous people were aware that the platypus was both egg-laying and venomous – facts that were only confirmed by European scientists after many decades of study. Traditional names for the species included "mallangong" and "tambreet" in New South Wales. Among the Wurundjeri people (who occupied much of Victoria) the name for the platypus was “dulaiwarrung”. Platypus were hunted for food in the water using long spears, but the meat appears not to have been highly prized.

After the British colony in Australia was founded in 1788, the strange appearance of the platypus soon fascinated the new arrivals. Early colonists called the platypus a "water mole" or a “duckbill”.

The platypus was first scientifically described by Dr George Shaw in Britain in 1799. His initial reaction to the first specimen was that it was an elaborate hoax. It was not uncommon at the time for exotic forgeries (such as “mermaids” made by joining the body of a monkey to that of a fish) to be brought back to Europe from far-flung parts of the world. Shaw was so convinced that the platypus specimen had been fabricated that he took a pair of scissors to the pelt, expecting to find stitches attaching the bill to the skin.



The “FeeGee Mermaid”, exhibited by P.T. Barnum – a fusion of monkey and fish parts.



The illustration made to accompany Dr Shaw’s first description of the platypus. Early illustrators had access only to dead specimens and so struggled to capture the qualities of a living platypus.

Dr Shaw named the species *Platypus anatinus*, from Greek and Latin words respectively meaning "flat-footed" and "duck-like". A German scientist named Blumenbach independently proposed a different scientific name in the following year, *Ornithorhynchus paradoxus,* with the first word meaning "bird-like snout" and the second meaning "puzzling".

It then transpired that the term *Platypus* had previously been used in 1793 to name a group of beetles. Accordingly, a different scientific name had to be formulated. This was achieved by combining the names suggested by Shaw and Blumenbach to produce *Ornithorhynchus anatinus*, which remains the official designation of the species today.

In the meantime, the abandoned scientific name "platypus" became the accepted common name for the species.

Given that the word "platypus" is derived from Greek, its plural form should (strictly speaking) be "platypodes" and definitely not platypi (which would be valid only if "platypus" were derived from Latin). However, given that "platypus" has now entered the English language as the common name for the species, the accepted plural is either "platypuses" or "platypus". (Note: for the sake of simplicity, "platypus" will be used as both singular and plural forms throughout this document.)

Cats raise kittens; lions raise cubs. In contrast, there is no well established term in the English language for a juvenile platypus. This presumably reflects fact that when a young platypus first emerges from its natal burrow it basically looks like a small adult. As juveniles are not normally seen by people at an earlier stage of development, there has never been a need to adopt a special term for a baby platypus. It has been suggested by staff working at Taronga Zoo in Sydney that "puggle" might be used. This word reputedly has had a reasonably long history of use to denote a baby echidna. However, as young platypus and echidnas look very different once they begin to grow up, the use of this term to denote a platypus is considered inappropriate by biologists who work with the species in the wild.

By the same token, there is no collective noun - equivalent to a school of fish or herd of cattle – which applies to the platypus. Platypus are fundamentally solitary in their habits, though more than one individual can sometimes be seen feeding at a given spot. Accordingly, there has never been a need to refer to these animals as a social unit.

Further reading:

Burrell, H. (1927). The Platypus. (Angus and Robertson: Sydney, reprinted in 1974 by Rigby: Adelaide).

Moyal, A. (2001). Platypus - The Extraordinary Story of How a Curious Creature Baffled the World. (Allen & Unwin: Crows Nest, NSW).

1.1.2. Related species and evolution

Just five modern species of monotreme (or egg-laying mammal) have been described:

- platypus (*Ornithorhynchus anatinus*)
- short-beaked echidna (*Tachyglossus aculeatus*) (**illustrated at right**)
- three species of long-beaked echidna (*Zaglossus bruijni*, *Z. bartoni* and *Z. attenboroughi*)

The platypus lives in Australia, long-beaked echidnas are found in New Guinea, and short-beaked echidnas occur in both Australia and New Guinea.

Based mainly on fossil remains found at Lightning Ridge (in New South Wales) and Dinosaur Cove and Flat Rocks (in Victoria), monotremes appear to have been a fairly diverse and important component of the Australian mammal fauna in the early Cretaceous period (roughly 110 million years ago). Living alongside these early monotremes were dinosaurs, turtles, lungfish and the now extinct ausktribosphenid mammals. These fossils date from a time when Australia was located far south of its current position and was joined to Antarctica as part of eastern Gondwana.

The only monotreme fossils found to date outside Australia belong to *Monotrematum suderamericanum*, described from teeth found in Patagonia (southern Argentina) that have been dated to about 62 million years ago. It is presumed that this discovery reflects the fact that monotremes dispersed to other parts of Gondwana after evolving in Australia.

The earliest known monotreme which unequivocally resembled what we think of as a platypus (based on finding a nearly complete, platypus-like bill) has been named *Obdurodon dicksoni* and dates from approximately 15-20 million years ago. *O. dicksoni* was a bit bigger than the modern platypus and had a larger bill and more powerful jaw muscles relative to the size of its head. In contrast to the current living form, adults also appear to have retained true teeth in the form of relatively thin-enamelled, six-rooted molars. The earliest known remains of the living species have been dated to around 100,000 years ago.

Investigating the evolutionary relationship between echidnas and the platypus has been hampered by the fact that the earliest known echidna fossils are only about 13 million years old. Based on patterns of genetic divergence, it has been hypothesized that the two groups began evolving independently as recently as 19-48 million years ago. Ironically, one of the most “primitive” physical features of monotremes – the typically reptilian design of the bones in the shoulder region – may explain why both the platypus and echidnas have survived so well. Although their limbs extend out from the body in a nearly horizontal plane and are primarily limited to rotational movements, the structure of their shoulder girdle also provides exceptional strength and ability when swimming (platypus) or digging (echidnas).

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Musser, A.M. (1998). Evolution, biogeography and palaeoecology of the Ornithorhynchidae. Australian Mammalogy 20: 147-162.

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1.1.3. Distribution and status

Platypus live only in Australia, inhabiting a wide range of flowing and still freshwater bodies from sea level up to an elevation of more than 1600 metres near the top of the Great Dividing Range. The species resides along the eastern and southeastern coast of mainland Australia from the Glenelg River catchment in western Victoria to about as far north as Cooktown in Queensland. In broad terms, populations still occur in about 80% of the river basins in Victoria, all of the east-flowing river systems and about 80% of the west-flowing systems in New South Wales, and around a third of reliably flowing river basins in Queensland. Predation by salt water crocodiles (*Crocodylus porosus*) and the severe flooding that often occurs along Australian tropical rivers in the wet season may both potentially contribute to the platypus's northern distributional limit.

Platypus distribution (shaded area)

Platypus are widely distributed in Tasmania, occupying lakes, ponds and glacial tarns as well as rivers and streams. The species also occurs in the rivers of King Island, which has been isolated from Victoria and Tasmania by the waters of Bass Strait for 10,000 or more years.

Only a few platypus specimens were ever collected in South Australia. Most originated along the Murray River (to as far downstream as Lake Alexandrina), although some were obtained along the Torrens and Onkaparinga Rivers before 1900. It is generally accepted that platypus no longer occur in the wild on the South Australian mainland, although vagrants moving downstream along the Murray River may occasionally enter the state. An introduced population is found near the South Australian mainland on Kangaroo Island, where animals were released in Flinders Chase National Park between 1928 and 1946. The absence of platypus populations to the north and west of South Australia undoubtedly reflects the rarity of reliable surface water in these areas.

The IUCN lists the conservation status of the platypus as of "least concern" and the Australian commonwealth and relevant state governments do not consider the species to be threatened (apart from South Australia, where it is listed as endangered). Nonetheless, there is ample evidence that platypus populations have declined precipitously in many parts of their range.

For example, a reasonable (though conservative) estimate for the number of platypus occupying the Wimmera River basin in western Victoria at the time of European settlement would have been in the order of 1500 animals. Mark-recapture studies carried out by the Australian Platypus Conservancy confirmed that this had declined to less than 200 animals by the 1990s, with animals mainly found in the Wimmera River upstream of Glenorchy and the Mackenzie River downstream of Lake Wartook. Habitat degradation, channel sedimentation, use of drum nets that drowned platypus as by-catch, and regulation of natural flows by the Wimmera Mallee Stock and Domestic System (which by the 1980s exported about half of the annual flow of the upper catchment to storage reservoirs) would all have contributed to reduced population size.

Further catastrophic losses occurred in the summer of 2006/2007, when exceptionally dry weather resulted in at least 95% of the Wimmera River channel upstream of Glenorchy drying out for an extended period of time. Along the Mackenzie River, a few animals presumably survived this drought in habitats maintained by a small environmental flow from Lake Wartook, but population size would have been strictly limited by the small amount of stream channel (c. 12 kilometres) available.

Similarly, platypus have not to the best of our knowledge been seen at any location in the neighbouring Avoca River basin since 2003. In the Bass River catchment in West Gippsland (where platypus appear to have been widespread until at least the 1980s), the most recent reliable sighting also dates from 2003.

Factors contributing to the platypus's vulnerability to predicted longer-term patterns of climate change include the animals' complete dependence on adequate surface water for survival, their characteristically low population density and low reproductive rate, and the fact that female platypus are likely to be out-competed for food by larger (and more aggressive) males and therefore suffer disproportionately high mortality rates when surface water is severely limited.

Further reading:

Grant, T.R. (1998). The historical and current distribution of the platypus, Ornithorhynchus anatinus, in Australia. Pp. 232-254 in Platypus and Echidnas (edited by M.L. Augee). The Royal Zoological Society of NSW, Sydney.

1.1.4. Captive maintenance and breeding at zoos

Platypus are currently maintained at a number of zoos or aquaria, but are not (as of 2010) on public display anywhere outside Australia.

Platypus appear to have been first displayed to the Australian public in 1910 by Harry Burrell at the Sydney Zoological Garden, which was then located at Moore Park. One animal was successfully maintained in a system of tanks and tunnels for three months, eating a mixed diet of freshwater shrimps, earthworms, beetle grubs and pond snails. The animal was eventually released into a pond at another urban park, when the approaching winter created difficulties in providing it with an adequate supply of food.

Contemporary protocols governing the husbandry of captive platypus are fundamentally similar to those adopted by Burrell. Animals occupy facilities which provide feeding tanks or pools linked to nest boxes by narrower tunnels. They are fed live invertebrate food, mainly comprising freshwater crayfish or yabbies (*Cherax sp.*), fly pupae, mealworms and earthworms. Tubifex worms, fly maggots and crickets may also be provided. Uneaten food is removed from tanks each day, and feeding tanks are emptied and scrubbed regularly. The cost of purchasing substantial quantities of crayfish, along with the large amount of staff time devoted to keeping tanks and their surrounds clean, means that platypus are one of the most expensive native mammals to be kept in Australian zoos.

Platypus were bred in captivity for the first time by David Fleay at Healesville Sanctuary in Victoria. The mother (named Jill) was originally brought to the Sanctuary in 1938, after being rescued by two men who found her trudging along a road. The father (named Jack) was captured by Fleay as a young juvenile in 1939, after being spotted swimming in a local creek. The pair was recorded mating for the first time in October 1943 and produced a juvenile female (christened Corrie) who was successfully raised to adulthood. Platypus did not reproduce in captivity again until the summer of 1998/1999, when two juvenile males hatched at Healesville Sanctuary, with one surviving to maturity. Since that time, platypus have also been bred successfully at Taronga Zoo in Sydney. Second generation breeding (i.e. by a pair of animals who had themselves been zoo-bred) occurred for the first time at Healesville Sanctuary in 2008/2009.

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Fleay, D. 1944. We Breed the Platypus. Robertson and Mullens, Melbourne.

Krueger, B., Hunter, S. and Serena, M. (1992). Husbandry, diet and behaviour of Platypus Ornithorhynchus anatinus at Healesville Sanctuary. International Zoo Yearbook 31: 64-71.

1.2. APPEARANCE AND PHYSICAL ADAPTATIONS

1.2.1. Size and appearance

Like many other animals, platypus living at the warm end of their range in Queensland are generally somewhat smaller than those found at the cold end of their range in Victoria and Tasmania. The largest platypus recorded to date (in Tasmania) was a male weighing 3.0 kilograms and measuring 0.6 metres in length. On the mainland, adult males typically weigh 1.2-2.4 kilograms and are on average 0.5 metres long, whereas adult females typically weigh 0.7-1.6 kilograms and are on average 0.4 metres long.

The platypus's general appearance is quite distinctive, combining a streamlined, furry body with a broad, paddle-shaped tail, four short legs, and a superficially ducklike bill. To help reduce drag in the water, the male's testes and penis are normally held within the body. A platypus also lacks ear flaps (or pinnae): the ear and eye are both located in a muscular groove placed at the side of the head, which automatically pinches shut when an animal dives to protect the eye and ear underwater.

The platypus bill is supported by a framework of bone (left).

Note the corrugations along the inside edge of the bill (right) which presumably help a platypus to strain out water before swallowing food.

The platypus's body is covered by dense fur apart from its bill, feet and tail. The bill is covered by smooth skin with a soft, suede-like texture and (unlike a duck's bill) is quite pliable and fleshy around the edges. The upper surface of the tail is covered by coarse hairs which can stand up to the wear and tear involved in using the tail to help push aside and tamp down soil when a platypus digs or remodels a burrow (see 1.3.5, *Burrows*). In contrast, the tail's lower surface is covered by short, fine hairs which are replaced each year when an animal moults but then wear away as the tail is dragged over stones and gravel, leaving the tail mostly bald below.

Across their entire range, platypus are dark brown above (except for a small patch of light-coloured fur located next to each eye) and creamy white below (sometimes tinged rusty-red). When the platypus's eyes are closed underwater, the light-coloured patches give the appearance of eyes remaining open, presumably fooling predators into being less likely to attack.

The upper surface of the bill is uniformly dark grey, with two nostrils located near the tip. The bill's lower surface can either be uniformly pigmented (**below left**) or quite mottled (**below right**).

The platypus's front foot is furnished with a broad expanse of skin which extends past the front claws to form a large and efficient paddle (**below left**). The webbing folds under the foot when out of the water, making it easier for a platypus to walk and use the sturdy front claws to dig burrows. The hind feet are used to help change direction and maintain balance in the water. In addition, they are equipped with sharp, curved claws used to groom the fur (**below right**).

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Connolly, J.H. and Obendorf, D.L. (1998). Distribution, captures and physical characteristics of the platypus (Ornithorhynchus anatinus) in Tasmania. Australian Mammalogy 20: 231-237.

Grant, T.R. and Temple-Smith, P.D. (1983). Size, seasonal weight change and growth in platypuses, Ornithorhynchus anatinus (Monotremata: Ornithorhynchidae), from rivers and lakes of New South Wales. Australian Mammalogy 6: 51-60.

1.2.2. Sensory systems

Vision. The platypus's eye is small (6 millimetres in diameter) and equipped with a round pupil. The internal structure of the eye is typically mammalian in most respects but includes some reptilian features, such as the presence of double (as opposed to single) retinal cone cells used to perceive colour. The lens resembles those found in otters and sea lions, in being fairly flat at the front and much more curved at the back. This shape reduces the eye's ability to see fine detail, but improves underwater vision.

The eyes of a platypus are located quite high on its head, making it easier for the animal to scan for predators while floating on the water surface.

Interestingly, the platypus rarely uses sight when submerged - its eyes normally close automatically as soon as it dives. One possible explanation is that the platypus's ancestors relied on underwater vision more extensively than the modern species does.

Hearing. Platypus ears resemble those of other mammals in most respects but do have a few primitive features, such as the fact that the ear region is encased in cartilage rather than bone. The platypus ear is most sensitive to sound frequencies around 4 kilohertz (exactly the same as in humans) but can hear frequencies as high as 15 kilohertz.

Smell and taste. Aquatic mammals typically don't rely much on smell to find food or detect predators, as chemical cues tend to be washed away by water. In the case of the platypus, only about half as many genes are linked to standard odour detection as compared to most land-based mammals. However, scientists have been intrigued to learn that the platypus has an exceptionally large number of genes coding for specialised smell receptors in the vomeronasal (or Jacobson's) organ – paired pouch-like structures located in the roof of the mouth. Vomeronasal organs are found in both reptiles and mammals and are mainly important in social communication – detecting odours produced by other individuals of the same species. Accordingly, these receptors are likely to be used by a platypus to track chemical signs left to mark territorial boundaries or advertise reproductive status, though it's possible they may also help the platypus find its prey underwater.

The platypus has two grooves at the back of the tongue which are lined with sensory papillae (tiny projections) which are believed to be used to taste food.

Bill sensory receptors. The skin of a platypus bill holds tens of thousands of specialised sensory structures providing information needed to navigate underwater and capture prey. Receptors known as "push rods" are sensitive to touch or pressure, either as an outcome of solid objects contacting the skin or water movement. Nerves are activated when the tip of a push rod receptor is displaced by as little as 20 microns (0.00002 metres), which means a platypus can detect the movements of edible invertebrates such as freshwater shrimp or crayfish at a distance of 15-20 centimetres, simply by sensing the associated movement of water.

The bill surface is also thickly dotted with acutely sensitive electroreceptors ("sensory mucous glands"), which respond to the tiny amount of electricity generated when the muscles of aquatic invertebrates contract. Because electricity moves so rapidly through water, the tail flick of a shrimp will be recorded a fraction of an instant earlier by bill electroreceptors as compared to push rods, providing a way for a platypus to judge the distance to a prey item.

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Pettigrew, J.D., Manger, P.R. and Fine, S.L.B. (1998). The sensory world of the platypus. Philosophical Transactions of the Royal Society of London, Biological Sciences 353: 199-1210.

Proske, U., Gregory, J.E. and Iggo, A. (1998). Sensory receptors in monotremes. Philosophical Transactions of the Royal Society of London, Biological Sciences 353: 1187-1198.

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1.2.3. Venom and spurs

Spurs and venom. The male platypus has a conspicuous spur (similar in size and shape to a dog's canine tooth) located on the inner hind ankles (**right**). Adult spurs are typically 12-18 millimetres long and made of keratin, the structural protein found in feathers and human fingernails. The spur is connected to a venom-secreting gland, known as the crural gland. Platypus venom is first produced when a male becomes mature, and more venom is secreted during the spring breeding season than at other times of year. Accordingly, it is believed that platypus spurs and venom have mainly evolved to help adult males compete for mates.

Platypus venom is a clear, slightly sticky fluid. It contains at least 19 different compounds which appear to have evolved quite independently from those found in snake venoms. Platypus venom is not life-threatening to humans, but can cause severe localised swelling and excruciating pain which gradually abates over a period of a few weeks. At its worst, the pain is not very effectively relieved by standard analgesics such as morphine and is only made worse by application of ice packs. However, it can be treated successfully with drugs such as bupivacaine, which act by blocking nerve transmission.

Venom leaking from the tip of an adult platypus spur.

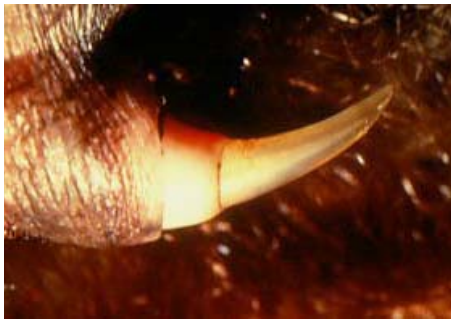
Platypus spurs are normally held in a relaxed position, folded back against the inner ankle. Particularly during the breeding season, a spurring response will be initiated if the male is touched or stroked on its abdomen in the area between the hind legs. The hind feet are rapidly rotated outwards and upwards, pulling each spur erect and locking it into position against the lower limb bones. Both spurs are then jabbed inwards with great force, impaling any object in their path from two directions.

Although platypus are not particularly aggressive animals, great care should be taken whenever picking up either an adult male or an individual of unknown age and sex. In particular, such an animal should NEVER be supported from below. Instead, grasp the animal firmly by the END half of the tail (which cannot be reached by the spurs) before lifting it up and transferring it to a cloth bag, lidded box or other secure container.

When holding a platypus by the tail, it should be easy to determine if the animal is a male (based on the presence of conspicuous spurs on the ankles).

The appearance of male spurs changes with age. In the case of young juveniles, spurs are relatively short and stubby and covered in a sheath of whitish keratin. This covering gradually wears away, exposing the true spur which continues to grow. The spurs of subadult (second year) males can normally be distinguished from older individuals by the presence of a pink collar of skin which initially extends about one-third up the length of the spur. The collar skin gradually regresses and is very much reduced by the time that males mature at the age of two years.

Examples of a juvenile male spur (left) and subadult male spur (right).



Adult females of any age are easily told apart from males because they do not possess true spurs. However, juvenile females do have a tiny pointed brown or whitish "spur" – typically 1-2 millimetres in length – on their hind ankles. This structure generally disappears within about 8-10 months of a young female's emergence from a nursery burrow, leaving behind a small pit in the skin.

Juvenile females have a tiny false spur (left, circled) which is lost by the time a female is one year old (right).

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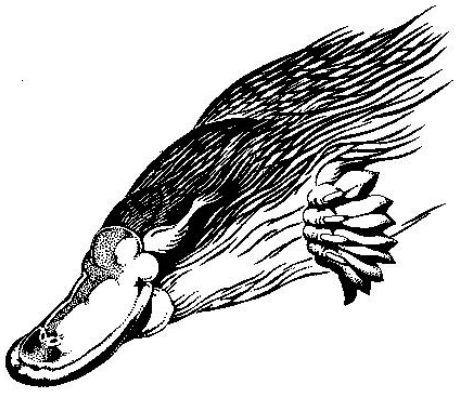
Koh, J.M.S., Bansal, P.S., Torres, A.M. and Kuchel, P.W. (2009). Platypus venom: source of novel compounds. Australian Journal of Zoology 57: 203-210.



1.2.4. Body temperature and torpor

The platypus normally maintains a body temperature close to 32°C. This is a bit lower than the body temperature of most other mammals – for example, the temperature of a healthy human is usually about 37°C. The platypus's relatively low body temperature is believed to be an adaptation to conserve energy, particularly when an animal is swimming in cold water.

To further reduce heat loss, platypus fur is made up of two layers: an extremely dense undercoat (including up to 900 individual hairs per square millimetre of skin surface) and coarser overlying guard hairs. These layers work together to trap air next to the platypus's skin when an animal enters the water, so most of the body surface actually remains dry. The combined insulation value of the fur and air layer has been estimated to be similar to a three millimetre layer of neoprene wetsuit material.

Secondly, the platypus has a special network of small intertwined veins and arteries in the pelvic region (known to scientists as a rete mirabile or literally "miraculous network"). This network serves as a countercurrent heat exchange system: cooled blood returning to the heart from the animal's legs and tail absorbs some warmth from blood being pumped from the chest, reducing the overall loss of body heat to the environment.

One disadvantage of being so well adapted to surviving cold conditions is that the platypus has a propensity to overheat: in captivity, animals become "noticeably lethargic" when the water in display tanks exceeds 29°C, and a platypus has reportedly lost consciousness after being exposed to an air temperature of 35°C for 17 minutes. Overheating is not normally a problem for platypus in the wild, as they prefer to spend their time either immersed in substantial bodies of water or resting in burrows, where average air temperatures typically do not exceed 18-20°C even in summer. However, it does mean that platypus are likely to overheat badly if they try to travel long distances across land in summer, for example to find new feeding sites during a drought.

Observations in both captivity and along a small stream in Victoria suggest that platypus may periodically enter a state of torpor in which the animals allow their body temperature to drop, remaining inactive for up to about six days. This behaviour has only been recorded in the colder months of the year (late May to early September). Interestingly, no records of inactivity have been recorded in the course of platypus radio-tracking studies undertaken in winter along two rivers in New South Wales or a sub-alpine lake in Tasmania, suggesting that low ambient temperatures are necessary but not sufficient to trigger torpid behaviour in this species.

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Grant, T.R. and Dawson, T.J. (1978). Temperature regulation in the platypus, Ornithorhynchus anatinus: maintenance of body temperature in air and water. Physiological Zoology 51: 1-6.

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Grigg, G., Beard, L., Grant, T. and Augee, M. (1992). Body temperature and diurnal activity patterns in the platypus (Ornithorhynchus anatinus) during winter. Australian Journal of Zoology 40: 135-142.

1.3. ECOLOGY, BEHAVIOUR AND GENETICS

1.3.1. Diet and foraging

Platypus feed only in the water. The animals mainly find their invertebrate prey by searching along shallow riffles, gleaning items from submerged logs and branches, digging under banks or diving repeatedly to the bottom of pools.

Platypus foraging behaviour in a pool begins with an animal doing a neat, quiet duck dive. The animal swims to the bottom of the channel and uses its bill to detect and seize prey. Rather than waste time chewing its food underwater, the platypus temporarily stores prey items in cheek pouches located at the back of the jaw. It returns to the surface when its oxygen supply runs low (usually within 30-60 seconds of the time it dived, though dives of up to 138 seconds have been recorded) and then typically spends about 10-20 seconds masticating and swallowing food before again diving. The use of dataloggers has confirmed that platypus mainly but by no means exclusively feed at night, with around 25% of animals tracked along a small Victorian stream and 40% of animals tracked in a Tasmanian lake observed to forage frequently during daylight hours.

A typical platypus "duck-dive" (left) – platypus are naturally buoyant and have to force themselves down into the water. A platypus chews its food while floating on the surface (right).

Platypus typically have a varied diet dominated by insects (especially caddis fly larvae, but also larval and adult water beetles, water bugs, and larval mayflies, damselflies, dragonflies, dobsonflies, midges, craneflies and blackflies). They also dine on freshwater shrimps, snails, "pea shell" mussels, seed-shrimps (or ostracods), water mites and worms. Burrowing crayfish have been found to be an important part of the platypus diet at Lake Lea in Tasmania, and trout eggs are known to be consumed by animals occupying the Thredbo River in New South Wales. After comparing the invertebrates found in different aquatic habitats with those identified in platypus cheek pouches, a researcher working in the Kangaroo Valley of New South Wales has concluded that platypus are particularly partial to the types of prey occupying edge habitats (defined as including pool margins and backwaters, the space below overhanging banks and among submerged vegetation and organic detritus), followed by those in pools and lastly by those associated with riffles.

The platypus's ability to prey on sizable fish or other vertebrates is restricted by its lack of true teeth. Remains of a small frog (which may have been consumed as carrion) have been found in one platypus cheek pouch sample from the Shoalhaven River in New South Wales. A young platypus is equipped with true molars located at the back of the jaw, which fall out about the time that a juvenile first enters the water and begins to eat solid prey. The teeth are replaced by rough grinding pads which grow continuously to offset natural wear.

Because the platypus is a relatively small, warm-blooded animal, it needs substantial amounts of food to serve as fuel. Studies in captivity have shown that adult males require around 15-28% of their body mass in food each day to maintain good physical condition, with more food consumed in winter and spring than at other times of year. Similarly, the average daily food intake of animals occupying a Tasmanian lake has been estimated to be 19% of body mass. Not surprisingly, the amount of food eaten by lactating females increases markedly as their offspring grow. For example, daily food consumption by a mother of twins in captivity rose to around 80% of her body mass just before the young first emerged from the nesting burrow - roughly three times her daily food consumption in the months before she mated.

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Holland, N. and Jackson, S.M. (2002). Reproductive behaviour and food consumption associated with the captive breeding of platypus (Ornithorhynchus anatinus). Journal of Zoology (London) 256: 279-288.

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1.3.2. Spatial organisation and movements

Based on radio-tracking studies, the home ranges of neighbouring female platypus occupying creeks in the Yarra River catchment near Melbourne often overlap by about half their total length. Adult males occupy areas which are not necessarily shared with other males but typically overlap the home ranges of two or more adult females. In cases where male home ranges do overlap, the males appear to try to avoid each other when active. The home ranges of adult males tracked for a few weeks in these creek habitats typically include 1-7 kilometres of channel, as compared to 1-4 kilometres for adult females. Males and females both visit roughly one-quarter to three-quarters of their total home range in most foraging periods. However, an adult male has been recorded to travel up to 10.4 kilometres (including backtracking) in a single overnight period, whereas the longest corresponding distance for an adult female is 4.0 kilometres.

Along the Goulburn River (where it presumably is much harder for an adult male to exclude other males from a given area, due to the greater width and depth of the channel), male home ranges overlap throughout the year, but less overlap is apparent during the breeding season than at other times of year. Male home ranges have been found to vary in length from 0.55-2.8 kilometres, corresponding to 2.45-15.45 hectares of foraging area. However, animals do not utilise all parts of their home range equally, with an intensively used core area typically comprising 30% of the total home range area. Including backtracking, animals were recorded to travel up to 4.1 kilometres in a given night.

Longer movements by platypus have been documented, including a radio-tagged adult male that travelled more than 15 kilometres (between two creeks in the Yarra River catchment) on at least two occasions within a period of 10 weeks. Based on mark-recapture studies, a young male is known to have moved about 40 kilometres in the Yarra system over a period of 18 months or less (from Andersons Creek to Steels Creek), and a young male travelled nearly 48 kilometres in the Wimmera River catchment over a period of 7 months or less (from the Wimmera River to Mount Cole Creek).

Due to their mobility, platypus may occasionally be seen in virtually any part of a river system where they occur. With respect to conservation management, this mobility has three important consequences:

- Suitable vacant habitats are predicted to be occupied quite promptly by platypus through natural colonisation (particularly if the new habitats are located reasonably close to areas already supporting the species).

- Stretches of river or stream which do not support a resident platypus population may still constitute important habitat for the species, by providing corridors along which breeding males and dispersing juveniles can travel.

- It is essential that manmade structures (weirs, flood fences, culverts, irrigation control gates, etc.) placed along natural water bodies or manmade channels that are accessible to platypus should be built in a manner which facilitates safe passage by the animals (see 2.1.11, *Culverts, pipes, gates and grilles* and 2.1.12, *Weir walls and drop structures*).

Further reading:

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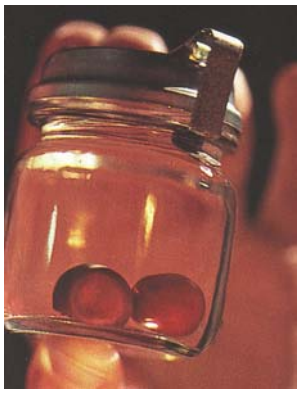
Serena, M. (1994). Use of time and space by platypus (Ornithorhynchus anatinus: Monotremata) along a Victorian stream. Journal of Zoology (London) 232: 117-131.

1.3.3. Reproduction and life history

The platypus is a monotreme, or egg-laying mammal. Males and females have a single physical opening (known as the cloaca) which is used both for reproduction and excretion.

Platypus have been observed mating in the wild in Victoria and New South Wales from early August to early November, with animals believed to breed a few weeks earlier in Queensland and a few weeks later in Tasmania. The animals do not appear to form lasting pair bonds: males probably court as many females as possible, and females rear their young without any assistance from their mates. Based on observations made in captivity, a female becomes receptive to males for a period of 4-6 days. Afterwards, she digs or renovates a nesting burrow and then spends 2-5 days collecting vegetation from the water (leaves, grass, bark strips, etc.) to line the nest. It is believed that wet nesting material is required to help keep platypus eggs and newly hatched young from drying out.

A clutch of 1-3 whitish, leathery-shelled eggs (like those of lizards and snakes) is laid approximately 2-3 weeks after mating. The eggs are incubated underground for around 10 days, clasped between a female's curled-up tail and belly as she lies on her back or side. The eggs are about 15 millimetres in diameter, and the young are correspondingly small when they hatch (about 9 millimetres in length). Their exit from the egg is assisted by a prominent bump (or caruncle) at the end of the snout, an inwardly curving egg tooth and tiny claws on the front feet.



Platypus eggs (left) are similar to those of reptiles (Photo: David Doubilet, *National Geographic*, April 2000).

Platypus milk oozes directly onto the belly from pores contained in two round patches of skin (note white patch at right).

After hatching, juveniles (there is no well-established special term for a baby platypus) develop in the nesting burrow for about 3-4 months before entering the water for the first time. Throughout this period, they are nourished only on milk. A female platypus does not have nipples. Instead, milk is secreted directly onto her belly fur from two round patches of skin. Platypus milk is thick and rich, containing on average about 39% solids (as compared to 12% solids in cow milk). The average fat content of platypus milk (22%) is about six times greater than that of cow milk, while its protein content (8%) is more than double the average value for cow milk.

The newly emerged juveniles are fully furred, well co-ordinated and about 80% of their adult length . They apparently are not taught to swim or how to feed by their mother, but have to learn by themselves through trial and error.

Males and females both become mature at the age of two years. However, some females may not produce young until they are four years old or more, with a long-term study carried out by Dr Tom Grant along the Shoalhaven River in New South Wales indicating that less than half of females breed on average in a given year (range = 18-80% over 27 years).

A juvenile soon after first emerging from its nesting burrow (left).

The juvenile mortality rate generally appears to be high, with only a small proportion of young platypus surviving to adulthood. However, it is not uncommon for adults to live for a decade or more. The oldest known platypus (a female) survived to the age of at least 21 years in the wild.

Further reading:

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Hawkins, M. and Battaglia, A. (2009). Breeding behaviour of the platypus (Ornithorhynchus anatinus) in captivity. Australian Journal of Zoology 57: 283-293.

1.3.4. Social behaviour and communication

Although the home ranges of several platypus may overlap at any given spot, individuals (including mothers and their offspring) normally forage independently of each other. Males have been observed grappling vigorously in the water during the spring breeding season, presumably in order to work out who is dominant. In places where several platypus regularly feed within sight of each other (such as some lakes), it is not unusual for one animal to swim directly towards another during the breeding season, generally starting from a distance of 30-100 metres. The second animal sometimes responds by leaving the area (with or without the first animal in hot pursuit). On other occasions, two animals will swim side by side for a short distance or feed near each other for a few minutes before again moving apart.

In captivity, platypus courtship behaviour may be initiated by females as well as males. A pair will gently nuzzle each other's bill or face one another on the surface with bills nearly touching for up to ten minutes. One animal will rub against the length of the other while gliding past, and a male will use his bill to grasp the tip of the female's tail and be towed behind her as she swims on or near the water surface, with the pair often travelling in a tight circle. Mating has only been recorded to occur in the water, for periods lasting from a few minutes up to nearly half an hour.

Platypus courtship behaviour in the wild.

When feeling threatened or annoyed, a platypus will voice its displeasure by emitting a querulous growl, similar to the sound made by a broody bantam hen disturbed on her nest. Olfactory cues may also assist communication: in the case of males, scent glands located at the base of the neck become particularly active during the breeding season, emitting a strong, musky odour. Captive males have also been observed producing a yellow, mucilaginous liquid from the cloaca after swimming to a stone or similar object. The liquid settles in a cloud over the object, presumably helping to mark the male's territory.

Further reading:

De-La-Warr, M. and Serena, M. (1999). Observations of platypus Ornithorhynchus anatinus mating behaviour. The Victorian Naturalist 116: 172-174.

Easton, L., Williams, G. and Serena, M. (2008). Monthly variation in observed activity of the platypus Ornithorhynchus anatinus. The Victorian Naturalist 125: 104-109.

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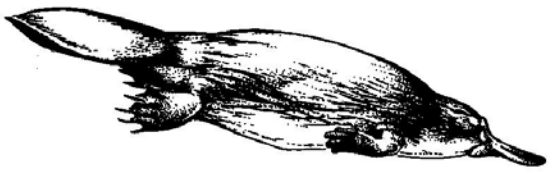

1.3.5. Burrows

Platypus resting sites most often consist of burrows located in the consolidated earthen banks of a river, creek or lake. However, the animals have also occasionally been recorded sleeping in a hollow log or within a large pile of twigs and branches emerging from the water, in a natural cave, or (in Tasmania) in a burrow constructed within dense vegetation such as sedge tussocks.

"Nesting" burrows provide shelter for a mother and her offspring for several months, from the time that eggs are laid to the time that young become independent. These burrows are typically 3-6 metres in length (measured in a straight line from the entrance to the nesting chamber), though they can be much longer. The entrance to a nesting burrow is roughly oval in cross-section and just large enough to allow an adult platypus to enter. It also tends to be elevated well above the water along a reasonably steep bank, with its height probably helping to reduce the risk of inundation after storms. Whenever she enters or exits the burrow, a mother of young juveniles blocks the entry tunnel at 2-9 points with compacted soil plugs (or "pugs"), each measuring about 30 centimetres in length. The tunnel often changes direction immediately after a pug, suggesting that its main role is to fool predators into thinking they have come to the end of the burrow.

Dense vegetation on stream banks provides excellent cover for platypus burrows (entrances marked with red arrows) (above left and centre). A burrow entrance, exposed after a drop in water level (above right).

"Camping" burrows mainly provide a safe place for an adult or subadult to sleep. They are shorter than nesting burrows, typically measuring 1-4 metres in length. Based on radio-tracking studies, some camping burrow entrances are located underwater, with the rest typically well hidden by thick vegetation or beneath a stably undercut bank or overhanging tree roots. Besides helping to camouflage burrow entrances, such sites provide a relatively secure, hidden route for a platypus to approach or leave a burrow without being seen.

An adult platypus will normally occupy several different camping burrows within a period of a few weeks, with a given burrow sometimes used by different animals at the same or different times. For example, a study carried out in Victoria found that eight radio-tagged platypus each occupied between two and eight burrows over periods of 8-58 days. One burrow was occupied by a subadult male and an adult male for four days in early January (i.e. well outside of the breeding season), and a second burrow was occupied by two grown females for five days in early February. The burrow occupied by the two males was also subsequently occupied by an adult female, more than a year after it was used by the males.

Further reading:

Grant, T.R., Grigg, G.C., Beard, L.A. and Augee, M.L. (1992). Movements and burrow use by platypuses, Ornithorhynchus anatinus, in the Thredbo River, New South Wales. Pp. 263-267 in Platypus and Echidnas (edited by M.L. Augee). The Royal Zoological Society of NSW, Sydney.

Otley, H.M., Munks, S.A. and Hindell, M.A. (2000). Activity patterns, movements and burrows of platypuses (Ornithorhynchus anatinus) in a sub-alpine Tasmanian lake. Australian Journal of Zoology 48: 701-713.

Serena, M., Thomas, J.L., Williams, G.A. and Officer, R.C.E. (1998). Use of stream and river habitats by the platypus, Ornithorhynchus anatinus, in an urban fringe environment. Australian Journal of Zoology 46: 267-282.

1.3.6. Genetics

Platypus genes are packaged in a set of 52 chromosomes, twelve of which are relatively large and the rest quite small. Like other mammals, the sex of a platypus is determined by inheriting X and Y chromosomes, with females having five pairs of X chromosomes and males having five X chromosomes and five Y chromosomes. However, much of the genetic information contained in platypus sex chromosomes appears to be different from that contained in the sex chromosomes of marsupials and placental mammals, with some evidence suggesting that a gene involved in determining the sex of birds may also be involved in determining the sex of a platypus.

The platypus genome has been estimated to include approximately 18,500 protein-coding genes, which is at the lower end of the range of estimates for the number of human genes. A map of the platypus genome was published in 2008, based on research carried out by more than 100 scientists based at 32 universities and research institutes located in nine different countries (Australia, New Zealand, United States, United Kingdom, Germany, France, Spain, Japan and Israel). It showed that most platypus genes (82%) also occur in other vertebrate animals such as mice, dogs, chickens, humans and opossums (a North American marsupial). These genes presumably are involved in basic biological functions that haven't altered for hundred of millions of years. The remaining 18% include genes that have developed since the platypus lineage began evolving independently of other modern vertebrates, along with genes that have been retained by the platypus but lost by other species over evolutionary time.

An analysis of microsatellite DNA sampled in two neighbouring river basins in New South Wales (Shoalhaven and Hawkesbury-Nepean) concluded that the two systems were not very divergent, suggesting that platypus move reasonably frequently between them. In another study, Tasmanian platypus were found to be genetically less variable than animals found on the Australian mainland, with even less variability recorded in the small and very isolated platypus population occupying King Island in Bass Strait.

Further reading:

Akiyama, S. (2000). Molecular ecology of the platypus in Tasmania. Australian Mammalogy 21: 263.

Kolomyjec, S.H., Chong, J.Y.T., Blair, D., Gongora, J., Grant, T.R., Johnson, C.N. and Moran, C. (2009). Population genetics of the platypus (Ornithorhynchus anatinus); a fine-scale look at adjacent river systems. Australian Journal of Zoology 57: 225-234.

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1.4. THREATS

1.4.1. Predators and disease

The earliest evidence that platypus were hunted and eaten by aboriginal Australians consists of bones found in caves occupied between 13,000 and 30,000 years ago.

Spotted-tailed quolls (*Dasyurus maculatus*), Tasmanian devils (*Sarcophilus harrisii*), white-breasted sea eagles (*Haliaeetus leucogaster*), wedge-tailed eagles (*Aquila audax*), grey goshawks (*Accipiter novaehollandiae*) and carpet pythons (*Morelia spilota*) have all occasionally been reported to capture and/or consume a platypus. Circumstantial evidence (the nature of injuries sustained by dead animals) suggests that domesticated or feral house cats may be responsible for some platypus mortalities. Australian water-rats (*Hydromys chrysogaster*) may also sometimes prey on platypus (particularly young juveniles), given that water-rats are known to kill reasonably large waterbirds.

The most significant platypus predators in recent decades are almost certainly wild and domesticated dogs and foxes (*Vulpes vulpes*). Dog attacks were deemed to be the commonest reason for platypus being killed in the years before foxes were introduced to Tasmania, accounting for 40% of the carcasses examined in a veterinary study in the 1990s. The Australian Platypus Conservancy has also recorded many cases of platypus being killed by dogs or foxes: an analysis of platypus mortalities in Victoria from the 1980s to 2009 indicated that nearly one-fifth of all reported deaths were due to predation, with most of these incidents (21/24) attributable to dogs or foxes, and the rest (3/24) to birds of prey.

This juvenile female was found next to a creek in Melbourne's southeastern suburbs – its crushed skull and the presence of puncture marks from sizable canine teeth indicated that it had been killed by a dog or fox.

While many micro-organisms and parasites have been detected in platypus tissue, few are known to be responsible for causing disease. In 1982, people began noticing that platypus in parts of Tasmania were starting to develop skin ulcers which resulted in some animals dying. The causative agent was eventually identified as a fungus, *Mucor amphibiorum*, which is known to infect frogs and also has been found to occur naturally in Queensland soil samples. It has therefore been suggested that the fungus may have been introduced to Tasmania via infected frogs carried in shipments of tropical produce, such as bananas. Fortunately, mucormycosis appears to becoming less of a problem over time: the incidence of infection in Tasmanian platypus declined by a factor of four from the 1990s to 2008-2009, suggesting that either animals are becoming more resistant and/or that the fungus is becoming less virulent. Interestingly, this disease has never been reported to affect platypus anywhere on the Australian mainland.

The platypus has its own species of tick (known to scientists as *Ixodes ornithorhynchi*) which does not occur on any other animal (**illustrated at right**). The ticks are mainly found around the platypus's lower hind legs (i.e. the part of the platypus's body which is most difficult to groom with the claws of the back feet) and do not cause their host any obvious physical harm.

Further reading:

Connolly, J.H., Obendorf, D.L., Whittington, R.J. and Muir, D.B. (1998). Causes of morbidity and mortality in platypus (Ornithorhynchus anatinus) from Tasmania, with particular reference to Mucor amphibiorum infection. Australian Mammalogy 20: 177-187.

Gust, N., Griffiths, J., Driessen, M., Philips, A., Stewart, N. and Geraghty, D. (2009). Distribution, prevalence and persistence of mucormycosis in Tasmanian platypuses. Australian Journal of Zoology 57: 245-254.

Marshall, B. (1992). Late Pleistocene human exploitation of the platypus in southern Tasmania. Pp. 268-276 in Platypus and Echidnas. (edited by M.L. Augee). The Royal Zoological Society of NSW, Sydney.

Serena, M. and Williams, G. (in press). Factors contributing to platypus mortality in Victoria. The Victorian Naturalist.

1.4.2. Effects of flooding

In theory, depending on their magnitude and duration, floods could have either a positive or negative impact on platypus populations. The effect of minor flooding is likely to be relatively benign and could even improve the quality of platypus habitat, for example by flushing accumulated silt from pools.

By comparison, severe flooding is much more likely to affect platypus populations adversely. The animals may drown, contract pneumonia after inhaling water, or be swept downstream and have to find their way back through unfamiliar terrain. Their burrows may also be inundated for a substantial period of time and food supplies badly depleted due to invertebrates being washed away.

Anecdotal evidence suggests that platypus can sometimes drown as a result of flooding.

Flooding can also degrade the quality of platypus habitat if it causes banks to erode, pools to become filled with sediment, or in-stream woody habitat (logs and branches) to be deposited on land as flood waters recede.

The longer-term impacts of flooding, such as bank erosion and deposition of sediment in the channel, can degrade the quality of platypus habitat.

A study conducted by the Australian Platypus Conservancy in mid-2008 examined how platypus populations in four Gippsland rivers were faring approximately 9-11 months after substantial floods occurred. In each case, flooding peaked at an estimated flow rate of more than 10,000 megalitres/day. In brief, the severity of flood-related habitat damage was inversely related to platypus population density and reproductive success: the river suffering the greatest damage had the lowest numbers of platypus and the smallest proportion of juveniles (none), whereas the least damaged area had the highest density of platypus and the largest proportion of juveniles. It was concluded that flood-related impacts can have a measurable adverse effect on platypus populations, particularly when (as was true in this study) the vegetation on adjoining slopes has recently been damaged by wildfire.

The fact that juvenile platypus are weaker and less accomplished swimmers than older animals suggests that they may be more likely to be killed by floods, particularly if these occur around the time that juveniles first emerge from the nesting burrow in summer. This is supported by the results of live-trapping surveys carried out in the Melbourne area after more than 120 millimetres of rain fell on the city in less than 24 hours in early February 2005 (the highest one-day total since weather records were first kept in 1855). The mean juvenile capture rate from February to June 2005 was less than 10% of the corresponding mean capture rate from 2001-2004. In contrast, the capture rate for adults and subadults occupying the same five water bodies from February to June 2005 was actually slightly higher than the corresponding mean capture rate from 2001-2004.

Further reading:

Serena, M. and Williams, G.A. (2008). The status of platypus in flood- and fire-affected catchments in Gippsland, 2008. Report to Department of Sustainability and Environment and Parks Victoria. (Australian Platypus Conservancy, Wiseleigh).

1.4.3. Effects of fire and drought

Platypus mainly shelter underground in burrows which should provide good protection from the flames, smoke and radiant heat generated by bushfires. In accordance with these facts, a study carried out by the Australian Platypus Conservancy along four Gippsland rivers in 2008 to examine the effect of wildfires and floods in the previous year on platypus populations concluded that no relationship was apparent between the amount of fire damage sustained by trees growing on the banks and platypus density and reproductive success. However, the water bodies included in this study were all reasonably large (typically 6-8 metres wide) and reliably flowing systems which would have helped buffer their aquatic ecosystems against direct fire impacts.

In contrast, anecdotal information provided by landholders living along Cardinia Creek – a small (typically 2 metres wide) stream which flows directly into Western Port in Victoria – indicates that platypus became locally extinct following the intense “Ash Wednesday” bushfire of 1983. In this case, the heat of the fire (in combination with drought) apparently resulted in parts of the channel drying out for some time, which would have made it highly problematic for platypus to find food and also increased their vulnerability to terrestrial predators. Given that the small size of Cardinia Creek would also have limited the number of platypus residing there, these circumstances could plausibly have resulted in the post-fire population declining to an unsustainable level.

An APC team engaged in post-fire monitoring. The impact of bushfires on platypus populations is likely to be related both to the size of the waterway and intensity of the fire.

Although a platypus requires adequate surface water in which to feed, there is no reason why these animals cannot survive periods of drought in isolated pools, as long as the pools are large enough to provide a reliable food supply in the form of aquatic invertebrates. As a pool and its food resources shrink, platypus presumably must weigh up the risk of starving versus that of being killed by a predator if they choose to go looking for better feeding opportunities elsewhere. Female platypus are likely to suffer disproportionately when competing with adult males for a dwindling food supply, given that males are generally both larger and equipped with venomous spurs.

Unfortunately, the amount of run-off reaching rivers after rainfall has dramatically declined in many systems due to construction of livestock dams on gullies as well as major headwater impoundments. At the same time, the availability of substantial natural pools has often been vastly reduced due to loss of riparian trees (and the large woody debris they generate), de-snagging, channelisation and/or increased rates of erosion in both the channel and its catchment area. The capacity of platypus populations to cope with natural and anthropogenic drought has diminished accordingly.

Given the trend of increasing competition for freshwater resources in temperate Australia, the occurrence of platypus in many areas will depend on sympathetic and informed management which ensures that enough reliable surface water is available to enable animals to survive and breed.

A drought-affected river in central Victoria in the summer of 2004.
Prolonged dry weather can have a devastating impact on platypus populations.

Further reading:

Grant, T.R. and Bishop, K.A. (1998). Instream flow requirements for the platypus (Ornithorhynchus anatinus): a review. Australian Mammalogy 20: 267-280.

1.4.4. Effects of on-stream dams and weirs

Dams and weirs may affect the size and survival of platypus populations in a number of different ways.

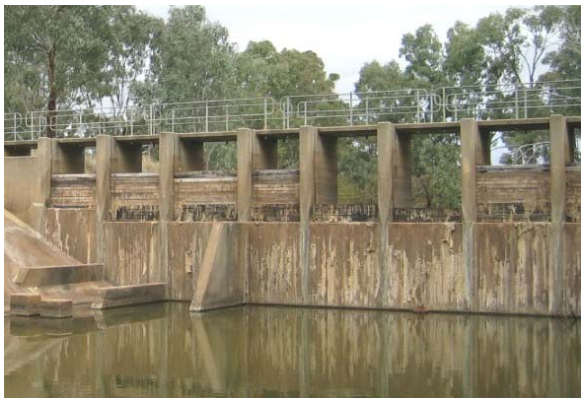
Firstly, platypus prefer to feed in relatively shallow water (ideally 1-3 metres deep), so most of the area within the deep water storages impounded by large dams will typically not be suitable for their use.

Secondly, large dams may support very different invertebrate communities as compared to the river habitats they replace, resulting in changes to the platypus diet. For example, animals captured in Bendora Dam (in the Australian Capital Territory) and Lake Jindabyne (in New South Wales) have been found to consume a much higher proportion of molluscs (snail, clams and/or mussels) than platypus captured in New South Wales rivers. However, it remains unknown how these dietary differences may be reflected in population density or reproductive success.

Most of the water in large reservoirs is generally too deep for platypus to use effectively for foraging purposes.

In contrast to deep impoundments, the shallower pools formed behind smaller on-stream weirs often are excellent foraging sites for platypus, and particularly in the case of relatively degraded streams may provide critical habitat for breeding and surviving drought.

Thirdly, although platypus are surprisingly good at scrambling up steep banks, they are generally unable to negotiate vertical (or nearly vertical) concrete structures. Accordingly, many dams and weir walls (or steeply pitched outlet structures) are unlikely to be passable to animals engaged either in routine foraging or longer range movements, such as those undertaken by breeding males or dispersing juveniles. Platypus may elect to leave the water to bypass such obstacles, but this will increase their exposure to predators and other dangers. The actual amount of risk presumably will reflect how far they have to travel across land, how much protective cover exists en route, and whether or not they need to cross a road to reach water again.



Vertical concrete or metal structures can be a significant barrier to platypus movement.

Fourthly, it has been suggested that platypus foraging efficiency in Victoria could be affected by the unnatural seasonal pattern of irrigation flows from dams, whereby water is typically retained in the dams through winter (when rainfall is usually highest) and released downstream in summer. For example, high flows might require platypus to forage over larger areas or for longer periods of time to meet the increased energy cost of feeding in deeper, colder, faster water. In practice, a study carried out along the Goulburn River in Victoria failed to find any measurable difference in how far adult males moved or how long they foraged in summer/early autumn (when flows were relatively high) as compared to late autumn/winter (when flows were relatively low). However, all radio-tagged animals spent time feeding in a backwater during the high flow period (with two of three animals concentrating their activity there), whereas only two of six animals visited the backwater during the low flow period. The researchers concluded that platypus may prefer to avoid foraging in strong currents if habitats with slower moving or still water are available.

Lastly, development of dams and weirs may adversely affect the platypus populations living downstream if less water is available to maintain pools (and connectivity between pools) than was historically the case. Unfortunately, the species is most likely to rely on sympathetic management of shared water resources at precisely those times when water is most critically limited by prolonged droughts.

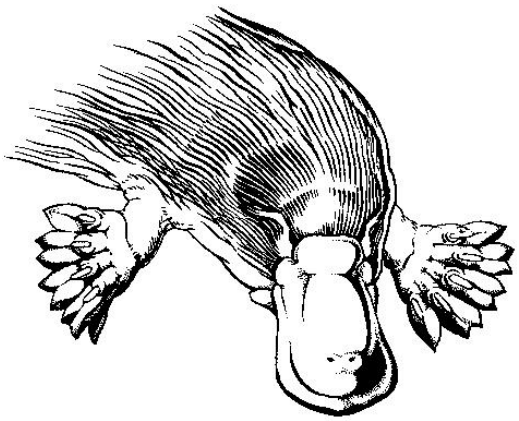
Flows downstream of impoundments can be unreliable, creating major problems for platypus survival.

One of the most characteristic outcomes of maintaining highly regulated flow regimes downstream of large dams is that – in the absence of occasional flushing flows – natural pools tend to fill with sediment. This in turn reduces the resilience of associated aquatic ecosystems when challenged by drought. Accordingly, in the absence of management which ensures either that a reliable environmental flow or adequate platypus refuge areas are maintained in highly regulated systems, platypus populations are predicted at best to contract and at worst to become extinct.

Further reading:

Grant, T.R. (1982). Food of the platypus, Ornithorhynchus anatinus (Monotremata: Ornithorhynchidae), from various water bodies in New South Wales. Australian Mammalogy 5: 235-236.

Gust, N. and Handasyde, K. (1995). Seasonal variation in the ranging behaviour of the platypus (Ornithorhynchus anatinus) on the Goulburn River, Victoria. Australian Journal of Zoology 43: 193-208.



1.4.5. Human activities contributing directly to platypus mortality

Platypus are completely protected by law across Australia. Nevertheless, more than 80% of all platypus mortalities reported to the Australian Platypus Conservancy from 1989 to 2009 where the cause of death could be reliably assigned were directly related to human activities.

The single biggest problem, accounting for more than half of platypus deaths, was animals being drowned in nets or traps set illegally to capture fish or crustaceans (yabbies or crayfish). Many of these incidents involved several animals being killed at one time. For example, at least eight platypus are known to have died in a pair of rectangular gill nets set overnight in a large reservoir located in north-central Victoria in the mid-1990s. More recently, APC staff confirmed that the remains of 17 platypus were contained in a single unlicensed fyke net that had been set and then abandoned along a small stream, and up to three animals have drowned overnight in one opera house trap. Although platypus are in theory protected across much of their range by laws restricting the use of nets and enclosed yabby and cray traps, these laws continue to be widely flouted, sometimes by persons who aren't aware that regulations exist and apply to them.

The remains of at least 17 platypus were found in this fyke net, abandoned along a small stream in the Otways region of Victoria (left).

A platypus found dead in an "opera house" yabby trap (right). If a breeding female drowns in late spring or summer, any dependent juveniles will also die. (Photo: Joanne Connolly).

A substantial number of platypus also died as a by-product of recreational angling, in some cases due to exhaustion after being caught on baited lines left overnight (illegally) to catch fish. Other animals were found dead with fishing line wrapped around the body or fishing hooks embedded in the bill or front foot. In some cases it appeared that the platypus died of stress or infection – for example, a loop of fishing line had gradually cut so deeply into one animal's chest that the lung cavity was exposed. Still other platypus drowned after fishing line attached to a hook became tangled in submerged branches or other objects.

This platypus was accidentally snagged by a fishing hook in its front foot (left). The attached fishing line broke (or was cut by the angler) and the trailing end eventually became tangled around a submerged tree branch, causing the platypus to drown.

Many platypus die slow and painful deaths after discarded fishing line becomes tightly looped around their neck or chest (right).

In addition, many deaths were caused by litter. Live-trapping surveys carried out by the Australian Platypus Conservancy from 1998 to 2007 found that nearly 5% of the platypus captured in suburban habitats around Melbourne carry loops of litter around their neck or chest: plastic cable-ties, six-pack holders, elastic bands, canning jar seals, knotted loops of twine, flexible engine gaskets, miscellaneous circular fittings (in one case, for a bicycle headlamp), tamper-proof rings from food containers, plastic bangle-type bracelets, elastic hair-ties, and a wide assortment of loops or rings of unknown origin. In country areas, the main problem tends to involve nylon fishing line, as described above.

Plastic rings and loops are responsible for many platypus deaths.

Because the platypus mainly feeds on bottom-dwelling insects, much of an animal's time is spent investigating the channel bed where litter tends to accumulate. A second problem is that the platypus mainly swims using two broad flaps of skin that unfurl beyond its front toes. Although the front feet are very efficient at paddling, they have virtually no ability to grasp or manipulate objects. The back feet are more dexterous, but their location means that they can't remove an object by pulling it forward if it gets tangled around the front half of the body. An item of litter that accidentally finds its way around a platypus's head therefore tends to work its way back along the body and then remain there until it breaks or the platypus dies - often due to horrific injuries that develop as constricting loops gradually cut through skin and underlying tissues.

Other examples of platypus mortalities linked to human activities include animals drowning after entering irrigation pumps or becoming stuck in a narrow space between irrigation gates, being run over by motor vehicles, and being shot.

Further reading:

Grant, T.R. (1993). The past and present freshwater fishery in New South Wales and the distribution and status of the platypus Ornithorhynchus anatinus. Australian Zoologist 29: 105-113.

Serena, M. and Williams, G.A. (1998). Rubber and plastic rubbish: a summary of the hazard posed to platypus Ornithorhynchus anatinus in suburban habitats. The Victorian Naturalist 115: 47-49.

1.4.6. Platypus habitat relationships: vegetation and catchment imperviousness

As long as adequate surface water is available, the number of platypus found in any given area is most likely to be limited by food. Factors which encourage the development of productive and abundant populations of aquatic insects and other invertebrates (the platypus's main food supply) should therefore also favour platypus populations.

Studies conducted by the Australian Platypus Conservancy along urban, rural and forested water bodies have consistently found that platypus numbers and foraging activity show a strong (statistically significant) positive relationship with the number of indigenous trees (eucalypts and wattles) growing on the banks. The same relationship holds for the amount of cover provided by shrubs and lower-growing plants overhanging the water. Similarly, a study carried out in New South Wales along the Macquarie River concluded that the amount of overhanging bank vegetation was positively linked to platypus usage.

Native trees growing on the banks are a highly positive habitat feature for platypus.

Numerous studies have confirmed that indigenous vegetation contributes to the health of Australian streams and rivers. Trees, shrubs and ground covers work together to stabilise banks, keep sediment out of the channel, contribute organic matter to the aquatic food chain, and shade the channel in summer (thereby helping to keep water well-oxygenated). These processes benefit aquatic invertebrates which in turn feed the platypus. Overhanging vegetation also helps to disguise platypus burrow entrances and provides protective cover for the animals themselves when they're active.

Platypus demonstrably can and do occur in water bodies that are lined with substantial numbers of willows or other exotic trees. Nonetheless, two studies by APC researchers have detected a negative relationship between the occurrence of willows (*Salix spp.*) and platypus foraging activity in summer and early autumn. The streams where this research took place were quite small and the willows were old and well established, so the channel under the trees was typically dominated by a nearly impenetrable mat of tough, fibrous roots – undoubtedly making it difficult for a platypus to detect and capture prey.

The occurrence of trees and other plants in a catchment assists infiltration of rain into soil, storing water which is only gradually released to streams and rivers. When vegetation is replaced by hard surfaces (such as roofs and roads), more rain ends up as surface run-off, promoting channel erosion and reducing inflow between storms. In practice, a study has found that platypus do not regularly inhabit water bodies where more than 11% of the catchment area has been converted to impervious surfaces. Similarly, researchers at the University of Melbourne have concluded that platypus populations disappear from streams or rivers characterised by more than 2.2% direct connected imperviousness (defined as the proportion of a catchment covered by impervious surfaces that are in turn directly connected to a natural water body by pipes or sealed drains).

Further reading:

Danger, A. and Walsh, C.J. (2008). Management options for conserving and restoring fauna and other ecological values of urban streams in the Melbourne Water Region. (Report to Melbourne Water). Department of Resource Management and Geography, University of Melbourne, Parkville.

Ellem, B.A., Bryant, A. and O'Connor, A. (1998). Statistical modelling of platypus (Ornithorhynchus anatinus) habitat preferences using generalised linear models. Australian Mammalogy 20: 281-285.

Serena, M., Swinnerton, M., Worley, M. and Williams, G.A. (2001). Attributes of preferred foraging habitats of platypus (Ornithorhynchus anatinus). Pp. 565-570 in Proceedings of the Third Australian Stream Management Conference (The Value of Healthy Streams). (edited by I. Rutherfurd, F. Sheldon, G. Brierley and C. Kenyon). CRC for Catchment Hydrology.

Serena, M., Worley, M., Swinnerton, M. and Williams, G.A. (2001). Effect of food availability and habitat on the distribution of platypus (Ornithorhynchus anatinus) foraging activity. Australian Journal of Zoology 49: 263-277.

1.4.7. Platypus habitat relationships: in-stream habitats and water quality

The capacity of a water body to support platypus is influenced by water quality and the quality of in-stream habitats.

Stably undercut banks. A positive relationship has been found to exist between platypus population density and the occurrence of consolidated soil banks undercut to a depth of 8 centimetres or more. Platypus foraging activity has also been positively linked to the distribution of stably undercut banks along creeks near Melbourne. These findings presumably reflect the fact that undercut banks support a wide range of aquatic organisms, many of which are consumed by platypus.

Stably undercut banks provide excellent places for platypus to feed and sites for burrows.

Channel depth. Studies carried out in Victoria, NSW and Tasmania agree that platypus prefer to concentrate their feeding activity in water that is approximately 1-3 metres deep.

Logs, branches and leaves. Research carried out by the APC has shown that platypus numbers and activity are both positively associated with the occurrence of logs, branches and finer organic materials such as bark, twigs and leaves in the channel. This presumably reflects the fact that many aquatic invertebrates rely on organic substrates to provide food, attachment sites, materials for cases or egg sacs, or shelter from strong currents. By marking sites in the water where edible invertebrates are likely to be concentrated, the presence of woody or leafy material may also help platypus to locate food more efficiently.

Piles of branches and other natural woody debris contribute to the quality of platypus in-stream habitat.

Inorganic substrates. Along the Hastings River of New South Wales, a study of platypus foraging behaviour concluded that the animals prefer sites where the channel bed is covered mainly by cobble-sized stones (as opposed to finer gravel, sand or silt). By comparison, platypus occupying a small stream in Victoria appeared to prefer feeding at sites dominated by gravel, pebbles, cobbles and larger rocks.

Water pollution. The amount of phosphate and suspended sediment in water have been found to be inversely related to the distribution of platypus around Melbourne: the more phosphate and suspended sediment that is present, the fewer platypus are captured. This plausibly reflects the effects of pollution on the platypus food supply, with substantial nutrient enrichment typically reducing populations of preferred prey species. High levels of suspended sediment can deplete populations of aquatic invertebrates by triggering them to drift downstream, and also contributes to silt being deposited in the channel (see above).

Salinity. The electroreceptors used by platypus to navigate underwater and locate prey presumably function over a limited salinity range and are predicted to perform best in fresh water. Although platypus are not known to regularly inhabit highly saline coastal environments, the animals do occur in rivers and stream where salinity sometimes reaches 10,000 to 14,000 Electrical Conductivity units (1 EC unit = 1 microsiemens/centimetre). By comparison, horses and sheep can respectively tolerate up to around 9,000 and 16,000 EC units in their drinking water without suffering a decline in condition. The salinity of ocean water is typically 51,500 EC units.

Further reading:

Grant, T. (2004). Depth and substrate selection by platypuses, Ornithorhynchus anatinus, in the lower Hastings River, New South Wales. Proceedings of the Linnean Society of New South Wales 125: 235-241.

Serena, M. and Pettigrove, V. (2005). Relationship of sediment toxicants and water quality to the distribution of platypus populations in urban streams. Journal of the North American Benthological Society 24: 679-689.

SECTION 2 – PLATYPUS CONSERVATION AND MONITORING

2.1. PLATYPUS CONSERVATION GUIDELINES FOR MANAGEMENT AGENCIES AND ENVIRONMENTAL GROUPS

2.1.1. Planning for platypus

The platypus is an important part of reliable freshwater environments in Australia and an excellent indicator of the productivity of aquatic systems. Conditions that are right for the platypus, a generalised top predator, will by definition favour many other native freshwater species. Accordingly, measures that enhance the quality of platypus habitat tend to promote biodiversity in general. The platypus is also a powerful and popular wildlife icon to harness community support on behalf of environmental action.

Catchment Management Authorities and other relevant agencies should ensure that platypus conservation requirements are routinely considered when developing catchment-wide environmental action plans or considering major changes to the flow regimes of water bodies in highly regulated systems. Likewise, local councils and regional planning bodies should take into account the species' needs when contemplating new developments or changes to zoning. Councils and managers of public land should also check that on-ground works in their areas are carried out in a manner that is sympathetic to these animals' survival.

Similarly, Landcare groups and other community-based organisations working to improve the environmental quality of streams, lakes and rivers should try to assist local platypus populations whenever possible.

Some of the key platypus-related issues that need to be taken into account by management agencies and environmental groups are discussed in the sections below.

2.1.2. Maintaining or restoring bank and channel stability

Actively eroding banks do not provide secure burrow sites for platypus, and the resulting sediment can seriously degrade the quality of platypus foraging habitat when it enters the water.

Unfortunately, many Australian waterways continue to suffer from unnaturally high rates of erosion along the banks and/or channel. This is true both in urban areas where run-off from hard surfaces like roads and roofs vastly increases the volume and speed of water flows after storms (see 2.1.3, *Managing stormwater drainage*), and in farming areas where protective vegetation has often been cleared right to the edge of the water.

In places where banks are bare and vulnerable to further erosion, a combination of management actions may be needed to halt and reverse the trend.

An eroding bank in the upper reaches of the Wimmera River in western Victoria.

What can be done to protect platypus

- Grade control structures, such as rock chutes or weirs, may be required to stabilise the stream bed. Beside working to control erosion, such structures often increase habitat diversity and thereby immediately improve conditions for fish, aquatic invertebrates and platypus.

- The vertical slope of a vulnerable bank may need to be reduced (or its toe protected with large rocks or other structures) while vegetation has a chance to become established.

- Grazing pressure by livestock along the edge of a waterway may need to be controlled to achieve sustainable levels - this may require additional fencing or the provision of formed (or off-stream) watering points.

- Grazing pressure by rabbits or other feral animals may need to be eliminated.

- Significant disturbance to creek or river banks should be followed as soon as possible by an appropriate revegetation program, ensuring that ground cover plants as well as trees are re-established. (On the other hand, lining substantial sections of the banks or channel with concrete to stop erosion should also be avoided in order not to "seal off" natural habitats from platypus and other freshwater species.)

- Take care to control soil loss from construction sites (or other patches of disturbed ground) when these are located next to natural water bodies or gullies leading to natural water bodies (see 2.1.9, *Use of heavy machinery along the banks and channel*).

2.1.3. Managing stormwater drainage

Storm run-off from roofs, roads and other hard surfaces can carry a wide range of pollutants into water courses. It also promotes bank and channel erosion, particularly when impervious surfaces drain rapidly to creeks and rivers via sealed drains or pipes, with very adverse consequences for platypus habitat quality.

What can be done to protect platypus

- Direct connected imperviousness in stream and river catchments (either those supporting a platypus population or where there is a reasonable likelihood that a population could become established if other limiting habitat factors are improved) should be limited to a value well below the critical threshold limit for platypus of 2.2% (see 1.4.6, *Platypus habitat relationships: vegetation and catchment imperviousness)*.

- Ensure that water-sensitive urban design principles are applied to new housing estates, shopping centres, industrial parks etc. to reduce the impact of associated run-off on creeks and rivers (e.g. see *www.clearwater.asn.au*). Ensure that run-off from sealed roads in suburban or country areas is designed to drain to vegetated swales as opposed to concrete drains leading to waterways.

- If you live in an area that is serviced by conventional stormwater drains, install a home water tank so rain falling on your roof can be stored and used to water the garden.

- Gross pollutant traps should be installed on stormwater drains as required to minimise the amount of litter and other materials that are harmful to platypus entering waterways (see 1.4.5, *Human activities contributing directly to platypus mortality*).

2.1.4. Weed control and revegetation

Riparian vegetation undoubtedly contributes to platypus well-being, by providing protective cover for the animals and their burrows and promoting favourable habitat conditions for their invertebrate prey (see 1.4.6, *Platypus habitat relationships: vegetation and catchment imperviousness*). In an urban context, maintaining a substantial corridor of ideally indigenous vegetation along waterways will help to screen out noise and artificial light, trap litter and other pollutants, reduce trampling and bank erosion, restrict access by foxes and unsupervised pets, and generally contribute to a more diverse and productive freshwater ecosystem.

Although some introduced plants such as willows appear to have a detrimental impact on the quality of platypus foraging habitat (particularly along smaller streams where willow roots can completely choke the channel), it is important when eradicating non-native plants to try to ensure that bank erosion does not ensue. Particularly in the case of narrow and/or shallow water bodies, platypus survival may be compromised if weed control programs result in inadequate plant cover along the banks, increasing the vulnerability of platypus to predators.

Weed removal programs should be carried out in an environmentally sensitive manner which avoids erosion and maintains as much protective cover as possible on the banks.

What can be done to protect platypus

- Urban (or other) development should never be allowed to encroach unreasonably close to the margins of streams and rivers which support platypus. The reserved strip of riparian land should normally be at least 30 metres wide (though ideally more), in order to support a self-sustaining plant community including mature specimens of the tree species originally found in the area.

- If time is required to establish riparian vegetation at the edge of a new housing estate or other area of high human activity (such as a shopping mall or recreation facility), consideration should be given to fencing the riparian area at least until trees and shrubs are well established.

- Willows should be progressively removed from stream and river banks to improve the quality of platypus habitats. To reduce the potential for erosion, areas where willows have been removed should be replanted as soon as possible with appropriate native trees and shrubs.

- In cases where a weedy plant dominates both banks for a considerable distance (e.g. 200 metres or more), consideration should be given to staging removal programs so the weed is eliminated from one bank in one year and the opposite bank in a later year.

- Herbicides used to control riparian weeds should never be allowed to enter the water, either directly or through storm run-off. Areas of bare soil developing after use of herbicide should be replanted as quickly as possible with appropriate indigenous species.

- To avoid damaging platypus burrows, weed removal activities which involve driving over or digging into banks with heavy machinery should be strictly minimised, particularly within about 10 metres of the water's edge (see 1.3.5, *Burrows*). Special care should be taken not to disrupt or cause banks to become compacted in the period when female platypus are raising their young (see 1.3.3, *Reproduction and life history*), particularly in areas where many platypus occur.

2.1.5. Providing in-stream woody habitat (logs and branches)

The presence of logs and large branches in the water is a very positive habitat feature for platypus, contributing to foraging success (see 1.4.7, *Platypus habitat relationships: in-stream habitats and water quality*) and occasionally providing them with shelter sites (see 1.3.5, *Burrows*).

Three studies have been carried out by APC staff to examine whether the amount of woody debris present in stream segments that are intensively used by platypus differs from the amount present in areas that are rarely used. In each case, the amount of woody debris was estimated by counting the number of logs and large branches projecting above the water surface during periods of normal base flow.

Large woody debris is a very positive habitat feature for platypus.

In brief, it was found that areas regularly used by radio-tagged platypus along two creeks in the Yarra River catchment respectively held an average 21 logs and large branches ($\geq$ 20 cm in diameter at the surface) per 100 metres of channel and 26 logs and large branches ($\geq$ 10 cm in diameter at the surface) per 100 metres of channel. Similarly, along the upper reaches of the Wimmera River in western Victoria, areas supporting reasonably high numbers of platypus held an average 22 logs or branches ($\geq$ 20 cm in diameter at the surface) per 100 metres of channel. In contrast, channel segments that were rarely used by platypus respectively held an average 11 logs and large branches ($\geq$ 20 cm in diameter at the surface) per 100 metres of channel (Running Creek), 12 logs and large branches ($\geq$ 10 cm in diameter at the surface) per 100 metres of channel (Little Yarra River) and 8 logs or branches ($\geq$ 20 cm in diameter at the surface) per 100 metres of channel (Wimmera River).

What can be done to protect platypus

- Logs and large branches should be retained whenever possible in streams, rivers and lakes in order to contribute to the quality of platypus habitat.

- Based on the studies described above, consideration should be given to augmenting the amount of in-stream woody habitat in the case of streams or small rivers where less than 20 logs or branches project on average above the surface in 100 metres of channel during normal base flow.

2.1.6. Maintaining adequate flow in managed river systems

Platypus are adapted to feed exclusively in an aquatic environment. In the absence of adequate surface water, platypus starve. Less extreme reductions in flow regime are likely to be mirrored in reduced reproductive success and, ultimately, reduced population size. Although platypus can survive for a time in isolated pools scattered along the length of a drying water course, mortality is likely to increase in such circumstances due to stress (particularly if animals are crowded together and food is in short supply) and increased exposure to foxes and other predators. (Also see 1.4.3, *Effects of fire and drought)*

The creeks and rivers of southeastern Australia normally carry the least amount of flow from mid-summer to early autumn, corresponding precisely to the period when juvenile platypus emerge from nesting burrows and have to learn to forage on their own. Their mothers are often in poor condition at this same time (as a by-product of recent lactation) and so are also particularly vulnerable to dying if water courses dry up in late summer.

What can be done to protect platypus

- The ideal flow regime for platypus entails plenty of surface water being available throughout the year in every year. However, if it's necessary to periodically institute a low (or no) flow regime in a managed river system, adequate surface flow should be maintained from August to June (in order to accommodate the entire platypus reproductive cycle including juvenile dispersal) at least one year in every two in areas of known platypus breeding habitat. In addition, it is essential that sufficient permanent pools are present in the system to sustain platypus populations through low or no flow periods (see 2.1.7, *Providing refuge areas during drought*).

- To help protect platypus from predators and meet their requirements while foraging, the volume of flow in platypus habitats should be sufficient to ensure that the average depth along runs and pools is at least 0.5 metres (though preferably more) if a channel is more than 5 metres wide, and at least 0.3 metres (though preferably more) if a channel is less than 5 metres wide.

2.1.7. Providing refuge areas during drought

Sizable pools have tended to disappear from many creeks and small rivers in the platypus's range in line with increased rates of catchment erosion, reduced numbers of large logs in the channel and (in the case of catchments subject to regulated flows) more constant and/or reduced surface flows as compared with historical norms. In turn, this undermines the system's resilience when challenged by natural or manmade drought, including instances where those charged with managing the system decide to reinstate a "natural" flow regime (i.e. one that is not augmented by mandated releases of water) downstream of an impoundment. In the absence of substantial deep pools to provide seasonal refuge habitat, many species (notably including the platypus) are liable to become locally extinct as water vanishes from the channel (see 1.4.3, *Effects of fire and drought)*.

Pools which persist during droughts can provide essential refuge areas for platypus.

What can be done to protect platypus

- Management agencies should always consider the role of sizable pool habitats in maintaining the viability of local platypus populations before eliminating them (for example, to remove a redundant weir). Particularly in the case of relatively small creeks, such pools are likely to provide essential habitat for breeding and foraging which in turn plays a key role in maintaining a locally viable platypus population. If such a pool definitely needs to be decommissioned, strong consideration should be given to developing a pool or backwater of at least comparable size and permanence elsewhere along the creek.

- Research is needed to identify the most practical and cost-effective techniques for restoring (or creating) sizable pools and billabongs in areas where they occurred historically but are now in short supply. There is also an urgent need to identify the most effective protocols for allocating environmental flows to maintain reliable pool habitats in regulated systems.

- Given the large amount of food typically consumed by a platypus (see 1.3.1, *Diet and foraging*) and the correspondingly large size of platypus home ranges (see 1.3.2, *Spatial organisation and movements*), we recommend that a useful platypus drought refuge should ideally measure at least 80 metres in length and comprise 500 square metres of surface area (through ideally more). Alternatively, a more practical option in some circumstances may be to create smaller pools that collectively comprise at least 500 square metres of pool habitat in a chain of ponds.

- To provide protection from predators and ensure that the water remains reasonably cool (to maintain appropriate conditions for a range of aquatic invertebrates), pools should ideally retain water at a minimum depth of 1-4 metres.

- To provide habitat for platypus burrows, some of the pool's perimeter should ideally be bounded by a reasonably steep and well-consolidated earthen bank rising at least 1 metre above the water.

- Overhanging vegetation should be encouraged to grow around the pool to improve habitat quality and help provide cover from predators. For the same reasons, shrubby vegetation should be encouraged to develop between neighbouring pools in a chain of ponds.

2.1.8. Designing platypus-friendly lakes and ponds

Platypus will demonstrably make use of a wide range of manmade off-stream water bodies, including dams developed for irrigation or stock and domestic usage, flood retarding basins, siltation or filtration ponds, and ornamental lakes associated with residential, recreational and industrial developments. Accordingly, development or refurbishment of such water bodies can provide excellent opportunities to create additional platypus habitat. In broad terms, the animals are most likely to find and regularly use an off-stream dam, lake or wetland if the following conditions apply:

- The manmade water body is located relatively close to a creek or river known to be occupied by platypus (in general terms, within 100 metres or ideally less) and is sometimes (ideally always) linked to the creek or river via surface water.

- The manmade water body supports substantial populations of edible aquatic invertebrates, particularly aquatic insects. In practice, this will rely on livestock being excluded from the banks and herbicides and pesticides and other agricultural chemicals not being deployed in the immediate vicinity.

What can be done to protect platypus

- To provide protection from predators and ensure that the water remains reasonably cool (to maintain appropriate conditions for a range of aquatic invertebrates), pools should ideally retain water at a minimum depth of 1-4 metres. To help protect platypus from foxes and other predators, the perimeter of the pool should slope steeply downward unless dense emergent aquatic vegetation (such as reeds) is to be established around the edge.

- To provide habitat for platypus burrows, some of the pool's perimeter should ideally be bounded by a reasonably steep and well-consolidated earthen bank rising at least 1 metre above the water.

- Overhanging shrubby vegetation should be encouraged to grow on the bank surrounding the pool to improve habitat quality and provide additional cover from predators. For the same reasons, shrubby vegetation should be encouraged to develop along the route taken by surface water overflowing from the manmade lake or pond to a nearby stream or river (including seasonally dry ditches or channels).

- Adding some items of large woody debris to an artificial water body (in the form of logs or large branches) is predicted to improve habitat diversity both for platypus and their prey and is therefore encouraged.

- For advice regarding the development of pedestrian paths, viewing platforms or lighting, see 2.1.10, *Walking tracks, viewing platforms, bridges and street lighting*. For information relating to the design of culverts and pipes or the development of weir walls and related structures see 2.1.11, *Culverts, pipes, gates and grilles* and 2.1.12, *Weir walls and drop structures*.

2.1.9. Use of heavy machinery along the banks and channel

Based on radio-tracking studies which investigated how platypus respond when heavy equipment such as excavators and tip trucks are used to reconfigure the banks and channel of streams, platypus normally continue to inhabit the area while works are in progress. However, severe and extensive channel disturbance can displace the animals temporarily, presumably due to reduced availability of food. Special consideration also needs to be given to the requirements of females with dependent young in the months when juveniles are confined to the nesting burrow (extending roughly from September to February in Victoria and New South Wales – see 1.3.3, *Reproduction and life history*). Mothers cannot move their young from one burrow to another in this period and so are effectively tied to the area. It follows that reducing the local food supply through major habitat disruption may compromise their survival as well as that of their offspring. By the same token, digging or substantially compacting the banks at the site of a nesting burrow is likely to be fatal to the entire family.

What can be done to protect platypus

- If a water body is known to support a breeding platypus population, capital works programs which involve reconfiguring the banks or channel should ideally be scheduled outside the period when dependent juveniles are present in burrows (see above).

- To reduce damage to platypus burrows, activities which involve excavating or driving over banks with heavy machinery should be minimised at all times of year, particularly on those parts of the bank located within roughly 10 metres of the water's edge (see 1.3.5, *Burrows*).

- To avoid disturbing platypus when the animals are active, work activities should only be scheduled during daylight hours.

- Great care should be taken to keep loose soil from moving from the banks to the channel while works are underway, and areas of bare or disturbed soil should be replanted as soon as possible with trees and understorey plants once works are completed (see 1.4.6, *Platypus habitat relationships: vegetation and catchment imperviousness*).

- Chemicals or litter associated with work activities should never be allowed to enter the water.

- To maintain natural foraging substrates for platypus, concrete should not be substantially used as a binding agent along the channel or banks. Similarly, gabion baskets should not be extensively employed to stabilise banks if practical alternatives are available.

- A contingency plan for dealing with any platypus that may be accidentally injured or displaced during work activities should be formulated and distributed to project staff (see 5.4, *Platypus Contingency Plans for Works Programs*).

2.1.10. Walking tracks, viewing platforms, bridges and street lighting

Based on information obtained in the course of radio-tracking studies, platypus mortality may increase very substantially following the development of a walking track which improves predator access to shallow stream margins. By the same token, it is believed that platypus are mainly active at night to reduce the chance they are detected by predators. Besides making platypus more visible to animals that want to eat them, the presence of bright artificial lights near a stream or river may reduce the platypus's food supply by inappropriately attracting aquatic insects as these emerge at dusk to breed and lay eggs.

Walking tracks built close to the edge of natural water bodies increase the risk that platypus are killed by predators, particularly if the water is shallow and vegetation is sparse.

What can be done to protect platypus

- In places where platypus are likely to occur, walking tracks should be located a substantial distance (ideally 30 metres or more) from sections of creek where the average depth is less than 0.3 metre and/or average width is less than 3 metres, on either a regular or seasonal basis.

- To reduce predator access and discourage the development of *ad hoc* human trails down to the water, pedestrian bridges and viewing platforms should be located at sites where banks are relatively steep and water is reliably deep.

- Maintain adequate vegetation between a walking track and the banks of a stream or river, ideally including a substantial amount of cover provided by leafy shrubs or the equivalent overhanging the water. As the absolute minimum, an unmown strip of low- to medium-growing plants (at least 4 m wide in the case of relatively small/shallow streams and 2 m wide in the case of deeper/wider rivers) interspersed with substantial clumps of taller overhanging shrubs should be encouraged to grow on the banks to help deter predators and provide places for platypus to hide.

- Street lights, security lights or the equivalent that are located within 100 metres of a natural water body should be designed to minimise the amount of artificial illumination directed towards the water, and ideally fitted with low-pressure sodium globes producing relatively low amounts of insect-attracting blue and ultraviolet light.

2.1.11. Culverts, pipes, gates and grilles

Given that platypus spend a large proportion of their time in a burrow, it is not surprising that they are willing to travel through pipes and culverts of considerable length. For example, radio-tagged platypus have been found to travel routinely through a 45-metre-long concrete culvert (1.3 metres in diameter) carrying creek water through an embankment. However, problems can arise if a culvert's design forces the animals to leave the safety of the water in order to continue traveling upstream or downstream. In such circumstances, it is by no means uncommon for animals to be run over by a car or killed by a fox or other predator. By the same token, although platypus will enter PVC pipes that are as narrow as 10 centimetres in diameter, they are apparently unable to back up or turn around in such a confined space and hence are liable to die if the far end is blocked (for example, by a recently closed valve). Cases are also known where platypus have drowned after becoming wedged in narrow openings in irrigation control gates or overlapping wire mesh panels placed in the channel to catch leaves.

What can be done to protect platypus

- Pipes and culverts located along a natural waterway or manmade channel that is used by platypus - or that carry water from such a waterway to an off-stream storage - should have a minimum internal diameter of 0.3 metre to ensure they can be negotiated safely by a platypus.

- To enable platypus to safely negotiate grilles or mesh barriers, these structures should be designed with grid spacings or apertures of 12 centimetres or more. Conversely, barriers meant to exclude platypus should be constructed of solid materials or have grid spacings or apertures of 3 centimetres or less. (Studies carried out by Dr Tom Grant have confirmed that platypus weighing up to one kilogram - i.e. a large proportion of adult females - can easily pass through a rigid 55 mm grid, and small juveniles can presumably pass through even narrower gaps.)

- To avoid forcing platypus to leave the channel, pipes and culverts conveying water along a natural waterway or soil-lined channel should not protrude from (or substantially overhang) the surrounding substrate. Similarly, culvert designs that frequently constrict stream flows and may therefore trigger platypus avoidance behaviour (due to increased water velocity) should not be adopted.

2.1.12. Weir walls and drop structures

Platypus generally find it difficult or impossible to climb up or down vertical or near-vertical concrete or metal surfaces, particularly if large volumes of water cascade down the surface. Accordingly, weir walls and drop structures often interfere with platypus freely traveling along the length of streams or rivers (see 1.4.4, *Effects of on-stream dams and weirs*). As in the case of culverts, platypus can exit the channel and walk around otherwise impassable barriers. However, leaving the water also exposes them to increased risks of being killed (see 2.1.11, *Culverts, pipes, gates and grilles*).

The concrete weir wall (above left) is too steep to be climbed by a platypus. In contrast, a platypus could easily negotiate the uneven surface of the rock weir (above right).

Two examples of fish ladders (above). Both structures are platypus-friendly.

In contrast, the vertical drop structure with grille (left) would be impassable to a platypus – forcing dispersing animals to leave the associated lake and move across land to travel downstream.

What can be done to protect platypus

- Support the development of fish ladders or the equivalent to provide a relatively safe route for platypus to negotiate dam and weir walls.

- If a weir cannot realistically be retro-fitted with a fish ladder, consider whether it might be possible to provide platypus with additional protective cover (in the form of dense shrubby vegetation) when they're forced to travel across land to move past the barrier.

2.1.13. Pumps and small-scale hydro-power generators

A surprisingly high proportion (5%) of all platypus mortalities reported to the APC from 1989 to 2009 where the cause of death could be reliably assigned occurred after animals were sucked into irrigation pumps or (in one case) a mini-hydroelectric generator. Small and inexperienced juveniles appear to be particularly likely to die in this manner, due in part to the fact that pump sheds tend to be located on elevated banks which in some places provide the best available habitat for platypus nesting burrows.

What can be done to protect platypus

- To prevent platypus and other aquatic wildlife from being sucked into (or against) water pumps or water-powered generators, a mesh cover or equivalent barrier should be fitted at an appropriate distance around all intake points.

2.1.14. Promoting awareness of platypus conservation needs

Most Australians are aware that the platypus is one of the world's most unusual animals. Ironically, this recognition of the species' iconic stature tends to foster the misconception that platypus are only found in remote, pristine areas.

For platypus to be conserved successfully, it is important that people develop a realistic understanding of where the animals occur and how they are affected by human activities.

What can be done to protect platypus

- Catchment Management Authorities, local councils and wildlife agencies should feature the platypus in community education campaigns designed to heighten awareness of issues such as litter control, pet management and responsible fishing practices.

- Consideration should be given to establishing Platypus Conservation Zones where this will assist the survival of threatened populations. Such zones could incorporate special signage and, if required, restrictions on fishing and access of pets to riparian areas. In particular, planning authorities should consider placing a ban on owning dogs and cats as a condition of approval of new housing estates located within 100 metres of creeks supporting a known threatened platypus population.

2.2. PLATYPUS CONSERVATION GUIDELINES FOR COMMUNITIES AND INDIVIDUALS

Platypus conservation is unlikely to succeed in the absence of careful, catchment-wide management of land and water resources which recognises that streams and rivers are incomplete without their associated plant and animal communities.

Ongoing stewardship of platypus populations by the persons living nearby is an essential aspect of this management.

Listed below are some measures that can make a genuine difference to platypus survival.

2.2.1. Litter

The wound on this platypus's neck was caused by a plastic bracelet (shown below the animal).

Discarded loops and rings frequently end up tangled around the necks and bodies of platypus, including items such as engine gaskets, the tamper-proof rings found around food jars, elastic hair-ties, plastic bracelets and tangled lengths of fishing line. For more background information, see 1.4.5, *Human activities contributing directly to platypus mortality*. Items made of metal or plastic are particularly likely to abrade the skin and underlying tissues, resulting in severe and potentially life-threatening injuries. Through their behaviour, people can make a big difference to the likelihood that a platypus (or native Australian water-rat or waterbird or turtle) encounters noxious litter in freshwater environments.

Tamper-proof sealing rings are potentially lethal devices to platypus. Cutting through all types of plastic, rubber or metal rings and loops before disposing of them is the only way to be sure that these items do not cause problems for wildlife.

What can be done to protect platypus

- Participate in (or organise, if necessary) “Clean Up” days along your local waterway.

- Make it your habit to cut through *all* small to medium-sized loops or rings (made of metal, plastic, rubber or natural materials such as jute or cotton) before disposing of them in an environmentally responsible manner. In particular, routinely snip through all the rings of six-pack holders and the plastic tamper-proof ring seals found around the mouths of beverage bottles and food jars.

- Make it your habit to pick up litter and dispose of it appropriately, including rubbish left by others.

- Make sure that your children understand that seemingly innocuous items like plastic bangles, elastic bands and elastic hair-ties can badly injure or even kill a platypus if they’re dropped outside and eventually get washed into a stream or river.

- Report any instances of large-scale dumping along waterways (old cars, building materials, industrial waste, etc.) to your local council or the Environmental Protection Agency so that prompt action can be taken to remove such hazards.

2.2.2. Illegal use of fish nets and yabby/cray traps

Platypus are air-breathing animals that can only hold their breath for a few minutes underwater before they drown. Enclosed nets and traps designed to capture freshwater crayfish and yabbies (such as opera house traps) or fin fish (such as fyke nets and drum nets) are lethal devices from the platypus’s point of view unless they are set partly out of the water with an air space left at the top (see 1.4.5, *Human activities contributing directly to platypus mortality*).

What can be done to protect platypus

- Be aware of the current regulations governing use of yabby and fish traps in your state, and immediately report the improper use of such devices to your state wildlife authority.

- Encourage shops that sell opera house traps to display a prominent notice outlining the legal restrictions on their use. Whenever possible, purchase angling and outdoor equipment from retailers who demonstrate their responsibility by displaying such notices.

- Spread the word among friends and acquaintances that opera house traps and homemade equivalents are responsible for drowning many platypus, Australian water-rats and freshwater turtles each year. The only reasonably safe way to set such nets and traps is to ensure that a generous air space is available at the top of the trap or net. Even then, animals may be killed if water levels rise overnight, for example after a thunderstorm.

- Use either baited lines and a dip net or lift-style “hoop nets” (**see diagram, right**) as wildlife-friendly methods for catching yabbies or spiny crays.

2.2.3. Recreational angling

Leaving a fishing hook embedded in a platypus's bill or foot is an inhumane practice which is likely to result in the animal's death.

Many platypus die of stress and exhaustion each year after becoming hooked on unattended "set lines" left overnight to catch fish (see 1.4.5, *Human activities contributing directly to platypus mortality*). Others die after becoming accidentally snagged on an attended line – if the line is simply cut, the animal is likely to drown when the free end of line attached to the hook gets tangled in underwater roots or branches. In addition, hooks embedded in the bill are likely to cause enormous pain and interfere with the platypus's ability to feed (see 1.2.2, *Sensory systems*). Platypus also suffer agonising injuries and can die when loops of fishing line become wrapped around their neck or chest and gradually wear through the skin and underlying muscle.

What can be done to protect platypus

- If you notice a platypus has started feeding nearby while you're fishing, move a short distance upstream or downstream to reduce the chance of hooking the animal accidentally.

- If you do hook a platypus, do NOT cut the line to release it. Instead, reel the animal in as gently as possible and remove the hook before releasing it back to the wild. Take GREAT care to avoid the spurs of adult males (see 1.2.3, *Venom and spurs*).

- NEVER set unattended fishing lines (which are mostly illegal in any case).

- NEVER leave tangled or surplus pieces of line behind when fishing – from the viewpoint of wildlife, abandoned line is just a deadly accident waiting to happen.

2.2.4. Pet management

Dogs and cats can and sometimes do kill a platypus (see 1.4.1, *Predators and disease*). Based on platypus mortalities reported to the Australian Platypus Conservancy from 1989 to 2009, juveniles (which are both smaller and often less cautious than their elders) are particularly vulnerable to predators. However, common sense needs to apply when seeking to establish an appropriate balance between platypus conservation and the legitimate desire of pet owners to exercise their dogs. On the one hand, pet owners clearly need to ensure that dogs remain under their direct supervision and control while being exercised. On the other, given that platypus rarely venture from the water's edge, it's quite reasonable to use fencing and/or plantings of dense vegetation to minimise the risk of dogs and platypus coming into contact. Similarly, there is no reason to believe that a platypus is ever likely to be attacked by a dog swimming in reasonably deep water.

What can be done to protect platypus

- Never let your dog or cat wander away from the immediate vicinity of your home without supervision.

- Obey local by-laws or park regulations that restrict where pets can go or where they can be exercised off-lead. More broadly, make it your habit to keep your dog leashed or otherwise firmly under your control when walking your pet within 30 metres of water bodies where platypus are known to be present and the banks are easily accessed.

- Try to avoid the hour after dawn or the hour before dusk when taking your dog for a swim in warm weather – these are the times of day when platypus are most likely to be active.

- Even if you don't like dogs, respect the fact that pets play an important part in many persons' lives and that most dogs require regular vigorous exercise to remain happy and in good health. Work constructively with local dog owners to designate areas where pets can be exercised off-lead without significant associated problems arising for wildlife.

2.2.5. Household chemicals and nutrient enrichment

Household chemicals (lubricants, paints, preservatives, solvents, cleansers, insecticides etc.) that enter a waterway through storm run-off after being poured onto the ground or into a gutter can harm platypus by fouling their fur or poisoning their invertebrate prey.

Nutrient enrichment is often the most serious water quality issue downstream of where people live, including those occupying bush blocks. Dissolved nutrients (in particular the amount of phosphorus in the water) have also been demonstrated to be negatively related to the occurrence of platypus populations (see 1.4.7, *Platypus habitat relationships: in-stream habitats and water quality*).

What can be done to protect platypus

- Household chemicals should never be poured down a drain or toilet - these normally lead to a septic system or water treatment plant, neither of which is designed to completely eradicate dangerous chemicals. Instead, check with your local council for advice on how chemical products can be recycled or disposed of properly.

- Use only low phosphate or phosphate-free detergents to wash dishes and clothes. Measure the amount of detergent added to washing machines so as not to use more than is needed.

- Use the minimum amount of chemicals needed to get the job done, and always consider whether there may be a less toxic or non-toxic alternative - for instance, clearing blocked drains with a metal "snake" instead of chemicals.

- Wash your car on the lawn to prevent detergent from running directly into the gutter.

- Maintain an effective home septic system. Don't overload the system (for example, by doing too many loads of washing in one day) and ensure that the tank gets cleaned out regularly by a reputable contractor.

- Apply chemical fertiliser to lawns or crops sparingly and at the proper time of year, so it's absorbed efficiently by growing plants. Use compost (ideally made by recycling your own kitchen and garden waste) instead of chemical fertiliser whenever possible.

- If your property is serviced by a stormwater drain, install a rainwater tank to collect water from the roof so it can be used to flush toilets, wash clothes and/or water plants in your garden. Direct the run-off from paths and driveways to your lawn or garden beds. Also, consider replacing extensive areas of concrete with "porous paving" – concrete grids or modular plastic pavers that contain openings filled with sand or gravel to capture stormwater and allow it to drain down into the soil.

2.2.6. Reducing water consumption

Human water consumption has reduced the natural flow of many streams and rivers, reducing their capacity to support platypus and other aquatic wildlife. Changing a few wasteful habits can make an enormous difference to the amount of water we use.

Installing rainwater tanks can help reduce the need to divert natural flow from rivers for human use.

What can be done to protect platypus

- Learn more about how you can conserve water in your home or business, and adopt at least one or two new water-saving practices each year.

- Install rainwater tanks and/or greywater systems.

- Replace grass lawns with indigenous shrubs or ground cover plants that require less water in summer (when natural flows are most restricted).

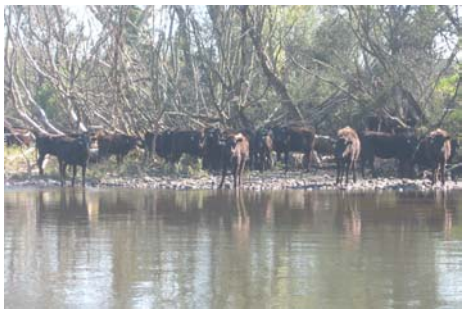
2.2.7. Safe use of pumps and small-scale hydro-power generators

As also noted in section 2.1.13, platypus can be killed by being sucked into unguarded inlets to irrigation pumps or mini-hydroelectric generators.

What can be done to protect platypus

- To prevent platypus and other aquatic wildlife from drowning or otherwise dying after being sucked into pumps or water-powered generators, a mesh cover or equivalent barrier should be fitted at an appropriate distance around all intake points and checked regularly.

2.2.8. Planning improvements to properties with creek or river frontage



Landholders who manage frontage along rivers and creeks can play a special role in helping to conserve platypus, by ensuring that land and water resources are utilised sustainably.

Uncontrolled stock access along waterways is a leading cause of water pollution and bank erosion.

What can be done to protect platypus

- Develop a management plan for your property which addresses environmental issues potentially affecting economic viability as well as regional water quality and biodiversity – including protecting native riparian vegetation, controlling bank and gully erosion, and managing grazing pressure in sensitive areas by livestock and feral animals.

- Try to minimise the amount of animal waste or fertiliser entering creeks and rivers (either directly or through run-off).

- If your home is located near a natural water body, resist the temptation to extend your lawn or garden down to the water's edge. A much better alternative is to encourage indigenous plants to grow near the water, as this will help platypus and other wildlife.

2.2.9. Other community actions

It is important that people realise that their individual actions have a genuine impact, for better or worse, on the survival of platypus populations.

What can be done to protect platypus

- Help to build awareness of the fact that platypus are (or should be) living in lakes, rivers and creeks across their historical range.

- Ensure that planning authorities consider the needs of platypus whenever a new development is proposed near a waterway. A reasonable level of development can be compatible with platypus conservation - provided that sensible precautions are taken to protect (and ideally strengthen) the quality of freshwater habitats.

- Ensure that the platypus's most fundamental requirement – namely that adequate surface water is reliably present in creeks and rivers – is taken into consideration when changes to the flow regime in managed river systems are being considered. Given the enormous amount of physical change that has occurred in these systems over time (including trees being cut down, channels being straightened, reservoirs being built in headwaters, dams being built on gully lines, and backwaters and billabongs being filled in) we consider it to be at best naïve to argue that the environmental values of historically intermittent water bodies will necessarily be improved by eliminating controlled water releases along their length. From the viewpoint of conserving biodiversity, a much better policy is likely to involve developing an environmental flow regime which reliably sustains refuge habitats in dry seasons for at least small populations of native aquatic fauna.

- Support local "Friends" or Landcare groups and other community conservation organisations in their efforts to control weeds, restore indigenous vegetation, pick up litter, and otherwise improve the environmental quality of waterways.

2.3. MONITORING PLATYPUS POPULATIONS

2.3.1. The need for monitoring

Information relating to the distribution and status of platypus populations should be an essential element of catchment management plans and local biodiversity conservation strategies.

In part, this reflects the fact that the platypus is a valuable indicator of waterway health. Keeping track of changes in platypus numbers therefore provides useful information relating to how river and creek habitats are faring through time.

As well, compelling evidence indicates that platypus numbers have declined or disappeared in many waterways across the species' range. There is consequently an urgent need to identify threatened populations so timely conservation action plans can be formulated.

The Australian Platypus Conservancy has developed a number of programs to help map and monitor platypus populations.

Firstly, it is important that people start to watch for platypus in their local area. The APC has produced *A Guide to Spotting Platypus and Water-rats in the Wild* which discusses how best to go about observing these two species (see section 5.4). To contribute to consistent record keeping through time, the APC also maintains an ongoing database of reliable platypus sightings records.

Secondly, the APC's community-based *Platypus Count* program provides a framework for monitoring local platypus populations, based on sightings made by individuals using a standardised survey method. In addition, *Platypus Group Watch* provides guidelines for teams of volunteers to keep track of how many platypus are active in one or more sections of stream or river channel.

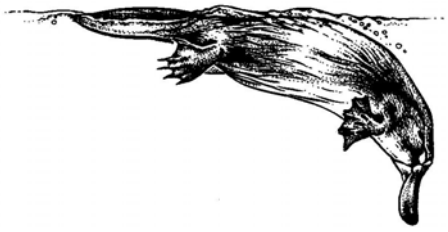
Lastly, APC staff carry out live-trapping surveys when this is necessary to develop a detailed view of platypus population structure and dynamics.

2.3.2. Looking for platypus

Platypus are most likely to be observed early in the morning or late in the evening, though animals may be active even in the middle of the day, especially when the sky is overcast.

Platypus occupy a wide range of habitats, including weir pools and reservoirs as well as natural lakes, rivers and creeks. They are generally most easily seen in places where the water surface is relatively still and calm (such as lakes, backwaters or large river pools), making it easier to detect the ripples formed when the animals are active in the water.

For more information about how to spot platypus and water-rats in the wild, see section 5.4.



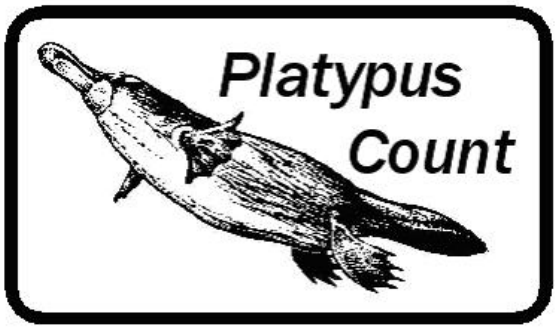
2.3.3. How to report platypus sightings

Platypus sightings provide important information relating to the distribution and status of the species. Sightings can be reported to the APC on-line (via the APC web-site) or the following information can be posted or emailed to the APC:

- The person's name and contact details
- Date of the sighting (as accurately as possible)
- Name of the waterway and location where the animal was seen (based on landmarks such as a road, township or bridge, or a GPS map reference)
- Any comments about the animal's behaviour or circumstances under which it was seen

Standardised reporting forms for both platypus and water-rat sightings are included in section 5.4.

2.3.4. Visual monitoring by individuals (*Platypus Count*)



There is no inherent reason why platypus populations cannot be monitored using visual survey methods: the animals are physically distinctive, occupy a wide range of water bodies that are often easily observed from the adjoining banks, and are diurnal enough in their habits that thousands of platypus sightings are made every year across the species' range.

Platypus Count provides a new approach to monitoring platypus, based on sightings made by volunteers using a standard visual survey method. It has been designed to be a very flexible program, catering to anyone who routinely walks, jogs, rides a bicycle or otherwise spends time along a creek, river or lake where there is a reasonable chance of seeing platypus (or water-rats) on a reasonably frequent basis.

Each volunteer chooses one or a few conveniently located spots to watch for animals and decides when (at what times of day and how many times a week or month) he or she will look for platypus.

Platypus Count data are entered into a secure computer database managed by the Australian Platypus Conservancy, and analysed to determine how many sightings have been made in different areas on a monthly or seasonal basis.

Personal details of volunteers and the specific location(s) of where they watch for animals are kept strictly confidential. However, reports summarising the combined general findings are produced and forwarded to all *Platypus Count* participants on a regular basis.

Persons who are interested in becoming *Platypus Count* volunteers are invited to contact the Conservancy for a full information kit.

2.3.5. Visual monitoring by groups (*Platypus Group Watch*)

Platypus Group Watch provides a standardised method for teams of volunteers to count platypus numbers periodically (in one or more sessions per year). The basic aim is to obtain a "snapshot" of the number of platypus (and/or water-rats) active in a particular area.

This typically involves stationing pairs of observers at 5 to 12 points distributed along 600 metres to 2 kilometres of stream or river channel, so they can scan for animals for one hour near dawn or dusk. *Group Watch* sessions are most likely to be informative and rewarding if they are carried out in an area where reasonably high numbers of platypus and/or water-rats occur.

Students from a Conservation and Land Management TAFE course conduct a Group Watch along the Snowy River at Orbost.

Undertaking just one survey per year is perfectly acceptable – any information gained about the status of local platypus and water-rat populations will have value. However, to improve the quality of results, at least two *Group Watch* sessions should ideally be conducted annually along each section of waterway to be monitored.

In addition to contributing to platypus and water-rat conservation, *Group Watch* sessions can also be a very rewarding social activity for all types of community-based environmental organisations, including Landcare and Friends groups.

Groups who are interested in undertaking platypus observation sessions are invited to contact the Australian Platypus Conservancy for an information kit.

2.3.6. Live-trapping surveys

Live-trapping surveys provide the only option for obtaining information relating to sex ratio, reproductive success and other platypus demographic parameters. Because platypus feed in the water and are mainly active at night, live-trapping work requires specialised equipment and is both time-consuming and logistically demanding.

Platypus surveys are normally undertaken by experienced biologists, working in accordance with research permits issued by the relevant state wildlife and/or fisheries agencies. Nets for platypus have to checked at frequent intervals throughout the night in the case of fyke nets and constantly attended in the case of gill nets, so that animals can be removed promptly and safely.

For further advice on the feasibility of conducting platypus live-trapping surveys in your local waterway, contact the Australian Platypus Conservancy.

An APC survey team sets fyke nets along the Mackenzie River in Grampians National Park.

SECTION 3 – SHARPEN YOUR PLATYPUS KNOWLEDGE

3.1. FREQUENTLY ASKED QUESTIONS

What is the plural of "platypus"?
This is a very commonly asked question. People feel that "platypi" doesn't sound quite right, but what's the alternative? According to the Australian *Pocket Oxford Dictionary* (Fourth Edition, reprinted in 1999), the word "platypus" is derived from two Greek words meaning "flat foot". Given that the plural of the Greek "pous" is "podes", we presume that — strictly speaking — platypodes occur in the Antipodes. However, given that "platypodes" has for some reason never really caught on, the dictionary goes on to state that the accepted plural is "platypuses" or (particularly in scientific and conservation contexts) "platypus".

What is the correct term for a juvenile platypus?
There is no established word in English to denote a baby platypus (or, for that matter, to distinguish a female from a male platypus). The term "puggle" has recently been suggested as a possible candidate, specifically in relation to a young platypus born in captivity. This word has a history of use in South Australia in relation to infant echidnas but - given how fundamentally different the platypus and echidnas are in terms of both their appearance and ecology – applying the same word to a platypus is not really appropriate.

What is the collective noun describing a group of platypus?
There is no collective noun for platypus that is equivalent to a pride of lions or flock of sheep. Platypus are essentially solitary animals and there is no evidence that they form cohesive social groups or lasting family units. Consequently, there has never been a need to refer to platypus collectively.

How did the platypus originate in the Dreamtime?
According to Aboriginal legend, the first platypus was born after a young duck mated with a lonely and persuasive water-rat. The duck's offspring inherited her broad bill and webbed feet along with the water-rat's four legs and brown fur.

What was the initial response of European scientists to the platypus?
In 1799, the platypus was scientifically described by a British scientist, Dr George Shaw. His first reaction to the original specimen was that it was an elaborate hoax. He even took a pair of scissors to the pelt, expecting to find stitches attaching the bill to the skin.

Is the platypus endangered?
The platypus is not considered to be either "Endangered" or "Threatened" by the Australian government, due to the fact that the species is still widespread and continues to be reasonably abundant in many places. However, experts agree that the platypus has been and continues to be adversely affected by factors such as habitat degradation, drought, damming of gullies, water extraction for agricultural, urban and industrial use, illegal fishing activities and proliferation of introduced pest animals such as carp and foxes. The cumulative impact of these and other threats has caused populations to decline precipitously in many streams and rivers, and become extinct in some parts of their range (see 1.1.3, *Distribution and status*).

How many platypus occur in the wild?
It's currently not possible to answer this question accurately, given that the number of platypus found in different river systems and different habitat types has never been established across most of their range. In turn, this reflects the fact that the platypus is an extremely difficult animal to census accurately. This is a species which spends the vast majority of its time either underwater or underground in a burrow. It is largely active at night and does not sing or call, leave footprints or piles of droppings, build visible nests or visit bait stations. From a distance, one platypus looks much like the next. However, based on the APC's field work in Victoria, we would not be surprised if the total number of platypus found today in the wild is in the order of 10-20% of the number that occurred in Australia at the time of European settlement.

Are platypus found in South Australia?
A few platypus were collected from the Torrens and Onkaparinga Rivers in the state of South Australia in the early years of European settlement. However, the last reliable report of a platypus being encountered in these rivers dates from shortly before 1900, when the species presumably became extinct there. Today, it is likely that platypus originating in the upper reaches of the Murray River occasionally move downstream and temporarily occupy the river's lower reaches (where it forms the boundary between South Australia and Victoria). In addition, platypus populations survive on Kangaroo Island, off the coast of South Australia. They are believed to have descended from animals brought to the island from Victoria in the 1940s.

Do platypus occur in tropical Australia?
Platypus occur along the east coast of mainland Australia to about as far north as the latitude of Cooktown in Queensland. It has been suggested that the absence of platypus from rivers located farther north in Cape York and those draining into the Gulf of Carpentaria may be due to predation by large salt water crocodiles.

Are platypus found in estuaries or along coastal beaches?
Platypus have occasionally been observed swimming in estuaries and other areas of tidal influence. However, resident populations have never been reported to occupy ocean habitats.

How much salinity can a platypus tolerate?
Platypus occupy rivers and streams in western Victoria where salinity sometimes peaks at 10,000 to 14,000 EC units. By comparison, horses and sheep respectively can tolerate up to around 9,000 and 16,000 EC units in drinking water without suffering a decline in health and condition.

Are platypus ever found in caves?
Platypus have been observed inside several caves in recent decades, including Junction Cave near Wombeyan in New South Wales, Moon Cave near Buchan in Victoria, and Croesus Cave in Tasmania. In each case, streams flowing through the cave system enable the animals to return to the surface after travelling underground.

What is the disease which has recently been infecting platypus in Tasmania?
In many parts of Tasmania, platypus are infected by a fungus (*Mucor amphibiorum*) which causes skin ulcers to develop and can result in death. This fungus is also known to occur in frogs on the Australian mainland (where *Mucor* infections have never been recorded in platypus) and may have been accidentally introduced to Tasmania in the late 1970s or early 1980s via green tree frogs transported in shipments of bananas. The good news is that studies carried out in 2008 and 2009 indicated a four-fold reduction in the prevalence of disease as compared to the 1990s, suggesting that Tasmanian platypus are acquiring resistance to the disease.

Where have the fossilised remains of platypus been found?
Fossils unearthed in Australia indicate that a type of prehistoric platypus swam around the legs of dinosaurs, more than 110 million years ago. Other fossils discovered in southern Argentina confirm that platypus occurred in South America as well as Australia until at least 63 million years ago - when the two land masses were still joined together as part of the southern supercontinent Gondwana.

What are the closest living relatives of the platypus?
The platypus is one of only five living species of monotremes, or egg-laying mammals. The others are the short-beaked echidna (found in both Australia and New Guinea) and three species of long-beaked echidnas which occur only in New Guinea.

How long can a platypus live?
Based on research undertaken by Dr Tom Grant in New South Wales, the oldest platypus recorded to date in the wild lived to the age of 21 years.

How long can a platypus survive out of water?
There are really two different ways to answer this question. On the one hand, the platypus is an air-breathing mammal that routinely spends many hours each day snugly asleep in a dry burrow. For this reason, persons who unexpectedly have to care for a platypus for a short time (such as an injured animal awaiting veterinary treatment) should never keep the animal in a water-filled bathtub, forcing it to swim when it chiefly needs to conserve energy. On the other hand, the platypus is adapted to obtain its food exclusively in the water — so if a platypus's freshwater habitat dries up (for example, due to drought), the animal will starve to death unless it can somehow find a new place to live.

Is the platypus venomous?
The platypus is the only Australian mammal known to be venomous. Adult males can inject poison from a pointed spur (typically measuring about 1.5 centimetres in length) located on the inner ankle of each hind leg. Production of venom peaks in and before the spring breeding season, suggesting that the primary purpose of this weaponry is male competition for mates or breeding territories. The venom is not considered to be life-threatening to humans, but can cause severe pain and swelling for several days.

What does a platypus like to eat?
Platypus do not have sharp teeth – instead, rough molar-like grinding pads are found at the back of their mouth. This means that they are not very well equipped either to kill or consume large vertebrate prey such as fish. Instead, the platypus dines on invertebrates such as worms, freshwater shrimp, crayfish, peashell mussels, and (above all) aquatic insects such as larval mayflies, damselflies and caddis flies.

How does the platypus find its food underwater?
The platypus normally keeps both its eyes and ears tightly closed when it dives. Instead, the animal mainly relies on sensory receptors located on the bill to locate invertebrate prey. The bill receptors are highly sensitive both to pressure and weak electrical fields. For example, research has shown that a platypus can detect the tiny electric current generated by the tail flick of a shrimp at a distance of about 10 centimetres.

Do platypus mark their territories?
The platypus has scent glands located just beneath the skin of the upper shoulders. The glands of adult males are particularly active during the breeding season, when they secrete a pale yellow, slightly sticky fluid — providing males with a strong, musky aroma at this time of year. By comparison, female scent glands are both smaller and less active year-round.

Do platypus hibernate?
Platypus do not appear to hibernate for lengthy periods. However, observations in both captivity and the wild suggest that platypus may sometimes enter a state of torpor, in which their body temperature drops considerably and they remain inactive in a burrow for up to about six days. Almost nothing is known about the conditions responsible for triggering this behaviour, apart from the fact that it has only been observed in the colder months of the year (from late May to early September).

How fast do platypus swim?
A platypus has been recorded travelling at a rate of more than 1 metre per second (3.6 kilometres per hour) in order to progress upstream through a section of fast-flowing water. When swimming in relatively still water (such as a lake or large pool), platypus most typically move at a rate of 1 to 2 kilometres per hour.

How often does a platypus dive when feeding?
Studies undertaken in Tasmania have shown that a platypus may dive up to 1600 times in a single foraging period, with nearly all dives lasting less than one minute.

How deeply does a platypus dive when feeding?
Based on information collected from data loggers deployed in a Tasmanian lake, platypus mostly feed at a depth of less than three metres, though one animal reached a depth of nearly nine metres on one occasion.

How many eggs does a platypus lay, and how large are they?
A female platypus lays a clutch of one to three eggs in late winter or spring. A platypus egg is approximately 14 mm wide x 17 mm long and has a leathery white shell, like those of lizards.

How long are platypus eggs incubated?
It is believed that platypus eggs are incubated for a period of about 10 days before they hatch. A mother platypus keeps her clutch of eggs warm by grasping them between her curled-up tail and lower belly as she lies in an underground nest.

How does a baby platypus feed?
A female platypus does not have nipples. An orphaned platypus will drink milk by sucking the liquid up noisily from a human hand while sweeping its stubby bill back and forth against the palm. In the wild, such pressure probably stimulates the flow of milk, which oozes from pores on the mother's belly.

How much does a lactating female platypus need to eat?
Studies carried out in captivity have shown that a mother platypus's daily food consumption rises as her offspring grow, peaking at about 80% of her body mass just before the young first emerge from the nesting burrow.

How does the platypus reduce its need for oxygen underwater?
Like most diving mammals, the platypus has blood that is rich in oxygen-carrying haemoglobin and red cells. The platypus also conserves oxygen when diving by lowering its heart rate from more than 200 beats per minute to less than 10 beats per minute.

Why do platypus have a light-coloured patch of fur located near each eye?
When viewed from above, platypus are uniformly dark brown apart from a small white spot located next to each eye. The spots make it appear that a platypus's eyes (which normally are shut when diving) remain open underwater. This may fool some predators into thinking that a submerged platypus will see their approach and flee, reducing the likelihood of an actual attack.

How can you tell if a platypus is fat?
About half (30-60%) of a platypus's total body fat is stored in its tail. The fat helps to insulate the tail (which is thinly furred compared to the rest of the body) when an animal is active in cold water. Researchers can get a good idea of how fat a platypus is by examining the tail and gently squeezing its edges. Interestingly, the majority of animals assessed in this way are scored as "average" – i.e. not particularly fat nor particularly thin – suggesting that most platypus populations are good at balancing their numbers with the overall availability of food resources.

How many chromosomes does the platypus have?
The platypus genome has been recently estimated to include around 18,500 protein-coding genes (about 15% less than the corresponding number in humans), packaged in a set of 52 chromosomes.

How fast can a platypus dig?
The platypus's front feet are equipped with blunt claws that can be used to dig or remodel a burrow at the rate of around 0.5 metre per hour. Radio-tracking studies have shown that an adult will most typically occupy several different burrows (up to about a dozen) over a period of a few weeks.

Where are platypus burrows located?
Platypus burrows are typically located in banks that rise at least one metre above the water and mainly at sites where the entrance is well hidden by dense overhanging vegetation or undercut tree roots.

Can a platypus jump?
It is sometimes stated that "elephants are the only land mammal that cannot jump". However, platypus are probably at least as inept as elephants when it comes to launching themselves up off the ground. This reflects the structure of the platypus skeleton: the limbs extend horizontally, so the chest and belly are actually in contact with the ground at low speed. The platypus's joints and ligaments are also better suited to rotational (as opposed to back and forth) limb movements. This means that the platypus can swim and dig very efficiently, but is poorly equipped to compete in any sort of track or field event!

Can a platypus climb?
The platypus's front foot is highly specialised, with webbing extending well beyond the end of the toes to assist swimming. In turn, this greatly restricts its ability to grasp objects. Nevertheless, platypus are exceptionally determined creatures when it comes to scaling surfaces that stand in their path. They can scramble up steep rocky banks, and have been known to try to escape from the confines of a galvanised metal tank by wedging themselves between the side of the tank and a vertical water pipe and propelling themselves upwards like a giant inchworm.

Do platypus have any external parasites?
The platypus has its own species of tick (known to scientists as *Ixodes ornithorhynchi*) which does not occur on any other animal. The ticks are mainly found on the platypus's hind legs and do not cause their host any obvious physical harm.

What is the body temperature of a platypus?
A healthy platypus normally maintains its body temperature at close to 32^{o}C (about 5^{o}C less than that of humans). One useful outcome of having a naturally low body temperature is that a platypus loses heat at a lower rate while swimming in cold water, thereby saving energy and allowing the animal to survive on less food.

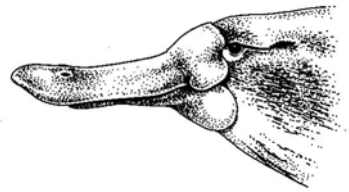
Can platypus be kept as pets?
Platypus are difficult and expensive animals to keep in captivity, even for major zoos and research institutions. They eat a lot of food (in the order of 20% of their body mass each day) and are also quite picky about what they eat, preferring live aquatic invertebrates such as insect larvae, worms and crayfish. Feeding and exercise tanks need to be as roomy as possible (after all, wild platypus have home ranges extending for a kilometre or more) and the water must be kept clean and fresh by appropriate use of automatic filters or being changed each day. Adult males in particular are potentially dangerous animals to handle because of the venom delivered by their spurs. Sensibly, platypus cannot be legally kept as pets in Australia, nor are there currently any legal options for exporting them overseas.

Can platypus be seen anywhere outside Australia?
Platypus are only known to occur naturally in Australia. As of 2010 there were no platypus held in any zoo or research institution outside Australia. This reflects official government policy – formulated in the 1990s – that no export of platypus will be considered until a self-sustaining breeding population is established in Australia zoos.

Have platypus ever been kept alive successfully outside of Australia?
Platypus could be seen outside Australia from 1947 (when naturalist David Fleay successfully conveyed two juvenile females and a young male to the Bronx Zoo in New York City) to 1957 (when the male was found dead in his enclosure, a few weeks after the sole surviving female managed to escape). During their years in America, the animals mainly dined on earthworms, mealworms, crayfish and egg custard.

Are platypus good to eat?
According to Harry Burrell (a keen naturalist who wrote a landmark book about the platypus in 1927), a group of early miners reported that cooked platypus was "a somewhat oily dish, with a taste between those of red herring and wild duck". Aboriginal people residing near the Burnett River reputedly did not include the platypus in their diet because the meat had "an objectionable smell", presumably related to the species' scent glands.

3.2. PLATYPUS QUIZ



Questions 1- 10 (Easy – 1 point per correct answer)

1. The platypus is a type of:
    A) Bird
    B) Mammal
    C) Reptile

2. Early European settlers called the platypus a:
    A) Duckbill
    B) Turtle rat
    C) Native otter

3. Platypus live in:
    A) Creeks and rivers
    B) Natural and manmade lakes
    C) All of the above

4. Platypus mainly eat:
    A) Insects, yabbies and worms
    B) Leaves and roots
    C) Fish

5. You are most likely to see a wild platypus:
    A) When it's very windy
    B) In the middle of the day when the sun is shining
    C) Early in the morning or late in the evening

6. The closest relative of the platypus is the:
    A) Water-rat
    B) Echidna
    C) Otter

7. Platypus occur in the wild:
    A) Only in Australia
    B) In Australia and New Guinea
    C) In Australia and China

8. Male platypus can inject venom using:
    A) Their claws
    B) A pointed spur located on their ankle
    C) Their bill

9. A mother platypus produces young by:
    A) Raising 1-3 joeys in a pouch
    B) Hatching 1-3 eggs in an underground burrow
    C) Laying many eggs in the water

10. To help protect platypus, it is important to:
    A) Never drop litter on the ground, especially near waterways
    B) Never waste water at home, at school or at work
    C) Both of the above

Questions 11- 20 (Harder – 2 points per correct answer)

11. The scientific name of the platypus is:
    A) Platypus monotrematus
    B) Ornithorhynchus anatinus
    C) Ornithorhynchus paradoxus

12. The oldest platypus recorded to date in the wild was:
    A) 6 years old
    B) 14 years old
    C) 21 years old

13. The fossils of ancient platypus-like animals have been found in Australia and:
    A) Argentina
    B) India
    C) New Zealand

14. The first scientific description of the platypus was by:
    A) Joseph Banks in 1771
    B) George Shaw in 1799
    C) Charles Darwin in 1836

15. The main parasites found on the platypus are:
    A) Fleas
    B) Leeches
    C) Ticks

16. Platypus were first bred successfully in captivity in:
    A) 1927-28
    B) 1943-44
    C) 1998-99

17. The body temperature of a healthy platypus is around:
    A) 32^{o}C
    B) 38^{o}C
    C) 44^{o}C

18. Platypus are NOT found in the wild in:
    A) Tasmania
    B) South Australia
    C) Western Australia

19. According to Aboriginal legend, the first platypus was born following the mating of a:
    A) Wombat and fish
    B) Duck and water-rat
    C) Frog and echidna

20. When it dives to find food, a platypus will normally remain underwater for:
    A) Less than 60 seconds
    B) 2-3 minutes
    C) 5-10 minutes

Quiz Answers

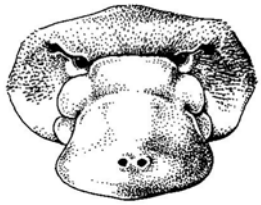
1. B
2. A
3. C
4. A
5. C
6. B
7. A
8. B
9. B
10. C

11. B
12. C
13. A
14. B
15. C
16. B
17. A
18. C
19. B
20. A

Questions 1-10 = 1 point per correct answer
Questions 11-20 = 2 points per correct answer

How did you score?

25-30 points – platypus expert!
15-24 points – very good
5-14 points – not bad
0-4 points – read the main text again!



SECTION 4 – THE AUSTRALIAN WATER-RAT (RAKALI)

4.1. AUSTRALIA'S NATIVE "OTTER"

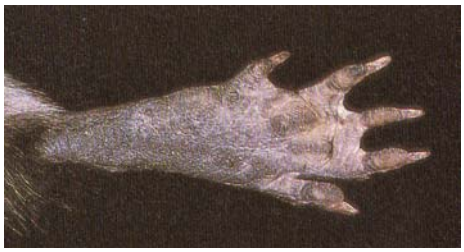
4.1.1. Introduction

The rodents that Australians are most likely to come in contact with are recently introduced species that are officially classified as pests: house mice, black rats and brown rats. However, Australia also supports a diverse array of native rodents that have been a part of the local landscape for at least half a million years and in some cases much longer.

The largest of these is the Australian water-rat (also known as rakali), a very attractive animal weighing up to 1.3 kilograms – as big as a medium-sized platypus. The water-rat's ancestors are believed to have arrived in Australia around 5-10 million years, after swimming (or possibly rafting) from New Guinea.

The Australian water-rat is an aquatic predator which resembles a small otter in many ways:

- Muzzle is blunt and furnished with a dense set of whiskers (**below left**)
- Hind feet are broad, partly webbed and paddle-like (**below centre**)
- Tail is well-furred and thick to help serve as a rudder when swimming (**below right**)
- Body is elongated and streamlined
- Ears are small and can be folded flat against the head for a streamlined profile
- Fur is soft and lustrous, drying quickly and helping to keep the animal warm in the water



Even if platypus don't occur in your local creek, it may well support a population of these fascinating rodents, which are equally deserving of protection as native wildlife.

4.1.2. Naming

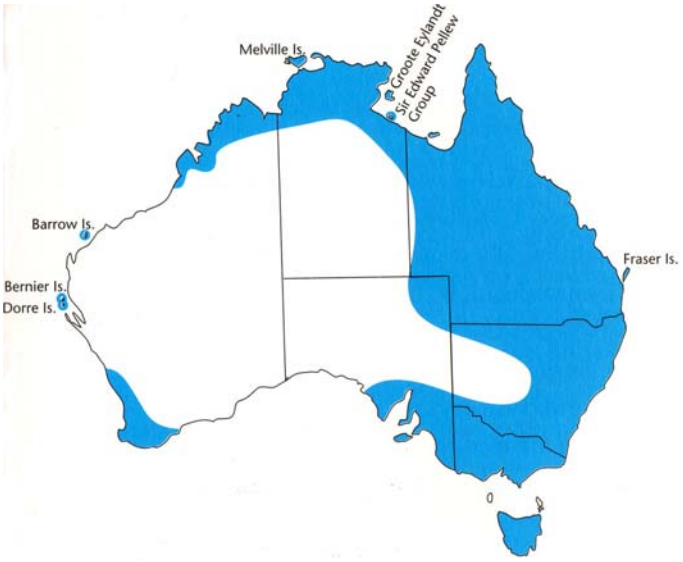
The scientific name of the species (*Hydromys chrysogaster*) translates as “golden-bellied water mouse”.

Early European settlers sometimes called this animal a “beaver rat”, even though it is actually much more like an otter than a beaver in its behaviour.

In the early 1990s the Australian federal government proposed changing the common name of the Australian water-rat to “rakali”, which is one of the aboriginal terms for the animal. Although rakali has gained some public acceptance as the common name for *Hydromys chrysogaster*, these animals are still more widely known as “water-rats”.

4.1.3. Distribution and status

Australian water-rats occupy a wide variety of natural and manmade freshwater habitats, including swamps, ponds, lakes, rivers, creeks and irrigation channels. They also inhabit brackish estuaries and sheltered ocean beaches. Water-rats are widely distributed on both the mainland and Tasmania and also occur on many offshore islands.



Distribution of *Hydromys chrysogaster* in Australia (source: Mammals of Australia)

Although very little is known about the current status of water-rats in most parts of their range, capture rates in most areas tend to be quite low.

In part, this reflects the fact that water-rats are highly intelligent animals that are naturally wary of entering metal cage traps and also spend a large proportion of their time feeding in the water rather than on land. Water-rats are also very good at escaping from nylon mesh survey nets set in the water, using their sharp teeth to snip holes through the netting and escape.

In addition, water-rats are relatively aggressive animals that do their best to defend a territory through scent-marking and aggressive behaviour towards other individuals. In turn, this will tend to ensure that relatively low numbers of adult water-rats occur in most habitats.

Anecdotal evidence also suggest that water-rat numbers have declined in many places in southeastern Australia particularly since the mid-1990s, probably due to the combined impacts of drought and habitat degradation. More work is needed to map where water-rats occur and determine how the species’ distribution may have changed in recent decades. In turn, this information will provide a factual basis for longer-term population monitoring.

4.1.4. Size and appearance

Adult water-rats measure up to 35 centimetres in length from their nose to rump, with a slightly shorter tail. Adult males typically weigh 0.8 kilograms (up to 1.3 kg) and adult females typically weigh 0.6 kilograms (up to 1.0 kg).

Depending on location, water-rats can vary considerably in colour. The head and back may be nearly black (with golden-yellow belly fur) or some shade of brown or grey (with fawn- to cream-coloured belly fur). However, apart from occasional individuals that have lost the end of their tail through fighting, water-rats are characterised by a distinctive white tip to the tail across their entire geographic range.

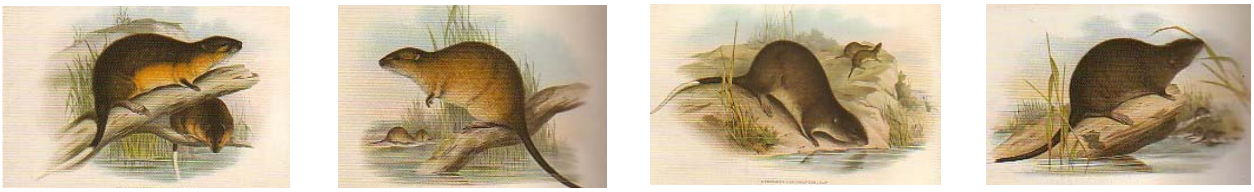
The white tip to the tail is the most obvious identifying feature of the water-rat, whether the animal is in the water or on land.

Water-rat fur is moulted twice a year, being coarser and denser in winter. As in the case of platypus fur, it consists of a dense, fine layer of underfur covered by coarser guard hairs. Although water-rat fur is reasonably waterproof, it is much less effective than platypus fur at keeping its owner warm – water-rats are unable to maintain their body temperature in water temperatures below 25^0C and consequently need to exit cold water at regular intervals in order to warm up in a burrow or other sheltered site.

4.1.5. Related species and subspecies

Hydromys chrysogaster has no close relatives in Australia, although several other species of *Hydromys* are found in the New Guinea region. By the same token, the Australian water-rat is not closely related to either the European water vole (a.k.a. water-rat) or the American muskrat.

Several subspecies of *H. chrysogaster* have been proposed over time, generally based on variation in fur colour. Confirmation that valid subspecies occur will probably depend on the findings of future genetic studies.



Illustrations of the Australian water-rat in John Gould's early 19th century *Book of Australian Mammals* – four species of "Beaver rats" were recognised at that time.
L to R: Golden-bellied, Fulvous, White-bellied and Sooty.

4.1.6. Foraging behaviour and diet

Water-rats mainly consume aquatic prey (including fish, frogs, turtles, crayfish, crabs, large aquatic insects, mussels and clams), but the remains of terrestrial prey (such as mice and bats) have also been discovered in water-rat faeces. It has been suggested that the proportion of foraging on land may increase in winter when water temperature declines.

Large water-rats have occasionally been documented to kill reasonably large water birds, such as ducks and coots. They will also eat carrion and scavenge for human food scraps. Based on anecdotal reports, water-rats will travel several hundred metres across dry land to dine on delicacies, such as pet food left out regularly on a back porch.

Water-rats are excellent climbers (above left). In addition to sometimes scaling trees to look for prey such as birds and bats, they have been reported running along the roof rafters at Flinders Street Railway Station in central Melbourne.

A water-rat snacks on bread provided for ducks on the banks of the Queanbeyan River in New South Wales (above right).

Water-rats also appear to have the rare ability to be able to kill the introduced cane toads found in Australia's tropical north. By flipping the toads over before biting them, they avoid the poisonous parotid glands found on the back of the toad's neck.

After catching their prey, water-rats typically carry it in their mouth to a favourite feeding spot on a log or rock located at the water's edge or in the channel. Large piles of clam shells, crayfish claws or fish bones and scales can accumulate at such platforms — the remains of many water-rat meals.

A water-rat at a typical feeding platform – in this case, a log in the middle of a weir pool.

4.1.7. Home range size and movements

Water-rats are highly territorial, marking their home ranges with a strong scent reminiscent of the odour of cat urine. Apart from females raising dependent offspring, it is presumed that adult water-rats lead solitary lives.

Relatively little is known about home range size and movements in this species. An adult male radio-tracked along a small creek in Victoria was found to have a home range extending at least 3.9 kilometres, whereas three males living in Queensland had home ranges that extended at least 0.9-2.2 kilometres. An overland movement of at least 3 kilometres has also been recorded.

In places where populations are dense there is considerable fighting, as evidenced by a high frequency of bite marks on tails and hind feet. This suggests that juveniles have to disperse from their mother's home range fairly soon after becoming independent; however, nothing is known about this process.

4.1.8. Reproduction and life history

Water-rats can potentially breed throughout the year if conditions are favourable, but mating most typically occurs in late winter to early summer, with juveniles appearing from September to February. The gestation period is around five weeks long. Females generally first breed at the age of about a year and raise two or three litters of young in a good year. A female water-rat only has four nipples and typically raises just two to four babies in a given litter, suckling her young for about a month. After weaning, juveniles remain with their mother for a few more weeks before leaving home for good.

It is believed that water-rats normally survive for a maximum of about 3-4 years in the wild.

4.1.9. Burrows and activity patterns

Water-rats occupy burrows located in creek and river banks, or shelter in large hollow logs lying near the water. Radio-tracking studies undertaken by Australian Platypus Conservancy staff have shown that platypus and water-rats will use the same burrows, though probably not at the same time. On one occasion, an adult female platypus occupied a burrow a few weeks after it served as a nursery for a female water-rat with a litter of young. Such behaviour is not especially surprising given that platypus and water-rats are about the same size and both are known to make use of many different burrows over time. It remains unknown whether the two species are equally likely to dig a new burrow in the first place.

This water-rat is about to exit the water and enter a burrow.

4.1.10. Conservation issues

Water-rats are subject to predation by many different species, including snakes, large predatory fish, birds of prey, and cats, dogs and foxes. However, there is no reason to believe that water-rats have ever vanished from any area solely due to predation. By the same token, there is no evidence that any diseases have an important impact on water-rat numbers.

Because water-rats are warm-blooded carnivores which require a lot of food to fuel their energetic lifestyle, the main problem facing the species is most likely to be habitat degradation, if this in turn reduces the animals' aquatic food supply.

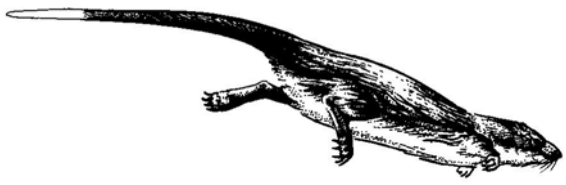
Given that water-rats have a fairly short natural lifespan (in most cases living no more than 3-4 years), local populations may decline in size and even disappear if females fail to reproduce successfully for several years in a row — for example, due to the combined effects of poor habitat quality and ongoing drought.

Water-rats were once widely trapped for their fur and sometimes culled when they were perceived to be a nuisance in irrigation districts. However, they are now fully protected by law as native wildlife.

In theory, water-rats can chew a hole to escape from a submerged opera house trap. In actual fact, the animals often drown before they can escape.

Unfortunately, many continue to drown in "opera house" traps and other enclosed nets designed to capture yabbies and freshwater crayfish. These nets are also known to kill large numbers of platypus and freshwater turtles. Recreational anglers are therefore strongly advised to consider using lift-style hoop nets or old-fashioned baited lines (without hooks) as wildlife-friendly alternative methods for procuring a meal of yabbies or crays.

Australian water-rats can sometimes come into conflict with humans when they raid fish farms or chicken yards, kill free-ranging guinea pigs in gardens, steal bait from anglers, leave piles of food debris on the decks of moored yachts or on verandahs, or deposit chewed up cane-toads around the edge of swimming pools! However, killing or relocating "problem" water-rats is illegal and subject to substantial fines. In any case, such action is likely to be totally ineffective because dispersing juveniles are likely to recolonise the area in a relatively short space of time. A much more sustainable solution is to learn to live with water-rats by rat-proofing problematic areas and not leaving food around that will attract them.



4.1.11. Co-existence of water-rats and platypus

Platypus and water-rats both function as top predators in Australian freshwater systems and probably compete to some extent for food. However, the size of prey that can be consumed by an adult platypus is limited by the fact that its bill is equipped only with rough grinding pads to help process food. In contrast, a water-rat has a formidable set of sharp incisors to help kill and dismember prey. Interestingly, the grinding surfaces of water-rat molars are quite smooth. Like the grinding pads of the platypus, this adaptation may be particularly effective at dealing with the hard, encased bodies of many aquatic invertebrates.

In practice, very little is known about the ecological and behavioural interactions between platypus and water-rats. The two species are found living together in many places, so water-rats clearly do not automatically exclude platypus from freshwater environments (and vice versa).

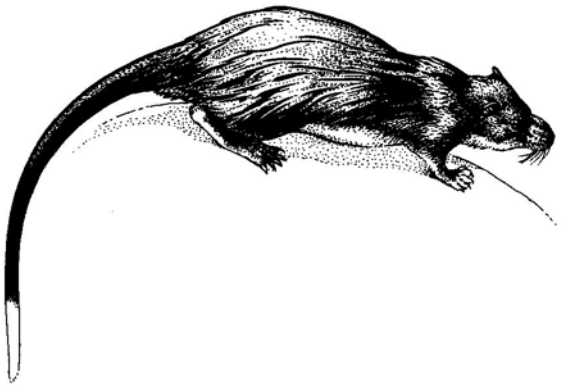
However, there are also waterways where only one of the two species is commonly found. In general terms, water-rats are much more likely to persist in badly degraded aquatic habitats than the platypus. This may reflect the fact that the water-rat is able to forage on land and also prey on introduced fish species.

It has been suggested that water-rats may sometimes prey on young platypus but there appears to be no actual documented evidence to support this idea.

For hints on how to observe and identify the two species, see G*uide to Spotting Platypus and Water-rats in the Wild* in section 5.4 Leaflets.

4.1.12. How to report water-rat sightings

Recent sightings of water-rats (including details of when and where the animal was seen) can be reported to the Australian Platypus Conservancy (platypus.apc@westnet.com.au). The information will be added to a secure data base, thereby contributing to an improved understanding of the species' distribution and status in the wild.



For further information on this species, see Section 5.1.2 (*Reading Lists – Australian Water-rat*).

SECTION 5 – OTHER INFORMATION AND RESOURCES

5.1. READING LISTS

5.1.1. Platypus

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5.2. ABOUT THE AUSTRALIAN PLATYPUS CONSERVANCY

5.2.1. Introduction

The Australian Platypus Conservancy is a non-government, non-profit organisation. dedicated to conserving the platypus and its freshwater habitats.

Since being founded in 1994, the Conservancy has conducted a wide range of research projects. This work has included many hundreds of overnight live-trapping surveys and a wide range of radio-tracking studies. As a result, much more is now known about the current status of platypus populations and the species' behaviour and ecological requirements. The factors responsible for the animals disappearing from certain areas are also much better understood, making it possible to identify what actions need to be taken to help conserve this amazing animal.

The APC continues to be strongly committed to ensuring that its research findings are used to stimulate practical action to protect platypus. This has led to development of innovative community-based visual monitoring programs, along with ongoing campaigns to combat the risks posed by illegal fishing activities and litter. It has also included co-operation with management agencies, community groups, businesses and private landowners to develop greater awareness of platypus conservation requirements. To assist this process, a wide range of public talks, technical workshops and special publications about platypus are provided each year. Platypus conservation strategies have also been prepared for a number of local councils and management authorities.

The Conservancy's work is the focus of considerable media interest, which both furthers its educational objectives and obtains recognition for project sponsors and partners.

Dr Melody Serena OAM, Senior Conservation Biologist, is responsible for directing the APC's research programs. She has been studying platypus full-time since 1989.

In addition to its work with platypus, the APC is one of the very few organisations carrying out research and conservation activities related to the Australian water-rat or rakali (*Hydromys chrysogaster*), an attractive but little-studied native rodent that shares the platypus's habitat in many places.

5.2.2. How you can assist platypus research and conservation

The research and conservation work of the Conservancy is supported by individuals, community groups, schools, management agencies, philanthropic trusts and corporate sponsors who share a concern for this unique Australian species.

Ways in which people and organisations can support the work of the APC include:

- Donations
- Platypus sponsorship
- *Friends of the Platypus*
- Corporate sponsorship
- Product royalties
- Bequests

Donations

The APC is endorsed as a deductible gift recipient (DGR) by the Australian Taxation Office. Accordingly, donations and bequests to the Australian Platypus Conservancy are tax deductible (in Australia).

Donations (by Visa/Mastercard or cheque payable to “Australian Platypus Conservancy Research & Conservation Fund”) can be forwarded to the APC; an official receipt will be issued for tax record purposes.

Platypus sponsorship

The Conservancy’s platypus sponsorship scheme offers a popular and easy way to help support research and conservation efforts, particularly as platypus sponsorships also make great gifts for family and friends.

For each sponsored platypus you will receive:

- A sponsorship certificate, bearing your name (or the name of a person you designate, if it is intended as a gift), a scanned picture and description of the sponsored platypus plus information about the study area in which the platypus lives

- A blank platypus greetings card

Details of the various platypus available for sponsorship can be found on the APC website. The cost is also outlined on the website, with each sponsorship involving just a one-off payment – i.e. there is no requirement for ongoing financial contributions.

Friends of the Platypus

By joining *Friends of the Platypus*, community groups, schools, management agencies, businesses and concerned individuals can support the important work of the Conservancy and enjoy being part of the exciting and very worthwhile challenge of platypus research and conservation.

Members of *Friends of the Platypus* receive a subscription to *Ripples*, the APC newsletter, which keeps them up to date with platypus research and conservation issues.

Details of *Friends of the Platypus* annual membership fees can be obtained from the Australian Platypus Conservancy website.

Corporate sponsorship

A wide range of businesses and corporate agencies support the work of the APC either through direct sponsorship (by commissioning specific projects) or via donation of goods and services needed by the Conservancy.

Contact the APC to discuss how platypus sponsorship can meet the specific requirements of your company or organisation.

Product royalties

A variety of businesses donate a percentage of sales from certain products or services to the APC.

Contact the Conservancy to discuss how your company might potentially benefit by contributing to platypus conservation activities.

Bequests

A general bequest to the Australian Platypus Conservancy is preferred and the suggested style is as follows:

I give to the Australian Platypus Conservancy Incorporated (ABN 64 255 612 676) for its general purposes the sum of _____(in words)($_____) (or percentage of my estate) free of all duties, probate, estate, succession, or otherwise and I declare that the receipt of an authorised officer of the said incorporated association shall be full and sufficient discharge to my Trustees or Executor.

Australian Platypus Conservancy

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The Australian Platypus Conservancy is incorporated in Victoria under the Associations Incorporation Act 1981 (Reg. No. A0029254D).

The Conservancy (ABN 64 255 612 676) has been endorsed by the Australian Taxation Office as both an income tax exempt charity and a deductible gift recipient, listed on the Commonwealth Register of Environmental Organisations.

The APC receives a Voluntary Environmental & Heritage Organisations grant from the Australian Government (Department of Environment, Water, Heritage and the Arts) to assist with administration costs, in recognition of the Conservancy's special role in caring for platypus.

5.3. *RIPPLES* (newsletter of the APC)

Ripples, the newsletter of the Australian Platypus Conservancy, is published several times each year and contains updates on platypus research and conservation matters.

Copies of *Ripples* are sent to members of *Friends of the Platypus* (see 5.2.2, *How you can assist platypus research and conservation*).

Main articles from the newsletter (including back editions) are also posted on the *Ripples* section of the APC website.

5.4. INFORMATION NOTES AND LEAFLETS

As part of its commitment to platypus and water-rat conservation, the Australian Platypus Conservancy has produced a variety of information notes and leaflets over time.

Schools, management agencies, community-based environment groups and interested individuals are welcome to reproduce and distribute the following items for any non-profit, educational purpose:

Australian Platypus Conservancy Information Notes

- ***Platypus Emergency Care*** (2 pages)
- ***Platypus-friendly Angling*** (2 pages)
- ***Platypus Contingency Plans for Works Programs*** (2 pages)
- ***Australian Water-rat: Our Native "Otter"*** (2 pages)

How to See Platypus and Water-rats in the Wild, and How to Report Sightings

- ***A Guide to Spotting Platypus and Water-rats in the Wild*** (4 pages)
- ***Platypus Sighting Report Form*** (1 page)
- ***Platypus Mortality Record Form*** (1 page)
- ***Water-rat Report*** (1 page)
- ***Platypus "Wanted" poster*** (1 page)

PDF versions of these documents are provided below.

PLATYPUS EMERGENCY CARE

AN AUSTRALIAN PLATYPUS CONSERVANCY INFORMATION NOTE

WHY ARE PLATYPUS SOMETIMES IN NEED OF EMERGENCY CARE?

Platypus may be displaced from their homes by catastrophic events such as major droughts and floods, be injured by a predator (such as a fox or wandering dog or cat) or become entangled in litter. Platypus are also occasionally discovered a kilometre or more from the nearest natural water body in completely inappropriate settings. This is especially likely to occur in late summer or early autumn, when many juveniles set out to find their own home ranges. These youngsters have been known to end up in all sorts of strange places, including suburban gardens, ploughed fields, swimming pools and roadways.

Platypus can also be accidentally caught by anglers using either baited hooks or artificial lures. Most typically, the hook will become embedded in either the bill or a front foot. When such a situation arises, it is essential that the platypus be freed from the hook before it is released. The platypus bill is fleshy and sensitive (like a human thumb), packed with thousands of sensory receptors needed to navigate underwater and find and capture prey. Hence, simply cutting the line and leaving the hook in the bill is likely to result in a slow and painful death for the animal concerned — from infection and/or starvation. Trailing fishing line may also become entangled in submerged roots or branches, causing a platypus to drown when the animal is unable to reach the surface.

HOW DO I HANDLE A PLATYPUS?

Platypus are wild animals with specialised living requirements. It is inappropriate (and illegal) to take one home and try to keep it as a pet - the animal will not survive the experience.

If you need to assist a sick, injured or displaced platypus, be extremely careful when picking up an animal of unknown age and gender because adult males have poisonous spurs, about 1.5 centimetres long, located on their hind ankles. While the venom is not considered to be life-threatening to humans, it can cause excruciating pain and spectacular swelling.

Unless it is definitely known that a platypus is not equipped with spurs, *never* place your hands under the animal or support it from below with your leg or arm. Instead, lift the platypus by gripping it firmly around the middle or end of the tail (but not the tail base, which a male can reach with his spurs).

If it is necessary to provide immediate first-aid (or to remove a fishing hook from the bill) try to keep the animal's eyes covered with a folded piece of clothing or other fabric to reduce its tendency to struggle. Alternatively, consider placing the platypus in a bag, exposing only the part of its body that needs to be treated.

IF NECESSARY, HOW DO I TRANSPORT A PLATYPUS?

If a platypus found in an unusual place appears to be alert and active, it should be taken at once to the nearest creek or river holding substantial water and released so it can begin feeding. If the animal appears to be unwell, it should be transferred as soon as possible (ideally, within a few hours) to a zoo having specialised veterinary facilities. If this is not possible, the animal should be taken to a local veterinarian for examination and treatment.

When selecting a container to hold an animal in transit, be aware that the platypus is extremely strong for its size and very good at squeezing through narrow gaps. A platypus may be confined for a short time in a sturdy cardboard box with a strong cover or lid. Alternatively, a bag such as a pillow case or hessian sack may be used. If these options are not available, make an improvised bag by knotting the sleeves of a long-sleeved garment such as a sweatshirt. Ensure the top of the box or bag is securely closed, though the container must also be adequately ventilated so the platypus can breathe.

HOW DO I PROVIDE SHORT-TERM CARE FOR AN INJURED PLATYPUS?

If a platypus needs to be held overnight before being taken to a zoo or local veterinarian, handle it as little as possible. Try not to stress the animal unnecessarily, for example by resisting the temptation to show it to friends and neighbours.

Platypus are air-breathing animals that spend up to 17 hours a day sleeping in a snug burrow. There is therefore no need to provide a platypus that is being held in captivity for less than 24 hours with a place to swim — instead, help it to conserve energy by keeping it quiet and dry.

The safest way to confine an animal overnight is inside a strong fabric bag (at least the size of a pillow case, so the animal has a bit of room to move about inside the bag). The top must be fastened very securely, for example by knotting a piece of twine tightly around the opening. If the animal's fur appears excessively wet, dry it gently with a towel before transferring it to the bag. Place the bag and its occupant in a box in a quiet, dark location (such as a closet, with the door closed for extra security) where the animal won't be disturbed by curious pets or children.

The feet and bill of a healthy platypus should feel cool to touch, as its body temperature is naturally lower than a human's. Because platypus are so well insulated by their fur, it is essential that the place where a platypus is being kept should also be reasonably cool (ideally 20-25^{o}C, and definitely less than 30^{o} C) so the animal doesn't overheat.

SOME PRACTICAL ADVICE FOR VETERINARIANS

Platypus can be anaesthetised using isoflurane (5% for induction, 2% for maintenance, oxygen flow = 1 litre/minute). Because the platypus is adapted to diving, it can hold its breath for several minutes. The heart rate of an anaesthetised animal may also vary from fewer than 20 to more than 200 beats per minute.

REPORTING A DEAD PLATYPUS

Much more remains to be learned about the factors contributing to platypus mortality. A dead platypus is therefore of great interest to biologists and wildlife veterinarians. If you find a dead platypus, please contact the Australian Platypus Conservancy immediately. If possible, place the body inside a sealed plastic bag and store in a cold place (preferably a freezer) until it can be collected. Even if it is not feasible to save the carcass, the APC would very much like to hear about your find, especially the following details:

- Where the body was found (in relation to the nearest natural water body)
- Date when the body was discovered
- A description of any injuries or other clues at the site suggesting the cause of death

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PLATYPUS-FRIENDLY ANGLING

AN AUSTRALIAN PLATYPUS CONSERVANCY INFORMATION NOTE

The Australian Platypus Conservancy receives several hundred reports of platypus being seen each year. Many of these reports are provided by anglers, who are often well placed to spot this fascinating animal in the wild.

These records also describe many examples of avoidable platypus deaths, some of which occur as an outcome of angling or yabbying. The main causes of platypus deaths and injuries related to fishing are:

- Becoming snagged on fishing hooks
- Drowning in illegal nets (e.g. drum nets, opera house traps, gill nets)
- Becoming entangled in loops of discarded fishing line

Platypus occur in a very wide range of rivers, creeks and freshwater lakes (both natural and manmade). You can help safeguard these animals by adopting a few simple habits.

- If you happen to notice a platypus feeding near you while you're angling, move a short distance upstream or downstream to reduce the risk of catching the animal on your hook (or stop fishing for a short time until the platypus moves away).

- If you do accidentally snag a platypus, make every sensible effort to reel in the platypus and remove the hook from its bill or foot, taking care to avoid the poisonous spurs present on the heels of adult males.

- Make it your habit to pick up discarded fishing line and other rubbish left along a stream or river and dispose of it properly, including that left by others.

- Report illegal fishing activities (such as unattended set lines) to state fisheries management officers.

- Report sightings of platypus (including dead animals) to the Australian Platypus Conservancy. Such information is absolutely vital to developing a better understanding of the species' status and factors affecting population survival.

WHAT IF YOU CATCH A PLATYPUS ON A LINE?

Platypus are sometimes caught on artificial lures as well as baited hooks. Most typically, a platypus will be hooked through the edge of its bill or the webbing of a front foot.

The platypus bill is fleshy and sensitive, packed with thousands of special sensory receptors which the animal relies upon to navigate underwater and find its invertebrate prey. In human terms, it functions a bit like a cross between a lip, an eye and a thumb. Simply cutting the line and leaving the hook embedded in the bill will certainly result in a platypus experiencing severe pain over a long period, and is likely to result in its slow and untimely death. The APC has also received many reports of a platypus being found drowned after line trailing from a hook became tangled around submerged branches or tree roots, preventing the animal from reaching the surface.

For these reasons, it is essential to always do your best to remove a hook from a platypus's bill or foot before releasing the animal back to the wild.

When handling a platypus, take extreme care to avoid the poisonous spurs, about 1.5 centimetres long, located on the heels of adult males. Platypus venom is not considered to be life-threatening to humans but it can cause a lot of pain and swelling. Unless you definitely know that a platypus is not equipped with spurs, **never place your hands under the animal or support it from below using your leg or arm.** Instead, lift the platypus by gripping it firmly around the middle or end of the tail (but not the tail base, which a male can reach with his spurs).

When removing a fishing hook from a platypus, it may help to keep the animal's head covered with a folded piece of clothing or other fabric to reduce its tendency to struggle — or to place the animal in a bag or sack to restrain it.

If the hook cannot be removed safely and easily, take the platypus to a local veterinarian for treatment. When selecting a container to hold a platypus in transit, be aware that these animals are both strong for their size and talented escape artists. A platypus may be successfully confined for a short time in a sturdy cardboard box with a strong cover or lid, though the container must also be adequately ventilated so the platypus can breathe.

Alternatively, a platypus may be held inside a pillow case or hessian sack. (If these options are not available, consider making an improvised bag by knotting the sleeves of a long-sleeved garment such as a sweatshirt.) Ensure the top of the bag is securely fastened with twine or the equivalent, and if possible place the bag inside a dry bucket or box so the bag and its occupant don't shuffle away or end up under a vehicle seat. A platypus's body temperature is naturally lower than that of a human, so it's essential to keep a confined platypus out of the sun and reasonably cool (ideally at an air temperature of 20-25^{o}C, and definitely no more than 30^{o} C) to ensure it doesn't lethally overheat.

WHAT IF YOU FIND ILLEGAL NETS OR SET LINES?

Large numbers of platypus continue to be killed each year in drum nets, gill nets and enclosed yabby traps, such as opera house nets. In many cases, several animals are killed at the same time, with up to three platypus found drowned in a single opera house trap set overnight. To curb such activities, report illegal nets or other inappropriate fishing practices (such as unattended set lines) immediately to state wildlife management officers (in Victoria, contact Fisheries Victoria on 13FISH or 133474).

HOW CAN PLATYPUS SIGHTINGS BE REPORTED?

Surprisingly little information is available concerning the platypus's current status in the wild. Anglers can make a real contribution to platypus conservation by reporting sightings (particularly of any dead platypus that are found) to the Australian Platypus Conservancy. Details can be reported on-line at www.platypus.asn.au.

If you fish frequently at the same spot and sometimes see platypus there, you might like to become a *Platypus Count* volunteer. This involves regularly recording whether or not you see a platypus on a simple datasheet (which is supplied by the APC and collected quarterly). Such information is an extremely valuable way to monitor platypus populations over time. For details on how to register for *Platypus Count*, contact the APC.

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PLATYPUS CONTINGENCY PLANS FOR WORK PROGRAMS

AN AUSTRALIAN PLATYPUS CONSERVANCY INFORMATION NOTE

A platypus's daylight hours are most typically spent resting in an underground burrow located next to a water body in a consolidated soil bank (normally rising more or less vertically for a distance of 1 metre or more above the water's surface, ensuring that the nest chamber is located well above water level). Burrow entrances are generally oval in cross-section and just large enough to allow a platypus to enter. Some entrances are located underwater, with most of the remainder very well hidden by overhanging vegetation, undercut tree roots, etc. In consequence, it is normally not feasible to identify active platypus burrows in a section of bank habitat that is due to be excavated or otherwise substantially modified by heavy equipment.

As a workable alternative, the best strategy to protect platypus in such an area is as follows:

1) Limit as much as possible the amount of severe bank disturbance or compaction occurring along water bodies where substantial numbers of platypus are known to occur, particularly in the period when females are likely to be raising dependent young (September-early March in Victoria). Although some platypus burrows may be very long (up to 30 and possibly even 55 metres), the majority appear to be less than 10 metres in length, measured from the edge of the bank to the burrow chamber.

2) Use caution whenever excavating the banks of natural or manmade water bodies and ensure that contingency plans are in place to deal with any platypus that may be accidentally dug up. In this regard, we advise the following:

CONTINGENCY PLANS FOR DISPLACED PLATYPUS

When picking up an injured or displaced platypus, great care should be taken to avoid the poisonous spurs of adult males. These structures are located on the inner ankle of the hind legs and resemble the canine teeth of a small to medium-sized dog in terms of their length (around 15 mm), shape (slightly curved) and colour (off-white, often stained brownish at the base). While platypus venom is not considered to be life-threatening to humans, it can cause severe pain and spectacular swelling. When being handled by a human, males will typically be much more focused on trying to escape than acting aggressively, but it would be extremely foolish to ever grab or hold an adult male (or an animal of unknown age/gender) from below.

Unless it is definitely known that a platypus is *not* equipped with spurs, do *not* place your hands or fingers under the animal's belly or use your legs or arms to support it from below. Instead, lift the platypus by gripping it firmly around the end half of the tail (but not the tail base, which a male can reach with his spurs) – see diagram above.

While holding a platypus in this way, it should also be easy to see whether or not it has spurs.

Note that juvenile males have non-venomous spurs that are typically around 10 mm long, more or less cone-shaped, and whiter than those of adult males. Females (both adults and juveniles) lack conspicuous spurs.

At least two clean cotton bags (about the size of a pillow case or a little longer) should be kept on hand in which to confine displaced animals (with only one animal at a time held in a given bag, apart from small siblings). If a bag becomes very wet or soiled, the animal inside should ideally be transferred to a fresh, dry bag to try to keep it comfortable. A piece of twine or the equivalent will be needed to secure the top of a bag, unless a knot can easily be tied in the neck of the bag itself.

To avoid having the bag and its occupant walk away unexpectedly (or become lodged under the seat of a vehicle), each bag should be placed inside a sturdy but well-ventilated cardboard box or the equivalent.

Common sense needs to be applied when deciding whether or not to take a displaced platypus to a veterinarian for examination/treatment before releasing it back to the wild. Platypus are highly susceptible to both stress and overheating – for example, holding an animal in a bag in the sun for more than a few minutes when the air temperature is above 28^{o}C is likely to be lethal. Accordingly, the best strategy may be to release the animal immediately back to the wild after moving it approximately 150-200 metres upstream or downstream of the works site (ideally to a location providing plenty of natural cover in the form of shrubs or grasses overhanging the water). Immediate release is particularly likely to be the recommended course of action if the following conditions apply:

- The animal appears to be alert and active and seems old enough to both be familiar with the local water body and a reasonably accomplished swimmer.

- The day is forecast to be warm (over 25^{o}C) and/or it's likely to take more than an hour or so to convey the platypus to an experienced wildlife vet (ideally those based at a major zoo or wildlife park).

Alternatively, if an animal is clearly injured and/or seems abnormally sluggish (i.e. may have suffered a concussion or internal injuries) and/or appears to be so young that it should still be confined to a nursery burrow, arrangements should be made to transport it without delay to a qualified vet for assessment.

To minimise stress during transport, try to speak quietly, close car doors as quietly as possible and turn off the car radio. Keep the car cool and well ventilated. Make certain that the box containing the platypus is stored securely inside the vehicle, so it doesn't tip over or rattle around.

More generally, try to respect the fact that the platypus in your care is a wild animal that may be experiencing pain and will certainly feel threatened by close contact with humans – avoid the temptation to handle the animal unnecessarily or show it off to interested bystanders.

For more information or advice (including on the day that an animal is found), please contact the Australian Platypus Conservancy.

See also these other APC Information Notes:

- Platypus Emergency Care
- Australian Water-rat: Our Native "Otter"

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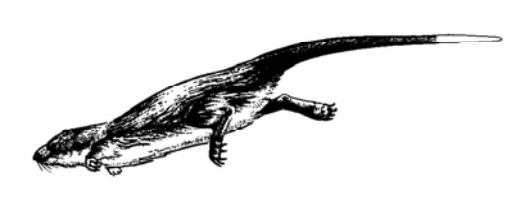
AUSTRALIAN WATER-RAT: OUR NATIVE "OTTER"



AN AUSTRALIAN PLATYPUS CONSERVANCY INFORMATION NOTE

Mention 'rat' to most Australians and images of two pests – the black rat and brown rat - spring to mind. Because of the unwelcome activities of these introduced species, we often forget that Australia has many attractive native rodents that were a natural part of the environment long before their Eurasian cousins arrived on the ships of explorers and colonists.

The Australian water-rat or rakali (*Hydromys chrysogaster*) is one of these native species. It is a top predator in a variety of aquatic habitats, including some estuarine and coastal areas. Their ecological role is equivalent to that of the otters found on other continents. The water-rat also has many otter-like features, including a thick coat of soft fur, a blunt and densely bewhiskered muzzle, partly webbed hind feet and a furry, tapering tail.

Water-rats are most often observed swimming on the surface of lakes or rivers, especially in the early morning or evening. However, the animals also frequently emerge from the water to eat (sitting up and holding their meal in their forepaws) or run along the bank searching for food. Water-rats grow to about 0.5 to 0.7 metres in length, including their tail. The colour of the head and back may be nearly black (with golden-yellow belly fur) or some shade of brown or grey (with fawn- to cream-coloured belly fur). In all cases, the animals have a conspicuous white tail tip.

The water-rat has sharp teeth which are used to capture fish, frogs, tortoises, crabs, crayfish (yabbies), mussels, large aquatic insects and even water birds - sometimes up to the size of ducks. Interestingly, the grinding surfaces of the molar teeth are quite smooth and therefore may be particularly effective at coping with the hard, encased bodies of freshwater invertebrates. The presence of water-rats in an area is often first detected by the scattered remains of yabbies or mussel shells left at favourite feeding "tables".

Although water-rats are widely distributed in Australia, the animals appear to be relatively uncommon along many waterways. There is also evidence that numbers have declined in some areas in recent years. Water-rats are warm-blooded carnivores which require a lot of food to fuel their active and energetic lifestyle. Hence, the main problem facing the species is most likely to be habitat degradation, if this in turn reduces the animals' food supply (especially in the form of fish and large aquatic invertebrates). Because water-rats have a fairly short natural lifespan (in most cases living no more than 3-4 years), local populations may vanish if females fail to reproduce successfully for several consecutive years during extended periods of drought.

Very little is known about the current status and distribution of Australian water-rats. Consequently, it is important to report water-rat sightings to develop a better understanding of where these animals occur and where they are absent – see overleaf for how to do so.

WHAT'S IN A NAME?

To help foster positive attitudes towards Australia's native rodents, new names for these species were proposed in the 1990s by the Australian government, based on aboriginal terms for the animals. The name selected for the Australian water-rat is "rakali".

HOW TO HELP WATER-RATS

Your local river, creek or lake may well support a population of these fascinating animals, which deserve our best efforts to protect them and their habitats.

- Encourage appropriate vegetation to grow along the banks of natural and manmade water bodies (including off-stream ponds and dams). This provides protective cover for water-rats and assists the development of a productive aquatic environment.

- Retain plenty of woody debris (logs and large branches) in streams, rivers, ponds and lakes. This creates handy feeding platforms for water-rats and enhances their food supply by improving habitats for native fish and aquatic invertebrates.

- Promote greater awareness of the fact that water-rats are attractive and interesting native animals that contribute to ecological health and biodiversity.

Be as conservative as possible in your use of water. After all, the less water that is wasted at home or at work, the more water can be readily spared for the environment — helping not only water-rats but also platypus and a huge range of other plants and animals.

LIVING WITH WATER-RATS

Although water-rats are protected by law, many continue to die in “opera house” nets and similar enclosed traps set to capture yabbies and freshwater crayfish. Instead, anglers are encouraged to use lift-style hoop nets or baited lines (without hooks) as inexpensive and effective methods for catching yabbies and crays.

Australian water-rats occasionally come into conflict with human interests, for example when they raid poultry pens or leave messy food remains on the decks of boats, near swimming pools or on verandahs.

Killing or relocating “problem” water-rats is generally both illegal and subject to hefty fines. In any event, such actions will almost certainly be ineffective given that dispersing juveniles are likely to occupy a vacant home range very quickly. A better solution is to learn to live with water-rats by rat-proofing areas where you don’t want the animals to go, and not leaving food around that will attract them.

A PLAT OR A RAT?

From a distance of 20 metres or more it can be very difficult to reliably distinguish a platypus from a water-rat in the water. The white-tipped tail of the rat is its best identifying mark. A water-rat also swims mainly using its back legs, causing a relatively narrow wake of ripples to form. In contrast, a platypus mainly uses its front legs to paddle, producing a relatively wider wake. As compared to a platypus, water-rats also tend to swim for longer distances and with a more sinuous motion, and are much more likely to leave the water and run on land.

REPORT WATER-RAT SIGHTINGS

Reliable sightings of Australian water-rats can be reported to the APC, including details of when and where the animal was seen. The information will be added to a secure data base, thereby contributing to our understanding of the conservation needs of Australia’s “otter”.

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A GUIDE to SPOTTING PLATYPUS and WATER-RATS in the WILD

When and where to look

Platypus *(Ornithorynchus anatinus)* and Australian water-rats (*Hydromys chrysogaster*) are most likely to be observed early in the morning or late in the evening, though both animals may also be active in the middle of the day.

Both platypus and water-rats occupy weir pools, irrigation channels and man-made dams or reservoirs as well as natural lakes, rivers, creeks, backwaters and billabongs. They are generally most readily spotted in places where the water surface is fairly calm, making it easier for observers to identify the ripples formed on the water surface as the animals swim and dive. Both species occur over a wide altitudinal range, from sea level up to at least 1500 metres. However, platypus are not commonly seen (and never abundant) in the salty water of bays and estuaries. In contrast, water-rats are known to inhabit ocean beaches and are found on many islands surrounded by sea water.

Size and appearance

At a distance of more than 20 metres, even an experienced observer may find it difficult to reliably distinguish a platypus from a water-rat, especially in poor light.

Platypus are dark brown in colour, with lighter underparts and a small white patch located next to each eye. Similarly, water-rat fur usually looks dark brown when the animals are wet. When water-rats are dry and seen at close range, their fur may (depending on the area) be chocolate brown, reddish brown, mouse grey or even mottled grey-brown, with underparts that vary in colour from cream to light brown to golden yellow.

Both species typically float low in the water, with just the top of the head and back (and sometimes a bit of tail) visible as they swim on the surface.

A platypus seen from a distance of about 25 metres (left) and a water-rat seen from a distance of about 15 metres (right)

Platypus and water-rats are also quite similar in size, with very large adult males of both species measuring up to about 60 centimetres in length (including the tail). Juveniles are of course smaller than most adults when they first enter the water. Juvenile platypus first emerge from nesting burrows in late January to early March in Victoria and New South Wales, with Queensland juveniles emerging a few weeks earlier and Tasmanian juveniles up to around two months later. By comparison, young water-rats are seen over a much longer period of time, from early spring to at least early autumn.

The best way to distinguish a water-rat from a platypus in the water is to look carefully at the tail: the water-rat has a long, narrow tail with a conspicuous white tip, whereas the platypus has a flat, uniformly dark, paddle-like tail.

Platypus are also very rarely seen on land, though they may occasionally rest on a log or rock, usually while grooming.

In contrast, water-rats are much more likely to be seen on land, either consuming their prey or running along the bank (as shown above).

Feeding habits and diet

The platypus's diet mainly consists of aquatic insects such as mayfly and caddis-fly larvae, along with other invertebrates such as worms, freshwater shrimps and yabbies. Although a platypus may sometimes glean prey from the water's surface, the animals mainly find their food by diving, with around 75 dives typically completed per hour. Prey items are stored in cheek pouches and then chewed up and swallowed after a platypus returns to the surface to breathe (as shown at left).

In contrast to a platypus, a water-rat is equipped with a sharp set of teeth and front paws that are good at grasping and holding things. Hence, while water-rats eat some of the same insects and other items regularly eaten by a platypus, they also dine on fish, large mussels and crabs, frogs (including cane toads) and occasionally even waterfowl such as ducks. All prey is captured and carried using the jaws, and then normally eaten out of the water – most typically on a conveniently placed log, rock or elevated clump of reeds which often becomes densely littered with yabby claws or mussel shells.

Diving patterns

A platypus diving sequence typically starts with the animal arching its back as it neatly propels itself forward and down into the water (as shown at right), leaving an expanding ring of ripples on the surface. There is generally little or no associated sound unless the platypus has been startled, causing the animal to push itself downwards more forcefully than usual, which in turn creates an audible splash.

A platypus will normally remain underwater for less than one minute while feeding (though occasionally a bit longer, particularly if the water is more than about 3 metres deep). When the animal's oxygen supply starts to run low it returns to the surface, most typically popping up within 10-20 metres of the point where it dived. However, if a platypus is alarmed by a bird flying overhead or some other perceived threat, it may hide underwater for 10 minutes or more, conserving oxygen by wedging itself under a handy log or the roots of an undercut tree at the water's edge. Alternatively, it may retire to a burrow or a protected location under an overhanging shrub until the danger has passed.

A platypus will hold its position by paddling gently with its front feet even while it's floating on the surface, creating a distinctive "bull's-eye" pattern of ripples which becomes stronger as the platypus dives, then gradually fades away. These strong ripples are very distinctive when the water surface is calm (as shown at left) and are often the first sign that a platypus is active in the area.

However, platypus ripples usually can be detected even in fairly choppy conditions (as shown at right). The path of a platypus underwater is sometimes marked by a stream of small bubbles rising to the surface, as air is squeezed from the fur.

The ripples formed when a water-rat dives are generally weaker and less well defined than those created by a platypus (as shown at left). Water-rats typically stay underwater for fairly short periods of time and often come to the surface relatively far from where they dived, reflecting the fact that they have been actively chasing fish or other prey underwater.

Swimming patterns

When a platypus wants to swim rapidly and directly from point A to point B, (for example, to return to a burrow to sleep at the end of a feeding session, or to chase another platypus), he or she will travel mainly on the surface so it's possible to breathe and paddle at the same time. This type of movement typically creates a long, narrow wake in the water (as shown at right), often visible from a distance as a distinctive silvery streak in calm water.

The maximum rate of travel recorded for a platypus swimming in a direct manner at the surface is around 3.6 kilometres per hour, though the animals usually progress at a more leisurely rate of around 1.5 to 2.5 kilometres per hour.

Platypus use only their front legs to paddle, resulting in quite a strong bow wave but relatively narrow trailing wake (below left). By comparison, water-rats mainly use their hind legs when swimming, which typically produces a wider trailing wake (below right).

Other behaviour

When resting on the water surface, a platypus may spend quite a lot of time scratching or combing its fur with a hind foot and can often look quite contorted (or ecstatic) while involved in this activity.

Water-rats may occasionally give themselves a quick scratch while in the water but prefer to carry out most grooming activities on land.

Other animals can sometimes be mistakenly identified as a platypus or water-rat.

It is possible to confuse diving birds (such as ducks, grebes, cormorants and darters) with both the platypus and water-rat. This is especially true of musk ducks (*Biziura lobata*): large, dark birds which often swim alone and produce a platypus-like pattern of ripples when they dive. Particularly in autumn, a male musk duck will sometimes swim with his head and neck stretched out straight in front of him near the water surface, producing a very platypus-like outline.

To distinguish waterbirds from platypus and water-rats, keep in mind that the silhouette of a platypus or water-rat is much flatter than that of even relatively small birds such as grebes and coots. If the profile of a swimming animal projects well above the water surface, it is unlikely to be that of a platypus or water-rat.

Freshwater tortoises and some of the larger fish (such as carp, eels and freshwater catfish) can sometimes be mistaken for a platypus or water-rat, particularly if glimpsed for only a few seconds in dim light. Carp in particular may spend long periods of time with their backs well out of the water as they feed near the shoreline. However, differences in the appearance and behaviour of these animals and the two mammals usually become quite obvious upon more careful observation.

Australian Platypus Conservancy

PO Box 22, Wiseleigh VIC 3885
Phone: (03) 5157 5568 Email: platypus.apc@westnet.com.au
www.platypus.asn.au

PLATYPUS SIGHTING REPORT

Australian Platypus Conservancy

1. Contact details for the person providing this report:

Name_____

Phone number or email address_____

Mailing address_____

_____Postcode_____

2. Date or period of sighting(s)_____

3. Number of platypus seen_____

4. Location of the sighting(s). To help us map this location quickly and accurately, please provide as many details as possible.

Name of waterway_____

Nearest town, village, suburb, etc._____

Describe the location clearly in relation to named roads or other landmarks (for example, about 3 km upstream of Jones Road bridge and 1.5 km downstream of Back Creek) ***OR*** by providing a GPS or map grid reference:

5. Any additional comments about what you saw:

Please return your completed form to:

Australian Platypus Conservancy
PO Box 22, Wiseleigh VIC 3885
Email: platypus.apc@westnet.com.au

PLATYPUS MORTALITY REPORT

Australian Platypus Conservancy

1. Contact details for person reporting the dead platypus:

Name_____

Phone number or email address_____

2. Date when dead platypus found_____

3. Name of nearest river/stream/lake_____

4. Location where carcass found (including approximate distance of carcass from water):

5. Sex of the platypus (tick one):

_____Male (conspicuous pointed spur, 10-20 mm long, present on inner hind ankles)

_____Female (conspicuous spur absent from hind ankles)

6. Did the platypus drown in a yabby trap/ fish net? Yes_____ No_____

7. Is a fishing hook embedded in the bill, foot or body? Yes_____ No_____

8. Are any pieces of foreign material (such as fishing line or litter) wrapped around the animal's neck or body? Yes_____ No_____

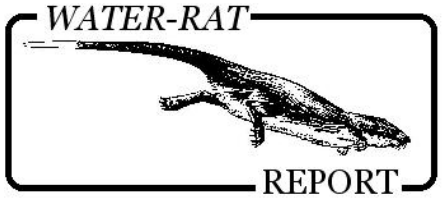
9. Are any signs of predation evident (for example, tooth puncture marks, a broken neck or crushed skull)? Yes_____ No_____

10. Summarise any additional observations relating to the cause of death below:

Please return your completed form to:

Australian Platypus Conservancy
PO Box 22, Wiseleigh VIC 3885
Email: platypus.apc@westnet.com.au

AUSTRALIAN WATER-RAT SIGHTING REPORT



1. Contact details for the person providing this report:

Name_____

Phone number or email address_____

Mailing address_____

_____Postcode_____

2. Date or period of sighting(s)_____

3. Number of water-rats seen_____

4. Location of the sighting(s). To help us map this location quickly and accurately, please provide as many details as possible.

Name of waterway_____

Nearest town, village, suburb, etc._____

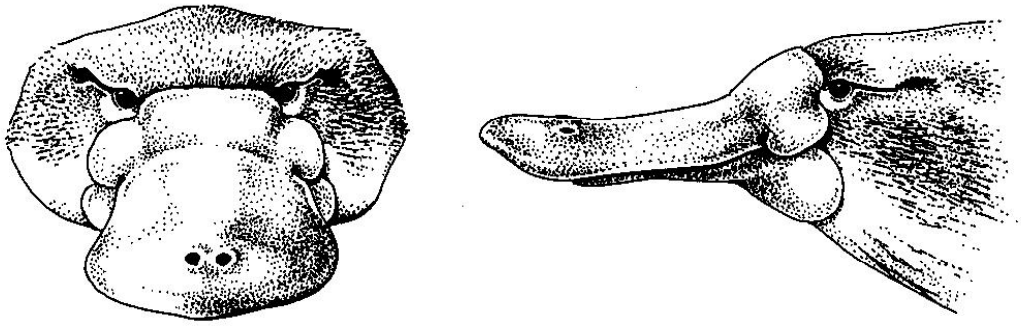
Describe the location clearly in relation to named roads or other landmarks (for example, about 3 km upstream of Jones Road bridge and 1.5 km downstream of Back Creek) ***OR*** by providing a GPS or map grid reference:

5. Any additional comments about what you saw:

Please return your completed form to:

Australian Platypus Conservancy
PO Box 22, Wiseleigh VIC 3885
Email: platypus.apc@westnet.com.au

WANTED



ALIVE!

PLATYPUS

(a.k.a. DUCKBILL or *ORNITHORHYNCHUS ANATINUS*)

**WANTED ON SUSPICION OF BEING A KEY FIGURE IN PLANS TO CREATE HEALTHY WATERWAYS.
COULD VANISH FROM YOUR AREA UNLESS DETAILS OF CURRENT WHEREABOUTS ARE ESTABLISHED SOON!**

HEIGHT: 40-60 CENTIMETRES (HEAD to TAIL)
HAIR COLOUR: BROWN ABOVE, SILVERY-CREAM BELOW
DISTINGUISHING FEATURES: LEATHERY BLACK BILL, WEBBED FEET
MOST LIKELY TO BE SEEN AT DAWN OR DUSK
MAY BE ARMED WITH A VENOMOUS SPUR ON EACH ANKLE

IF YOU HAVE EVER SEEN THIS AMAZING ANIMAL PLEASE REPORT DETAILS TO:

**AUSTRALIAN PLATYPUS CONSERVANCY
PO BOX 22
WISELEIGH VIC 3885
or report online: www.platypus.asn.au**