Australian Platypus Conservancy

Platypus Fyke-netting Guidelines

Introduction

This document (most recently revised in July 2019) aims to (1) identify the welfare issues that can arise when a platypus is captured in a fyke net and outline ways to reduce these risks, (2) identify the welfare issues for vertebrate by-catch that can arise when fyke nets are set for platypus and outline ways to reduce these risks, and (3) describe recommended protocols for platypus transport and handling, how best to deal with captured animals that are hypothermic or entangled in litter, and how best to release a platypus back to the wild (see Appendix 1). Although mainly drawn from the experience of APC biologists working in Victoria, the principles outlined below should be widely relevant across the platypus's range.

Platypus welfare issues associated with fyke-netting

Drowning. By dropping its heart rate to as little as 1.2 beats per minute, an inactive platypus can survive underwater for up to 11 minutes (Evans *et al*. 1994). However, this interval is reduced to less than 3 minutes when animals are active (Grant *et al*. 2004). The platypus will therefore drown quickly if held inside a submerged fyke net. This is most likely to occur if water levels rise after nets have been set, e.g. due to rainfall. Increased water depth and/or flow velocity may inundate fyke nets or cause them to collapse after tearing them loose from their anchoring points.

Hypothermia. The platypus normally maintains a body temperature close to 32^{o}C in both air and water (Grant and Dawson 1978a; Grant 1983). Thermal insulation in the water largely relies on an air layer trapped in dense underfur, which can be dispersed and lost when fur rubs against netting (Grant and Dawson 1978b). In practice, Smyth (1973) reported that a platypus's body temperature dropped by about 10^{o}C after being held in a tank in 11.5^{o}C water for 3.5 hours; and the temperature of animals entangled in mesh gill nets in winter typically drops by about 2^{o}C within 15-30 minutes (Grant and Dawson 1978a). In our experience, signs of hypothermia (lethargy, chilling) are most likely to develop in fyke nets if two or more animals occupy the same net in winter. In this situation, small individuals are particularly likely to become hypothermic after being squashed between netting and a larger animal.

Hyperthermia. Due to its low body temperature and limited sweating capacity, the platypus can easily overheat when held out of the water. The mean body temperature of a quietly resting platypus has been found to increase only modestly (from 32.1^{o}C to 32.9^{o}C) as air temperature increases from 25^{o}C to 30^{o}C (Grant and Dawson 1978a).However, vigorous activity will generate additional metabolic heat, e.g. if an animal repeatedly tries to escape from a bag or struggles while being handled. Caution should be exercised whenever holding a platypus at ambient temperatures >25^{o}C, and exposure to temperatures >30^{o}C should be viewed as potentially life-threatening: a platypus reportedly lost consciousness ('fainted') after being held at 35^{o}C for 17 minutes (Martin 1902, described in Grant and Dawson 1978b).

Food and energy requirements. The platypus has a very small stomach, and typically feeds on macro-invertebrates for 8-16 hours a day (see papers cited in Serena and Williams 2012). The gut transit time (stomach to colon) is just five hours (Booth and Connolly 2008). Non-breeding adults consume the equivalent of around 15-25% of their body mass in prey each day, increasing to as much as 80% of body mass late in lactation (Holland and Jackson 2002). No satisfactory technique has ever been developed to feed a platypus while it's confined in either a fyke net or a capture bag.

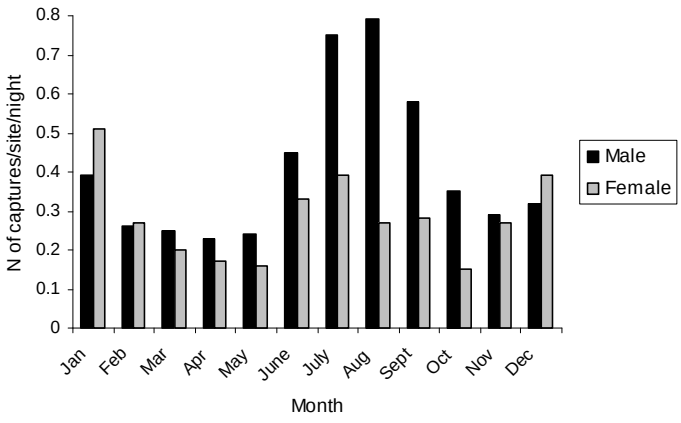
Capture-induced stress. McDonald *et al*. (1992) found that plasma concentrations of glucocorticoids (adrenaline and noradrenaline) rose sharply (from <50 nmol/l to about 300 nmol/l) in the first 30 minutes after a platypus was captured in a mesh gill net or fyke net. In the case of fyke nets, glucocorticoid concentrations dropped over the next two hours (though remaining at least twice as high as baseline levels) before rising to 600 nmol/l by c. 12 hours after capture. The magnitude of the platypus stress response to capture varies seasonally, with adult male and female responses respectively peaking in winter and spring.

Predation. Attempted predation of a platypus held in a fyke net has occasionally been recorded in APC fyke-netting surveys. In one incident, a very large water-rat was observed standing on a net set at mid-channel while staring intently at the point where a small adult female platypus was hiding under a netting funnel. A second incident involved a fox that ran from the end of a net which both contained an adult male platypus and was located in shallow water at a ford. In both cases, the netting of the chamber holding the platypus had been bitten through extensively and it is considered likely that the platypus inside would eventually have been killed if researchers hadn't intervened. Water-rats presumably may attack a platypus when both species occupy a net at the same time, though this will be limited by the water-rat's propensity for freeing itself within a short time of being captured. Long-finned eels *Anguilla reinhardtii* can grow to nearly 1.6 metres long and weigh up to 16.8 kg (Cadwallader and Backhouse 1983); large specimens may therefore constitute a credible threat to platypus held in fyke nets though corroborating data are lacking.

Aggression between adult males. Although agonistic interactions between wild males are probably rarely fatal, mortality has been recorded in captivity (Grant 2007). A similar outcome could arise if two adult males are held in the same fyke net, especially during the breeding season in late winter and spring when male aggressiveness and venom production both reach an annual peak (Temple-Smith 1973).

Miscellaneous accidents and injuries. One incident has been reported of a platypus drowning in a fyke net set in a suburban stream after someone untied the cod end from its supporting stake (possibly to release a duck) and failed to refasten it properly (R. Armistead, pers. comm.). On two occasions during APC fyke-netting sessions, an internal line in the final net chamber became twisted around the spur and hind leg of a captured adult male, resulting in ankle abrasions. Shallow cuts or abrasions may also appear on a platypus's bill tip as a presumed outcome of an animal pushing vigorously against netting in a bid to escape. Although not directly related to the capture process, platypus often carry litter wrapped around the neck and/or body that can cause deep lesions to form (Serena and Williams 1998; Serena and Williams 2010). Persons setting fyke nets should therefore be equipped with small scissors, forceps and antiseptic that can be used to remove litter before entangled animals are released ASAP back to the wild.

Temporal variation in capture rates. Monthly platypus capture rates in fyke nets vary substantially, with adult and subadult males most likely to be captured in the weeks leading up to the breeding season and females most likely to be captured at the peak of lactation (see graph at right summarising data for Victoria). Capture rates also vary through the night, with 63% of adults/subadults and 73% of juveniles recorded in the first half of the night when fyke nets are set overnight (Serena and Williams 2012).



Net-setting protocols to protect platypus welfare in platypus surveys

- To protect platypus from drowning, the cod end of a net must be securely attached to a fixed object (e.g. tree, metal stake hammered into the channel) so a substantial air space is available in the end chamber and ideally along the entire length of the net.

- Adopt a proactive and cautious approach to ensure that nets do not become submerged after being deployed. For example, do not set nets if appreciable run-off is likely to occur, and promptly remove nets from water if water levels begin to rise after unexpected rainfall. (In practice, substantial run-off in urban areas may occur after as little as 5 mm of rainfall.)

- To avoid drawing the attention of foxes or other predators to captured animals, do not stretch the end of fyke nets onto the bank (and ideally place the end chamber in water that is ≥20 cm deep).

- To prevent captured animals becoming exhausted as a by-product of dealing with strong currents or turbulent flow, place the end chamber of nets in relatively slow-moving water (e.g. near the bank or sheltered by a log if flow is otherwise swift) and ideally angle the end chamber more or less across the current.

- Check all nets just before dark to ensure they are still set correctly and to release water birds or other vertebrate by-catch.

- The frequency of nocturnal net-checking must necessarily vary with water temperature to reduce the risks that animals become hypothermic or incur large energy costs while confined in nets at low ambient temperatures. In practice:

  - If water temperature at dusk is ≥15^{o}C (the presumed lower limit of the platypus's thermoneutral zone: Bethge *et al*. 2001), check all nets within the first 4 hours after dusk, and at intervals of <4 hours thereafter until nets are closed.

  - If water temperature at dusk is <15^{o}C, check all nets at intervals of <2 hours, starting at dusk. Apply common sense: given that a platypus's metabolic rate is predicted to rise as water temperature declines, aim to minimise the amount of time that animals spend in nets, particularly if water is very cold.

- In waters where large long-finned eels are likely to be abundant, check nets at intervals of <2 hours in February-March, when small juvenile platypus enter the trappable population.

- To limit hunger and stress experienced by a captured platypus, ensure that the maximum interval that an animal remains captive (measured from the time when the net holding the platypus was previously checked to the time when the animal is released back to the wild) is <4 hours.

Welfare issues for non-target vertebrates in fyke nets deployed for platypus

The main non-target vertebrates entering platypus nets include Australian water-rats/rakali, water birds (mainly ducks) and various fish species. Turtles are typically not encountered very often in platypus fyke-netting surveys, but may sometimes occur in reasonably high numbers alongside platypus (e.g. in on-stream dams or lagoons/billabongs), thereby increasing the likelihood that turtles enter platypus nets set at these sites.

Water-rats/rakali

Drowning. Australian water-rats can (and generally do) escape from fyke nets elevated partly above the water by biting through netting to create an exit hole. The main exception involves small juveniles, which are occasionally found curled up (in a resting posture) on elevated netting at the cod end of a net. Two water-rats drowned in submerged fyke nets set to survey fish near Bairnsdale in the 1970s (Beumer *et al*. 1981); drownings have also reportedly occurred more recently in submerged opera house traps and commercial fyke nets (Williams and Serena 2018). We conclude that being confined underwater in a net is a genuine mortality risk for this species.

Hypothermia. Water-rats can easily become hypothermic in cold water, e.g. core body temperature typically drops from approximately 36^{o}C to 28^{o}C within 1-3 hours of entering 15^{o}C water (Fanning and Dawson 1980). However, given that only small juveniles are typically detained in fyke nets for any length of time, and that the water-rat breeding season extends from September to January in Victoria (McNally 1960), the risk that water-rats become hypothermic in fyke nets is low.

Water birds

Duckling mortality. Ducklings are often captured in platypus fyke nets. Some mothers accompany their offspring into the net, whereas others remain nearby without entering. Ducklings can normally be freed without incident, but young birds are occasionally found dead after their siblings and mother are released. It is presumed that mortalities occur accidentally when ducklings are held underwater or suffer a broken neck as their mother vigorously seeks to escape from approaching humans. Predatory by-catch (such as large eels) may also occasionally kill ducklings when both are confined together. To reduce the risk that ducklings die or are separated from their mother for any length of time, check all nets before dusk and release birds immediately. When small ducklings and their mother have entered a net together, first restrain the female by firmly holding her wings against her body, then transfer ducklings by hand from the net to a suitable container (e.g. a bucket). Release the family together at a spot located >10 metres from the net (in the direction they were originally travelling), ideally near protective cover such as shrubs overhanging the water.

Fish

Predation. Fish remains are sometimes found in platypus survey nets following apparent predation by larger fish, water-rats, crayfish and (rarely) adult male platypus. The estimated incidence of predation would presumably be much higher if ingested fish remains were detectable.

Gilling' injuries. Small fish occasionally become wedged in netting as they try to escape from platypus fyke nets. In our experience, this rarely involves more than one fish per net. With care, some individuals can be released without apparent harm by gently pushing them backwards.

Migration events. Because they block the entire channel, platypus fyke nets can potentially intercept or deter migratory movements by fish. For example, 19 fish species found in Victorian freshwater habitats are known to move substantial distances to spawn or otherwise complete their life cycle (Table 1). Mass movements by Victorian species are particularly likely to be triggered when strong and sustained rises in flow occur (e.g. ≥30% above baseflow: Tony Steelcable, pers. comm.), but much smaller rises in flow may promote movement in some species (Justin O'Connor, pers. comm.). In practice, we are aware of only one case in which large numbers of migrating fish are known to have been intercepted by platypus nets in Victoria: 116 common galaxias *G. maculatus* and 491 short-finned eels *Anguilla australis* were captured (after being progressively released through the night) at sites along a creek following a series of storms in early December (Mitrovski 2008). The risk posed by platypus fyke nets to migrating fish is normally limited by the fact that experienced practitioners avoid conducting surveys when flows have recently risen, in a bid to prevent excessive quantities of leaves and other debris from accumulating in nets.

Turtles

Drowning. Turtles may drown if a fyke net contains hoops and/or funnels that become progressively narrower along its length, making it impossible for some animals to reach the elevated cod end to access air. In Victoria, this is most likely to occur in the case of broad-shelled turtles *Chelodina expansa* (Katie Howard, pers. comm.)

Net-setting protocols to protect non-target vertebrates captured in platypus surveys

Water-rats/rakali

The protocols to protect platypus welfare in fyke nets should adequately protect the welfare of water-rats entering fyke nets as by-catch.

Water birds

The protocols to protect platypus welfare in fyke nets should generally protect the welfare of water birds entering fyke nets as by-catch.

Fish

- To reduce predation risk in nets, routinely release fish and decapod crustaceans on each occasion that nets are checked (apart from declared noxious species, which should be killed humanely). (N.B. Releasing fish and crustaceans should also reduce the number of water-rats entering nets, and hence the likelihood that platypus may escape via holes created by water-rats.)

- Adopt a vigilant and informed approach towards the possibility that mass movements of migratory fish may occur: be aware of any migratory species that could occur in a water body where platypus nets are being set and when (in what months) fish may move; do not set nets along a water body supporting migratory species (in the months when movements could occur) if stream flow has recently increased by ≥30%; and immediately remove all nets from the water if there is any evidence that a migratory event is in progress. In addition, routinely set fyke nets with the wings in a V-shaped configuration so fish are encouraged to enter the main body of a net rather than to try to swim through the wings (Tarmo Raadik, pers. comm.). Finally, to reduce the risk that a migratory event is delayed unduly, avoid setting nets on consecutive nights in water bodies supporting migratory fish species in the months when movements could occur, particularly if flows have recently increased.

Turtles

The protocols to protect platypus welfare in fyke nets should generally protect turtle welfare, especially if an air space is maintained in all sections of the net. Routinely release captured turtles on each occasion that platypus nets are checked. If hoops/funnels become progressively narrower at any point along the length of a net, take special care to ensure that the entire length of the net is partly raised above the water surface in places where turtles (particularly *Chelodina expansa*) are likely to occur.

Acknowledgements

An earlier version of this document benefited from input provided by C. Bloink, M. Campbell, J. Griffiths, K. Handasyde, K. Howard, J. O'Connor, A. Pickworth, T. Steelcable, R. Weber, and A. R. Weeks.

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July 2019

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Table 1. List of Victorian fish species found in freshwater habitats that engage in mass movements over substantial distances at some stage(s) in the life cycle. Information provided courtesy of Biosis Pty Ltd (Melbourne Resource Group), based on Koehn and O'Connor (1990).

Species name	*Timing of movements*	*Distribution in Victoria*
Short-headed lamprey (*Mordacia mordax*)	Downstream Aug-Nov Upstream Aug-Dec	Patchy distribution in coastal drainages
Pouched lamprey (*Geotria australis*)	Downstream Jul-Aug Upstream Jul-Nov	Very patchy distribution in coastal drainages west of Lakes Entrance
Short-finned eel (*Anguilla australis*)	All year (at different stages)	Possible in all coastal drainages
Long-finned eel (*Anguilla reinhardtii*)	Jan-Jun (glass eels)	Possible in all coastal drainages east of Wilsons Promontory
Common galaxias (*Galaxias maculatus*)	Downstream Apr-Jun Upstream Sept-Dec	Possible in all coastal drainages
Broad-finned galaxias (*Galaxias brevipinnis*)	Downstream Apr-Jun Upstream Sept-Dec	Possible in all coastal drainages
Spotted galaxias (*Galaxias truttaceus*)	Downstream Apr-Jun Upstream Sept-Dec	Locally abundant in Otway Coast drainages; otherwise patchily distributed in coastal drainages
Tasmanian mudfish (*Neochanna cleaveri*)	Upstream Sept-Nov	Possible in most coastal drainages, especially from Otway Coast to Bunyip River basin
Australian grayling (*Prototroctes maraena*)	Downstream May-Aug Upstream Oct-Dec	Possible in all coastal drainages east of Warrnambool, notably Bunyip, S. Gippsland and Snowy River basins
Murray cod (*Maccullochella peeli*)	Sept-Jan	Possible throughout the Murray-Darling Basin; also translocated to Yarra River Basin
Trout cod (*Maccullochella macquariensis*)	Unknown	Murray, Goulburn and Ovens River basins
Macquarie perch (*Macquaria australasica*)	Oct-Dec	Upper reaches of Ovens, Goulburn and Broken River basins; also translocated to Yarra River basin
Golden perch (*Macquaria ambigua*)	Jun-Dec	Possible in all drainages in Murray-Darling Basin
Estuary perch (*Macquaria colonorum*)	Jul-Dec	Possible in all coastal drainages except in Melbourne region
Australian bass (*Macquaria novemaculeata*)	Downstream Apr-Jul Upstream Aug-Oct	Coastal drainages east of Wilsons Promontory
Silver perch (*Bidyanus bidyanus*)	Sept-Dec	Possible in all drainages in Murray-Darling Basin
Tupong (*Pseudaphritis urvilii*)	Jul-Aug	Possible in all coastal drainages
Striped gudgeon (*Gobiomorphus australis*)	Unknown	Distribution poorly known; recorded in and east of Snowy River basin
Cox's Gudgeon (*Gobiomorphus coxii*)	Unknown	Distribution poorly known; recorded in and east of Snowy River basin

Appendix 1. Recommended Platypus Handling, Transport and Release Protocols

How to remove a platypus from a fyke net

Check all nets for the first time just before dark to release water birds and rectify any changes to the way nets are set. After dark, the presence of a platypus in a net is usually indicated by the net wiggling slightly when first illuminated by torches: the animal itself will generally be hidden under the netting sleeve in the final chamber. However, platypus behaviour in traps varies considerably, with some animals being more active than others. It may be necessary to gently shake the net to elicit movement from a platypus that is hiding.

It is highly recommended that at least two persons should work together to remove a platypus from a fyke net, both for their own personal safety and to reduce the likelihood that an animal escapes. To reliably motivate a platypus to swim to the cod end with minimum fuss after dark, one person (Person 1) should move to the front of the net and shine a torch towards the rear, where the second person (Person 2) should be standing with his or her torch turned off. When the animal reaches the end, Person 2 should tie a precut piece of string or cord tightly around the netting just in front of the final hoop, thereby isolating the animal and restricting its forward movement. (If the trap contains two or more animals, remove them individually in sequence, taking care not to force remaining animals underwater without access to air.)

Once the platypus is isolated at the cod end of the net, Person 2 can untie the net from the stake or other structure to which it is secured. Person 1 should then firmly hold the final hoop horizontally in both hands (as if holding a dinner plate), so the platypus is resting, supported by netting, in the middle of the plate. Person 2 can then undo the knot securing the cod end and open the end of the net to look down at the platypus, holding up a reasonably high wall of netting around the animal to deter it from scrambling out. At this point animals will most typically be moving in a circular pattern around the edge of the dinner plate, looking for a way to escape. It is essential that Person 1 continues to hold the hoop firmly as the animal moves around – in our experience, the platypus will not attempt to spur hands holding the hoop (or apparently even register their presence as such). Some animals will also try to climb up towards the open top of the netting. Do not attempt to grab an animal if it does this! Instead, Person 2 should simply give the netting a brisk shake to dislodge the animal so it falls back onto the dinner plate.

Even a very active platypus will normally pause after a minute or two. When it's at rest and in a position that's clear of internal fyke net lines, Person 2 should immediately reach down into the net with one hand and firmly grasp the animal **around the end half of its tail if it's an adult male or of unknown age/sex** (see additional comments below). Pull the animal from the net, inspecting its ankles for spurs if this hasn't already occurred. Animals will at this point often grab the hoop and/or netting with their front feet; Person 1 can assist by applying some downward pressure on the hoop or otherwise gently releasing the animal's grip. It is also now Person 1's responsibility to reach for a dry capture bag (which should previously have been draped over the shoulder or placed in another easy-to-reach spot), open it up wide so the platypus can be dropped inside, then immediately knot or tie the top securely shut so the platypus can't escape.

Transport, handling and release

If possible, process captured animals on site and return them to the water ASAP so they can resume feeding. Minor bleeding may occur after marking an animal with an implanted PIT identification tag (in line with elevated blood pressure following capture); if so, apply pressure with a gauze square or the equivalent until bleeding stops before returning the animal to the water.

If animals are to be taken to another location before being processed, transport each platypus in a cloth bag (about the size of a pillow case or a little longer). Place each bag individually in an open-topped box to reduce stress and the risk of possible disease transfer between animals. Avoid unnecessary noise throughout the period that animals are held: speak quietly, turn off the car radio and close car doors as quietly as possible.

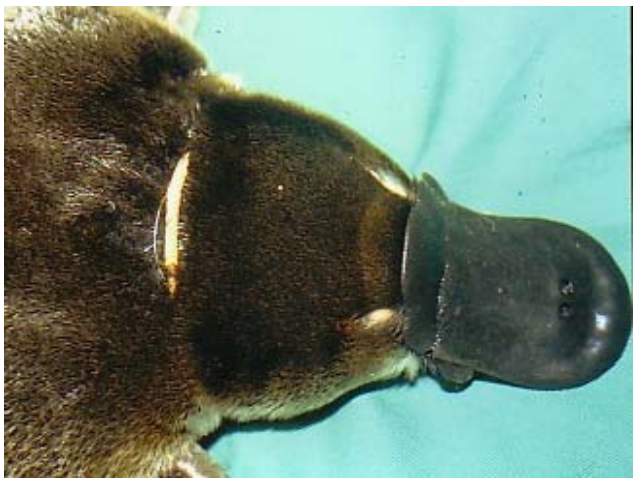
Following transport to a centralised location, transfer each animal as soon as possible to a fresh (i.e. dry) cloth bag. Keep an animal's eyes covered during handling and aim to complete all measurements and other procedures within 10 minutes. Only hold animals in dry, clean cloth bags: change bags if they become soiled with urine/faeces. Hold animals in individual boxes in a quiet, cool location and check occasionally that they are arranged comfortably inside bags in the period before they are released. Given the timing and direction of changes in post-capture glucocorticoid profiles (McDonald *et al*. 1992) and the fact that gut transit time in this species is 5 hours (Booth and Connolly 2008), the total interval that a platypus is detained (including both the length of time that it may have been in a net and the amount of time it is held out of the water) should be $\leq$4 hours.

Release animals a short distance (around 20 metres) upstream or downstream from their capture site (i.e. as opposed to right next to a net). In the case of small juveniles, release animals in the direction that will facilitate their backtracking to a burrow. In the case of older animals, release them in the direction they were originally travelling so they can continue to follow their preferred foraging route. Regardless of which side of the nets is chosen for release, there is a fairly low likelihood that an animal will be recaptured at a given site on the same night, particularly if researchers stand near nets immediately following its release with their torches on. If an animal is found to have re-entered a net when the site is next checked, remove both nets from the water before again releasing it. Do not release an animal that appears to be hypothermic (mildly or severely chilled and lethargic); hold the animal in a dry bag and allow it to warm up gradually until it is active and responsive.

Take care to ensure that a captured platypus is not subject to heat stress while out of the water. Animals must never be held in bags for more than a few minutes if air temperature exceeds 25^{o}C, with exposure to temperatures >30^{o}C appropriately viewed as potentially life-threatening. Don't turn on a car heater when an animal is transported inside a vehicle, and hold and handle animals away from room heaters (or in shaded locations during the day). To help keep a platypus's body temperature from dropping at air temperatures below 15^{o}C, place a folded bag or the equivalent under the animal to provide insulation between its body and the surface below.

As a standard precaution, persons coming into contact with a platypus or used capture bag (particularly if contaminated with urine or faeces) should wash their hands thoroughly with soap (or apply hand sanitising solution) immediately after such contact. Place a washable plastic table cloth or the equivalent on the surface where animals are marked and measured, and store used capture bags in a disposable plastic bag until they can be laundered in hot water.

Identifying and dealing with animals entangled in litter



Persons checking nets set in urban and suburban settings are particularly likely to encounter a platypus with plastic, rubber or metal litter encircling its neck and/or body. Known examples include elastic hair-ties, a hospital identification wrist band, an engine gasket, food packaging materials, cable-ties, plastic bangles and (as shown at right) fishing line and rubber bands. These materials gradually wear through the skin and underlying tissues and can cause life-threatening injuries (Serena and Williams 1998; Serena and Williams 2010). It is therefore imperative that any item of litter should be identified and removed (using scissors and forceps as required) before releasing the animal without delay so it can resume feeding and be spared further unnecessary stress.

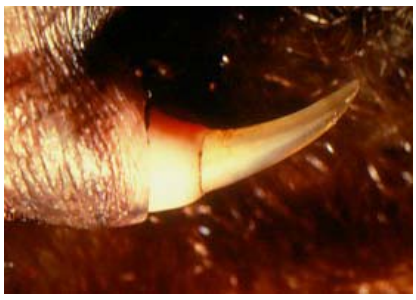
Identifying and dealing with hypothermic animals

The feet and bill of a healthy platypus should feel slightly cool to the touch, as its body temperature is normally a few degrees lower than that of a human. If an animal's whole body feels chilled and/or it is noticeably lethargic when taken from a net, it is almost certainly hypothermic. In extreme cases, animals can effectively become moribund; the only animal we have seen in this state (a juvenile male confined in a fyke net with an adult male for no more than 2 hours in winter) was barely able to move its limbs and had crawled out of the water onto exposed horizontal netting at the cod end of the net, presumably to avoid drowning. A hypothermic platypus should be dried as thoroughly as possible with a towel, transferred to a dry bag and encouraged to warm up gradually. It should not be released back to the wild until it is alert and lively, i.e. capable of avoiding predators, swimming efficiently and locating a burrow.

Platypus spurs

When picking up a platypus, take care to avoid contact with the poisonous spurs located on the heels of adult males. An adult male (or animal of unknown age/sex) should only be carried by gripping the end half of the tail (but not the tail base, which a male can reach with his spurs) – see diagram at right. While holding a platypus in this manner, it should be easy to determine whether or not obvious spurs are present. While platypus venom is not life-threatening to humans, it can cause excruciating pain and spectacular swelling. Unless it is definitely known that a platypus is *not* an adult male, *never* place your hands or fingers against the animal's abdomen or between its hind legs, or use your legs or arms to support it from below (even if the animal is in a bag).

The size and appearance of platypus spurs can be used to help identify an animal's age class as well as its sex (Temple-Smith 1973; Williams *et al*. 2013). In the case of juvenile males (<1 year old), spurs have a relatively stubby, conical appearance due to being covered in a sheath of whitish keratin (as shown below at left). The keratin sheath gradually wears away (starting from the tip), revealing the off-white or amber-coloured true spur. Spurs of subadult (or second-year) males can be distinguished from those of older animals by the presence of a basal skin collar that initially covers about one-third of the spur's total length (as shown below at middle). The collar skin gradually regresses and is very much reduced in width by the time that males reach maturity at the age of two years. Spurs of mature males (as shown below at right) are typically 12-20 mm long and sometimes stained darker brown around the base, presumably by dried venom.



Juvenile females have a vestigial brown or whitish 'spur', typically just 1-2 mm long, located on each hind ankle. This structure is often easier to feel than to see and is normally lost at the age of about 9 months, leaving a small, shallow pit in the skin of older females.

Drawing courtesy of Peter Marsack, photos: APC