WOMBAROO

MILK REPLACERS & FOOD SUPPLEMENTS

for native animals

3rd Edition 2016

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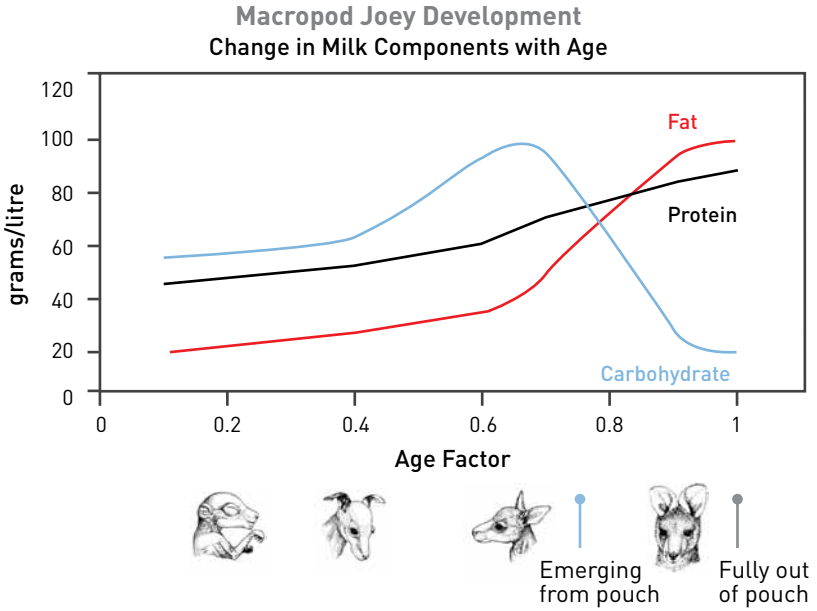
ABOUT MARSUPIAL MILK

Milk provides the essential nutrients for growth and development of juvenile marsupials. Information on the nutritional composition of milks from a range of different species is sourced from both published data as well as private research undertaken by Wombaroo. This research shows that marsupial milk undergoes significant changes in composition (fat, protein & carbohydrate) over the period of lactation. The chart below shows the changes in milk components for a typical macropod (kangaroo) joey. Different species of marsupials (possums, wombats, koalas) have different compositional changes during lactation and therefore have different developmental charts.



The changes in milk composition cater for the widely differing nutritional requirements of the developing joey from furless "pinkie" to fully out-of-pouch. For example early lactation macropods obtain much of their energy from carbohydrate and cannot tolerate high fat levels. However later in lactation this situation is reversed, with milk becoming heavily concentrated with fat to provide additional energy. Protein levels also change to cater for the increased requirements for fur growth during mid lactation and the rapid growth rate seen around pouch emergence. For these reasons a single milk formula is not ideal for hand rearing any marsupial. Different Wombaroo milks are therefore formulated to provide the optimum nutrition at different stages of a joey's development.

The Wombaroo milk stages are related to the Age Factor (AF) of the joey, which is the age of a joey as a proportion of its total pouch life:

$$\text{Age Factor (AF)} = \frac{\text{Age of joey}}{\text{Age when fully out of pouch}}$$

For example a Grey Kangaroo is normally fully out of the pouch at about 320 days. Therefore a Grey Kangaroo joey at 160 days has an Age Factor of 160/320 = 0.5. A joey at fully out of pouch age has completed 100% of its pouch life so it has an age factor of 1.0. By definition, a joey that spends any time in the pouch has an age factor of less than 1.0. Pouch emergence begins for most species of macropods at an Age Factor of around 0.7 to 0.8.

The concept of Age Factor helps us standardise the nutritional requirements for joeys from related species. Macropods develop at roughly the same rate when compared using Age Factor so that a Potoroo at 65 days, a Swamp Wallaby at 130 days, and a Grey Kangaroo at 160 days all have similar nutritional requirements (All have an Age Factor = 0.5).

The table below outlines the typical developmental "milestones" for macropods based on Age Factor (reproduced with permission from Helen George). This provides a useful guideline as to the expected development of a joey over time.

Age Factor	Stage of Development	Nutritional Considerations
0 (birth)	Eyes closed; front legs developed; buds for hind legs.	Low energy milk, with a low fat content. Digestive system is not well developed - milk contains easily digested carbohydrates and proteins. Immunoglobulins to boost immune system. Limited gut flora.
0.2	Eyes closed; ears folded flat on top of head; ear-canal closed; membrane joining lip; small hole at front of mouth for teat; hind legs formed.	
0.3	Membrane between lips has disappeared; whiskers growing. Runny yellow faeces.	
0.4	Eyes still closed; ears still flat but starting to become upright; animal fully formed.	Steadily increasing energy content of milk. Protein contains sufficient levels of sulphur-containing amino acids (cysteine & methionine) for the onset of hair & nail growth. Still limited gut flora.
0.5	Eyes now open; dark colouring on back of hands, bridge of nose, tips of ears; fur about to come through skin; poking head out from pouch occasionally; Faeces yellow custard to toothpaste consistency.	
0.56	Fur colour visible under skin on entire body; Fur forming on bridge of nose and head.	

Age Factor	Stage of Development	Nutritional Considerations
0.6	Fur lengthening rapidly all over the body; fur appears last on belly/chest; leaning from mother's pouch and eating dirt to establish gut flora, starting to thermoregulate. Faeces darkening and forming.	Peak carbohydrate content in milk with high levels of associated digestive enzymes. Able to handle higher fat levels in milk.
0.7	Joey grazing from pouch making use of green feed; secondary coat appearing, the animal looks like a miniature adult. Faeces soft to firm green pellets.	High energy milk with a high fat content - coincides with increased activity levels of joey. Sharp fall in carbohydrate content of milk with decrease in associated gut enzymes. Increasing levels of "body-building" proteins (caseins, α-globulins) to coincide with peak growth rate. Gut flora developed for digestion of solid food.
0.8	Joey starting to emerge from the pouch; spends longer and longer periods outside the pouch; feeding, urinating, defecating outside the pouch.	
0.9	First incisor teeth erupting through gum; full length fur growth.	
1.0	Joey fully emerged from the pouch; still drinking milk; solid food plays a large part in the diet.	

WHAT'S IN WOMBAROO

Wombaroo contains a blend of protein, carbohydrate, fat, vitamins and minerals formulated to match as closely as possible the composition of natural mother's milk.

PROTEIN is a recombination of bovine milk protein fractions to produce the optimum proportion of caseins and whey proteins, with a balanced amino acid profile. Essential amino acids have been fortified with extra lysine, cysteine & methionine the latter of which are particularly important for healthy hair growth.

CARBOHYDRATE is mainly in the form of glucose. Some formulations also contain maltodextrin made from the enzymatic digestion of starch, which is high in glucose-oligosaccharides and low in α-limit dextrin. Our research has shown this to be a well-digested form of energy, particularly for early lactation marsupials when carbohydrate accounts for up to 40% of the milk's energy (Rich BG, 1993. *Activities of intestinal disaccharidases in hand-reared macropods*. Wildlife Diseases Association of Australasia. Mallacoota). All marsupial formulae are low in lactose and free galactose to minimize digestive upset.

FAT is a mix of milk fat solids, vegetable oils and fatty acid esters prepared from fish oil. These ingredients are blended to produce the optimum mix of saturated, mono-unsaturated and polyunsaturated fats and include the essential omega-3 fatty acids α-linolenic acid (ALA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

VITAMIN and MINERAL composition data in marsupial milk is sparse.The addition of these micro-nutrients is based on best estimates obtained from those milks that have been analysed. The nutrients well quantified in marsupial milk include vitamin A, vitamin E, calcium, phosphorous, potassium, sodium, iron and copper. Where values are unknown we have added the full complement of vitamins and minerals in quantities that are acceptable by recognised animal husbandry standards. This includes vitamin D_3, vitamin C, vitamin K_1, thiamine, riboflavin, pyridoxine, niacin, pantothenic acid, folic acid, biotin, cyanocobalamin, choline, inositol, magnesium, zinc, manganese, iodine and selenium. See **Appendix 4** for further discussion about calcium levels and the incidence of bone fractures in joeys.

HOW TO USE WOMBAROO

Use Wombaroo as a complete food for rearing orphaned joeys or as supporting nutrition for debilitated or convalescing animals. Maternal milk supplies immunoglobulins throughout much of a marsupial's lactation, providing immunity to diseases and intestinal protection due to its many antimicrobial properties

Success in hand rearing joeys may be improved if **Impact Colostrum Supplement** is added to Wombaroo milk to help boost the immune system (page 11).

Using Wombaroo milk for marsupials is a three-step process.

Step 1 Determine the Age Factor of the joey in care.

Step 2 Select the correct Wombaroo milk replacer for that age factor.

Step 3 Feed the correct volume of milk replacer based on the body weight of the animal.

Age Determination

Accurate age determination means that the correct formula for the stage of development can be fed. Joeys can be aged according to their physical characteristics (eg hair growth, body measurements, consistency of faeces). The developmental milestones outlined for macropods in the table on pages 2 and 3 may be a useful guide. This booklet provides growth charts for some of the common species that come into care, which can be used as a guideline for feeding joeys. Contact Wombaroo or visit **www.wombaroo.com.au** for growth information of any other species not listed in the booklet.

Body weight should not be used to estimate age as this can be highly misleading due to large variations between individuals, malnourishment or dehydration.

Using the Growth Charts

It is important to note that the growth charts are only a guide and do not take into account differences due to sex, geographical variation and health condition of the joey. Estimate the animal's age from the body measurements given for that species (see **Appendix 5**). Where available, head length is the most accurate indicator of age, followed by foot and tail lengths. Often measurements do not exactly correlate, so use the average age indicated by the measurements on the chart.

The estimated age determines the stage of Wombaroo milk to feed.

Based on the estimated age, the charts provide a typical body weight for that age. This is a guideline only and may be subject to a high degree of variation between individuals. However comparing the joey's actual weight to that presented on the chart may provide an indication as to the condition of the joey. For example in drought conditions it is not unusual for joeys to be up to 50% underweight compared to normal years.

The joey's actual body weight determines the daily feed volume.

Feed according to the joey's actual body weight, as this gives the correct feed volume for your particular joey. Individual growth rates can vary substantially from the growth charts, so some animals won't match up with the charts. However if you are concerned that an animal is failing to thrive, underweight or malnourished it is always useful to seek veterinary advice. Further information on underweight or malnourished joeys is provided in **Appendix 2**.

Making Up Milk

Wombaroo should be made up according to the directions on the pack. Different formulae are made up at different concentrations of solids per litre of milk. For example Kangaroo Milk Replacer >0.7 formula is made up at 250g of powder per litre of prepared milk. This means that about 800mL of water is added to 250g of powder to make up 1 litre of formula. Do not simply add 1 litre of water to the 250g of powder as this will produce more than 1 litre of milk and result in a diluted formula.

Wombaroo milk powders have different densities and should be weighed when preparing milk.

If weighing out milk powder is not possible then use the enclosed scoop to measure out small quantities of milk powder in accordance with the directions on the pack. Note that using the scoop is less accurate, so wherever possible we still recommend to weigh out the powder.

Even if only feeding small quantities, it is preferable to make up milk in larger volumes (i.e. a litre at a time) as this is more accurate to measure out and mix up. Once made up, milk can be stored frozen in smaller quantities (e.g. in ice cube trays or freezer bags). These smaller quantities can then be thawed, remixed and used as required with minimal wastage. Do not re-freeze thawed milk. Prepared milk can be stored in a refrigerator for a day or frozen for up to 2 weeks.

When making up milk use pre-boiled water, as this sterilises the water and reduces microbial contamination.

Use warm water (about 50°C), too cold and the powder won't disperse properly and too hot can curdle the milk proteins and destroy some nutrients. Some formulae are particularly high in fat so are best mixed with an electric whisk to prevent separation. Milk may not make up properly if there are contaminants in water (eg tank water), or if the powder has been exposed to heat, moisture, light or is out of date. Refer to **Appendix 1** about storage of milk powders.

Feeding

Milk should be warmed to about 30°C and fed using a bottle and teat. Your Wombaroo stockist can supply 100ml graduated plastic bottles and a suitable latex teat from our range of shapes (see page 45 for the range of Wombaroo teats available).

Tables of suggested feed volumes are supplied with each packet of milk replacer. Feed volumes have been carefully calculated using a mathematical relationship between body weight and daily energy requirement. This relationship is not linear, so feeding a straight percentage of body weight is not accurate. Often new carers are told rules of thumb like "Feed 15% of body weight per day." This simple rule eventually produces feed volumes that are grossly inaccurate and can be detrimental to the health of the animal. Depending on the species and stage of lactation, the feed volume can range from 4% to 70% of body weight per day. Overfeeding may cause diarrhoea.

Do not concentrate or dilute Wombaroo milk replacers by making them up to volumes other than that indicated on the packet directions. This will change the osmolarity of the milk solution and may lead to malabsorbtion of nutrients from the gut. Avoid introducing additional nutrients to the milk (other than Impact Colostrum Supplement) as this may unbalance the nutrient profile of the Wombaroo.

Feeding Frequency

Young joeys suckle small volumes of milk frequently and can only cope with large, infrequent feeds as they become older. As a rule, it is preferable to feed a little often rather than a lot infrequently. Husbandry guidelines for macropods are as follows:

Age Factor	Milk Feeds per day	Faecal Consistency	Housing Temperature
<0.4	12-8	Thin Custard	34-36°C
0.4	8-6	Thick Custard to Toothpaste	32-34°C
0.6	5-4	Toothpaste to Soft Pellets	28-30°C
>0.7	4-3	Soft to Firm Pellets	20-25°C
1.0 to weaning	2-1	Firm Pellets	Ambient

Source: Vogelnest, L & R Woods (Eds.). (2008). *Medicine of Australian mammals*. CSIRO PUBLISHING. p 22.

Feeding frequency is also dependent on the species' biology. For example, once left in the burrow, young wombats and echidnas are naturally fed larger volumes but less frequently. If unsure, consult an experienced carer about the husbandry requirements of the species in question.

Growth Rate

Weigh joeys regularly. Consistency in growth rate is a good measure of adequate nutrition. Animals have an optimum, or ideal, growth rate that allows development to occur in a controlled fashion. Overfeeding, leading to an excessive growth rate may lead to obesity and possible skeletal deformities. Underfeeding, causing sub-optimal growth rate may lead to poor development and a more disease prone animal. A continuing decline in growth rate could indicate the onset of disease or malnutrition in young animals. See **Appendix 2** for more information on treating underweight or malnourished joeys.

Transition of Milk

Milk transition refers to when a joey is changed from one Wombaroo milk stage to the next. This transition is necessary to cater for the changing nutritional requirements of joeys as they grow. It is important to transition joeys at the correct age to ensure they are getting the proper nutrition for their stage of development. We recommend to transition from one milk stage to the next gradually over a period of about 10 to 20 days (depending on species and age). This is outlined in the various growth charts presented for individual species. The gradual transition of milk formulas reduces the likelihood of digestive upset for the joey.

For example to transition a 950g Eastern Grey Kangaroo from 0.4 to 0.6 formula over a 10 day period:

Start	100mL 0.4 Kangaroo Milk Replacer
Day 1-3	Mix 75mL 0.4 formula with 25mL of 0.6 formula
Day 4-6	Mix 50mL 0.4 formula with 50mL of 0.6 formula
Day 7-9	Mix 25mL 0.4 formula with 75mL of 0.6 formula
Finish	100mL 0.6 Kangaroo Milk Replacer

Note that the start and finish volumes are the same, and that simply the ratio of one milk to the other is changed throughout the transition. If an animal is not tolerating the transition well (e.g. diarrhoea), then go back to a higher proportion of the earlier stage milk, and progress through the transition more slowly.

Some developmental problems can be related to joeys not being transitioned at the correct age, or being left on a particular stage of milk for too long. For example the 0.6 Kangaroo stage only lasts for about 30 days for a Grey Kangaroo.

Even if a joey is significantly underweight for its age, it still needs to be transitioned to the next stage milk after the specified amount of time indicated in the growth chart. The reason for this is that changes in milk composition and digestive physiology still occur at the same age regardless of the joey's weight or body condition.

Drinking Water

When a joey first comes into care, it is important to provide sufficient rehydration fluids before feeding milk.

Pouch-bound Joeys: Having been properly rehydrated, the normal feed volume of Wombaroo milk adequately supplies the maintenance water requirements recommended for small mammals (see **Appendix 3**). Pouch-bound young with low activity levels, housed at the optimum temperature and humidity therefore do not usually require additional drinking water. However young joeys can dehydrate rapidly if not maintained under ideal conditions. If the joey is showing signs of dehydration (e.g. during hot weather, or due to diarrhoea), give extra drinks of water between feeds.

Emerging Joeys: Joeys begin to regulate their own water intake once they start to emerge from the pouch. Offer small drinks of water between feeds once they begin emerging and ensure drinking water is always easily accessible when joeys are fully out of pouch. Joeys should also have access to fresh grass and browse at this stage, and this can be sprayed with water to mimic dew that provides a natural source of moisture to grazing animals.

If providing drinking water, do not add large volumes of extra water into the milk, as this dilutes energy intake and may reduce absorption of nutrients. If possible, give drinking water separately, between milk feeds.

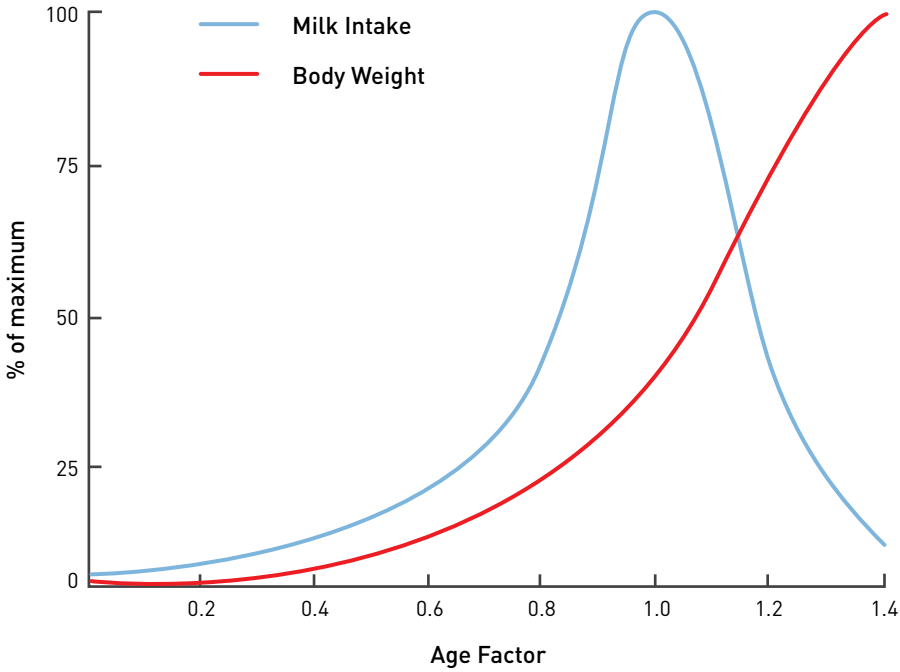
See **Appendix 3** for more detailed information on Dehydration & Drinking Water.

Weaning

Once a joey leaves the pouch it begins to eat more solid food and becomes less reliant on milk. The amount of milk fed until fully weaned depends on the amount and nutritional value of other food eaten.

A typical milk intake curve for the Tammar Wallaby is shown on the following page (Merchant 1989). It is expected that most marsupials would have a similar shaped milk production curve. The key points are:

1. Maximum milk intake occurs at full pouch emergence (Age Factor =1.0).
2. Milk intake drops rapidly after pouch emergence, as the joey weans on to solid food.
3. Joey is weaned at an age factor of about 1.4.



Using the above guideline, it is expected that joeys are usually weaned at an Age Factor of around 1.3 -1.5 times the joey's pouch life. For example a Grey Kangaroo with a pouch life of 320 days would be fully weaned by about 1.4x320 = 450 days. Sick or malnourished joeys may need to be weaned later than healthier ones. However the continued feeding of large volumes of milk after pouch emergence should be discouraged as this makes weaning a more difficult and prolonged process. Since sexual maturity and/or dispersal of young occurs shortly after weaning in many species, it is important that hand-reared animals are weaned at a similar time to mother-reared young.

Animals destined for release should be weaned on to solid foods that form part of their natural diet in the wild. For grazers and browsers maintained in captivity such as kangaroos, wallabies and wombats, **Wombaroo Kangaroo Pellets** (page 38) can be used as an ideal supplement for weaning joeys.

Reference

Merchant JC (1989). Lactation in macropodid marsupials. In *Kangaroos, Wallabies and Rat-Kangaroos* (eds G Grigg et al) p362.

Impact Colostrum Supplement

Impact Colostrum Supplement	Analysis	
For newborn animals and marsupial joeys. Contains high levels of immunoglobulins and antibacterials including lactoferrin, lysozyme and lactoperoxidase that may provide immunity and intestinal protection to young animals. Feed to newborn eutherians in the first 48 hours after birth or as an adjunct to milk replacers for marsupial joeys up until weaning. **Pack size: 25g, 50g, 250g, 500g.**	Protein	60%
	Fat	6%
	Carbohydrate	20%
	Immunoglobulin	75g/kg
	Lactoferrin	2g/kg
	Lactoperoxidase	100,000 iu/kg

Immunity in Marsupials

Young marsupials receive immune protection from immunoglobulins present in their mother's milk. Evidence suggests that there are low levels of immunoglobulins in the milk throughout much of lactation, with a spike around the time of first pouch emergence, when the young are first exposed to new pathogens in the environment. Therefore the period available for immune transfer from the milk is much longer in marsupials than the short colostrum phase seen in most other mammals. However when orphaned joeys come into care, immunity derived from the mother's milk can deplete significantly after 7 days and may be completely gone by 4-6 weeks. This may be a significant contributing factor to disease in hand-reared joeys. There is strong evidence that the antimicrobial proteins in bovine colostrum are effective against a number of common pathogens across a range of species, and there is long-standing anecdotal support for its beneficial effect in marsupial joeys.

Using Impact for Marsupials

Impact is ideally fed to pouch-bound marsupials within a week of first coming into care, particularly for those animals with a compromised immune system. **Impact** may be fed as either a concentrated 5-day course or a less-concentrated maintenance dose.

Concentrated 5-day course: Determine the required amount of **Impact** powder for body weight and mix directly into the daily volume of milk. Repeat this procedure for up to 5 days, every 4 to 6 weeks, as necessary. Use when animals initially come into care, for sick or stressed animals, or just prior to first pouch emergence (Age Factor of 0.6).

Maintenance dose: Add 1g of **Impact** powder per 100mL of milk fed, repeated daily, as required. Use as a preventative measure to provide a constant low-dose of immunoglobulins during care.

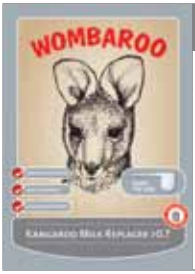
Milk for Kangaroos

Suitable for all species of macropods including kangaroos, wallabies, pademelons, bettongs & potoroos.

Kangaroo Milk Replacer <0.4	Analysis	
For joeys with less than 40% of pouch life completed. Furless. Pink skin. Eyes closed. Ears down. Faeces: Yellow custard consistency. **Pack size: 140g, 700g.**	Solids	140g/litre
	Protein	36%
	Fat	14%
	Carbohydrate	41%
	Energy	2.6MJ/litre

Kangaroo Milk Replacer 0.4	Analysis	
For joeys with 40% of pouch life completed. Furless. Darkening skin. Eyes nearly open or just opened. Ears nearly erect Faeces: Yellow toothpaste. **Pack Size: 180g, 900g, 5kg.**	Solids	180g/litre
	Protein	34%
	Fat	22%
	Carbohydrate	36%
	Energy	3.6MJ/litre

Kangaroo Milk Replacer 0.6	Analysis	
For joeys with 60% of pouch life completed. Fur: Fine to short. Ears Erect. Faeces: Mustard toothpaste to soft green pellets. **Pack size:** **220g, 1.1kg, 5kg, 10kg.**	Solids	220g/litre
	Protein	32%
	Fat	28%
	Carbohydrate	32%
	Energy	4.7MJ/litre



Kangaroo Milk Replacer >0.7	Analysis	
For joeys with greater than 70% of pouch life completed. Fur: Short to dense. Spends time out of pouch. Faeces: Soft to firm green pellets. **Pack size:** **250g, 1.25kg, 5kg, 10kg, 20kg.**	Solids	250g/litre
	Protein	30%
	Fat	42%
	Carbohydrate	14%
	Energy	6.1MJ/litre

Red Kangaroo *(Macropus rufus)*

Milk	Age (days)	Tail (mm)	Foot (mm)	Head (mm)	Weight (g)	Feed (ml/day)	Notes
<0.4	50	48	25	32	40	12	
	60	59	31	37	65	17	
	70	70	39	42	95	23	
	80	84	48	46	125	28	
	90	98	57	51	180	36	
Transition	92	101	59	52	192	36	27mL <0.4 + 9ml 0.4
	95	105	62	53	210	36	18mL <0.4 + 18ml 0.4
	98	109	65	55	228	36	9mL <0.4 + 27ml 0.4
0.4	100	112	67	56	240	36	
	110	128	77	60	315	47	
	120	145	89	65	405	55	Eyes opening
	130	162	102	69	510	64	
	135	171	109	74	570	68	
Transition	137	175	111	75	594	68	50mL 0.4 + 18ml 0.6
	140	181	115	76	630	68	34mL 0.4 + 34ml 0.6
	142	185	118	78	658	68	18mL 0.4 + 50ml 0.6
0.6	145	192	122	79	705	68	
	150	203	128	83	785	73	
	160	226	142	88	970	85	Fine hair covering
Transition	162	231	145	89	1016	85	65mL 0.6 + 20ml >0.7
	165	238	149	90	1085	85	40mL 0.6 + 45ml >0.7
	168	245	153	92	1154	85	20mL 0.6 + 65ml >0.7
>0.7	170	250	156	93	1200	85	
	180	275	169	97	1450	100	Emerging from pouch
	190	302	180	102	1800	120	
	200	330	191	107	2250	140	
	210	360	202	111	2750	155	
	220	393	211	116	3375	175	
	230	430	220	121	4100	205	
	240	467	227	125	4900	240	Fully out of pouch
Weaning	250	Growth rate now about 75g per day				240	Feed volume now depends on amount of solids consumed
	270	Not Valid				180	
	290					120	Gradually increase solid food and reduce milk intake until fully weaned
	310					80	
	330					40	
	350					0	Fully weaned

Eastern Grey Kangaroo *(Macropus giganteus)**

Milk	Age (days)	Tail (mm)	Foot (mm)	Head (mm)	Weight (g)	Feed (ml/day)	Notes
<0.4	60	47	28	36	45	13	Whiskers visible
	70	58	34	40	65	17	
	80	69	41	45	90	22	
	90	80	49	50	115	26	
	100	94	57	55	145	31	Eyelashes visible
	110	108	65	59	195	38	
	120	123	74	64	260	48	
Transition	122	126	76	65	274	48	36mL <0.4 + 12ml 0.4
	125	131	79	67	296	48	24mL <0.4 + 24ml 0.4
	128	136	81	68	319	48	12mL <0.4 + 36ml 0.4
0.4	130	139	83	69	335	48	
	140	156	93	73	420	57	
	150	172	103	77	525	65	
	160	191	113	81	640	75	Eyes open
	170	209	123	85	780	90	
	180	228	133	88	950	100	Fine fur visible on head
Transition	182	232	135	89	990	100	75mL 0.4 + 25ml 0.6
	185	238	138	90	1050	100	50mL 0.4 + 50ml 0.6
	188	244	141	91	1110	100	25mL 0.4 + 75ml 0.6
0.6	190	248	143	92	1150	100	
	200	268	153	96	1350	110	
	210	288	163	99	1550	120	Fine fur covering body
Transition	212	292	165	100	1600	120	90mL 0.6 + 30ml >0.7
	215	298	168	101	1675	120	60mL 0.6 + 60ml >0.7
	218	305	171	102	1750	120	30mL 0.6 + 90ml >0.7
>0.7	220	309	173	103	1800	120	
	230	329	183	106	2070	135	
	240	350	194	109	2350	145	
	250	371	204	112	2700	155	Emerging from pouch
	260	392	214	115	3150	165	
	270	414	224	118	3600	185	
	280	436	234	121	4100	200	Incisors through gums
	290	458	244	123	4600	220	
	300	480	254	126	5100	240	
	310	495	259	128	5600	250	
	320	510	264	130	6100	260	Fully out of pouch
Weaning	330	Growth rate now about 50g per day				240	Feed volume now depends on amount of solids consumed
	360	Not Valid				180	
	390					120	Gradually increase solid food and reduce milk intake
	420					60	
	450					0	Fully weaned

*Note: Smaller animals (eg females) may better follow the growth curve of the Western Grey Kangaroo.

Western Grey Kangaroo (*Macropus fuliginosus*)*

Milk	Age (days)	Tail (mm)	Foot (mm)	Head (mm)	Weight (g)	Feed (ml/day)	Notes
<0.4	60	44	26	34	40	12	Whiskers visible
	70	53	32	39	58	16	
	80	63	38	43	77	20	
	90	74	45	47	100	23	
	100	86	52	51	125	28	Eyelashes visible
	110	99	59	55	160	33	
	120	112	67	59	205	40	
Transition	122	115	69	60	215	40	30mL <0.4 + 10ml 0.4
	125	119	71	61	230	40	20mL <0.4 + 20ml 0.4
	128	123	73	62	245	40	10mL <0.4 + 30ml 0.4
0.4	130	126	75	63	255	40	
	140	141	84	67	310	46	
	150	157	93	71	380	53	
	160	174	102	75	460	61	Eyes open
	170	191	111	79	560	68	
	180	208	120	82	680	80	Fine fur visible on head
Transition	182	212	122	83	712	80	60mL 0.4 + 20ml 0.6
	185	217	125	84	760	80	40mL 0.4 + 40ml 0.6
	188	222	127	84	808	80	20mL 0.4 + 60ml 0.6
0.6	190	226	129	85	840	80	
	200	244	139	88	1000	90	
	210	263	148	91	1160	100	Fine fur covering body
Transition	212	267	150	92	1190	100	75mL 0.6 + 25ml >0.7
	215	273	153	93	1250	100	50mL 0.6 + 50ml >0.7
	218	278	155	93	1310	100	25mL 0.6 + 75ml >0.7
>0.7	220	282	157	94	1350	100	
	230	302	167	97	1550	110	
	240	322	176	100	1770	120	
	250	342	185	103	2050	130	Emerging from pouch
	260	362	195	106	2400	145	
	270	383	204	109	2800	155	
	280	406	214	112	3250	170	
	290	428	224	114	3700	190	
	300	446	232	116	4200	210	
	310	455	235	118	4700	230	
	320	463	237	120	5200	240	Fully out of pouch
Weaning	330	Growth rate now about 40-50g per day				240	Feed volume now depends on amount of solids consumed
	360	Not Valid				180	
	390					120	Gradually increase solid food and reduce milk intake
	420					60	
	450					0	Fully weaned

*Note: Larger animals (eg males) may better follow the growth curve of the Eastern Grey Kangaroo. WA animals (subspecies ocydromus) may grow more slowly and reach developmental milestones later than indicated on the chart.

Euro (*Macropus robustus erubescens*)*

Milk	Age (days)	Tail (mm)	Foot (mm)	Weight (g)	Feed (mL/day)	Notes
<0.4	50	43	22	22	7	
	60	51	27	39	12	Whiskers present
	70	61	33	56	15	
	80	72	40	82	20	
	90	86	48	115	26	
Transition	92	89	50	122	26	20mL <0.4 + 6ml 0.4
	95	94	52	133	26	13mL <0.4 + 13ml 0.4
	98	99	54	145	26	6mL <0.4 + 20ml 0.4
0.4	100	102	56	155	26	
	110	120	65	205	32	
	120	140	74	260	38	Eyes opening
	130	160	84	320	47	
	135	170	90	350	50	Fine fur visible on head
Transition	137	174	92	365	50	40mL 0.4 + 10ml 0.6
	140	180	95	388	50	25mL 0.4 + 25ml 0.6
	142	184	97	403	50	10mL 0.4 + 40ml 0.6
0.6	145	191	101	425	50	
	150	202	107	465	52	
	160	225	120	550	60	Fine hair covering
Transition	162	230	122	579	60	45mL 0.6 + 15ml >0.7
	165	238	126	623	60	30mL 0.6 + 30ml >0.7
	168	245	129	666	60	15mL 0.6 + 45ml >0.7
>0.7	170	250	131	695	60	
	180	275	143	840	65	
	190	303	155	1080	80	Emerging from pouch
	200	332	166	1400	100	
	210	358	174	1800	120	
	220	385	182	2200	140	
	230	402	186	2610	150	
	240	420	191	3020	160	Fully out of pouch
Weaning	250	Growth rate now about 40-50g per day			160	Feed volume now depends on amount of solids consumed
	270	Not Valid			140	
	290				100	Gradually increase solid food and reduce milk intake until fully weaned
	310				60	
	330				30	
	350				0	Fully weaned

* Note: Some animals may better match the Common Wallaroo growth curve.

Common Wallaroo *(Macropus robustus robustus)**

Milk	Age (days)	Tail (mm)	Foot (mm)	Weight (g)	Feed (mL/day)	Notes
<0.4	60	54	29	42	12	
	70	66	35	60	16	Whiskers present
	80	78	41	84	21	
	90	90	48	112	25	
	95	96	53	128	28	
Transition	97	99	55	137	28	21mL <0.4 + 7ml 0.4
	100	104	57	150	28	14mL <0.4 + 14ml 0.4
	102	107	59	159	28	7mL <0.4 + 21ml 0.4
0.4	105	113	62	173	28	
	110	122	68	200	32	
	120	141	79	255	37	
	130	162	91	320	47	Eyes opening
	140	186	103	390	55	
	150	210	117	475	60	Fine fur visible on head
Transition	152	215	120	495	60	45mL 0.4 + 15ml 0.6
	155	223	124	525	60	30mL 0.4 + 30ml 0.6
	158	230	129	555	60	15mL 0.4 + 45ml 0.6
0.6	160	235	131	575	60	
	170	263	145	685	66	
	175	280	152	745	70	Fine fur covering body
Transition	177	287	155	770	70	50mL 0.6 + 20ml >0.7
	180	297	159	810	70	35mL 0.6 + 35ml >0.7
	182	303	161	840	70	20mL 0.6 + 50ml >0.7
>0.7	185	313	164	885	70	
	190	328	169	960	75	
	200	359	178	1200	85	Emerging from pouch
	210	391	187	1520	105	
	220	418	196	1880	125	
	230	445	203	2280	140	
	240	466	208	2680	155	
	250	486	212	3090	165	
	260	505	216	3500	180	Fully out of pouch
Weaning	270	Growth rate now about 40-50g per day			180	Feed volume now depends on amount of solids consumed
	290	Not Valid			140	
	310				100	Gradually increase solid food and reduce milk intake until fully weaned
	330				60	
	350				30	
	370				0	Fully weaned

* Note: Some animals may better match the Euro growth curve.

Agile Wallaby *(Macropus agilis)*

Milk	Age (days)	Tail (mm)	Foot (mm)	Weight (g)	Feed (mL/day)	Notes
<0.4	50	48	22	28	9	
	60	60	27	40	12	Whiskers present
	70	72	32	62	16	
	80	84	40	85	21	
Transition	82	87	42	90	22	16mL <0.4 + 6ml 0.4
	85	90	45	100	22	11mL <0.4 + 11ml 0.4
	88	94	47	110	22	6mL <0.4 + 16ml 0.4
0.4	90	97	49	120	22	
	100	112	59	170	29	
	110	129	70	235	35	
	120	148	82	320	48	Eyes opening
Transition	122	152	84	335	48	36mL 0.4 + 12ml 0.6
	125	158	88	365	48	24mL 0.4 + 24ml 0.6
	128	164	92	400	48	12mL 0.4 + 36ml 0.6
0.6	130	168	94	420	48	Lower Incisor through gums
	140	192	106	540	60	
	150	218	120	685	65	Fine hair covering
Transition	152	224	122	715	65	50mL 0.6 +15ml >0.7
	155	232	126	765	65	30mL 0.6 + 35ml >0.7
	158	241	130	815	65	15mL 0.6 + 50ml >0.7
>0.7	160	247	132	850	65	
	170	280	142	1050	80	Upper incisor through gums
	180	315	150	1300	95	
	190	351	157	1550	110	Emerging from pouch
	200	384	164	1800	120	
	210	418	170	2050	130	
	220	450	176	2300	140	Fully out of pouch
	230	478	181	2550	150	
Weaning	250	Growth rate now about 25g per day			120	Feed volume now depends on amount of solids consumed
	270	Not Valid			90	
	290				60	Gradually increase solid food and reduce milk intake
	310				30	
	330				0	Fully weaned

Red-Necked or Bennett's Wallaby *(Macropus rufogriseus)*

Milk	Age (days)	Tail (mm)	Foot (mm)	Weight (g)	Feed (mL/day)	Notes
<0.4	60	48	23	50	14	Whiskers present
	70	59	28	65	17	
	80	69	33	85	21	
	90	80	38	105	24	
	100	90	44	130	28	
	110	101	51	160	32	
Transition	112	104	53	170	32	24mL <0.4 + 8ml 0.4
	115	108	55	185	32	16mL <0.4 + 16ml 0.4
	118	112	57	200	32	8mL <0.4 + 24ml 0.4
0.4	120	115	59	210	32	
	130	128	67	260	38	
	140	142	75	320	47	Eyes opening
	150	158	83	390	55	
	160	177	92	470	60	
Transition	162	181	93	488	60	45mL 0.4 + 15ml 0.6
	165	187	96	515	60	30mL 0.4 + 30ml 0.6
	168	192	98	542	60	15mL 0.4 + 45ml 0.6
0.6	170	196	100	560	60	First incisors through gums
	180	217	110	660	65	
	190	239	120	780	72	Fine hair covering
Transition	192	243	122	808	72	54mL 0.6 + 18ml >0.7
	195	250	125	853	72	36mL 0.6 + 36ml >0.7
	198	258	128	898	72	18mL 0.6 + 54ml >0.7
>0.7	200	263	130	930	72	
	210	289	140	1100	80	
	220	319	148	1310	95	Emerging from pouch
	230	350	156	1540	105	
	240	378	163	1770	120	
	250	403	168	2000	130	
	260	415	174	2250	140	
	270	428	179	2500	150	
	280	440	183	2750	155	Fully out of pouch
Weaning	290	Growth rate now about 25g per day			140	Feed volume now depends on amount of solids consumed
	310	Not Valid			100	
	330				60	Gradually increase solid food and reduce milk intake.
	350				30	
	370				0	Fully weaned

Swamp Wallaby *(Wallabia bicolor)*

Milk	Age (days)	Foot (mm)	Head (mm)	Weight (g)	Feed (mL/day)	Notes
<0.4	60	23	32	40	12	
	70	27	36	50	14	
	80	32	40	65	17	
	90	37	44	90	22	
	100	42	48	115	24	
Transition	102	43	49	119	24	18mL <0.4 + 6ml 0.4
	105	45	50	126	24	12mL <0.4 + 12ml 0.4
	108	47	51	136	24	6mL <0.4 + 18ml 0.4
0.4	110	48	52	145	24	
	120	56	56	190	31	
	130	65	60	240	36	Eyes opening
	140	74	64	300	45	
	150	82	68	370	50	
Transition	152	84	69	380	50	40mL 0.4 + 10ml 0.6
	155	86	70	405	50	25mL 0.4 + 25ml 0.6
	158	88	71	430	50	10mL 0.4 + 40ml 0.6
0.6	160	90	72	450	50	
	170	99	76	550	60	
	180	106	79	670	65	Fine hair covering
Transition	182	107	80	695	65	50mL 0.6 + 15ml >0.7
	185	109	81	735	65	30mL 0.6 + 35ml >0.7
	188	111	81	785	65	15mL 0.6 + 50ml >0.7
>0.7	190	112	82	820	65	
	200	119	84	1000	75	
	210	125	86	1180	85	Emerging from pouch
	220	131	88	1370	100	
	230	137	90	1580	110	
	240	142	92	1830	120	
	250	145	94	2100	135	
	260	148	96	2350	145	Fully out of pouch
Weaning	270	Growth rate now about 25g per day			125	Feed volume now depends on amount of solids consumed
	280	Not Valid			100	
	300				60	Gradually increase solid food and reduce milk intake.
	320				30	
	340				0	Fully weaned

Tasmanian Pademelon *(Thylogale billardierii)*

Milk	Age (days)	Tail (mm)	Foot (mm)	Head (mm)	Weight (g)	Feed (mL/day)	Notes
<0.4	40	29	22	23	38	12	
	50	35	26	26	46	13	Whiskers present
	60	41	31	30	55	15	
	70	48	36	33	65	16	
Transition	72	50	37	34	68	16	12mL <0.4 + 4ml 0.4
	75	52	38	35	73	16	8mL <0.4 + 8ml 0.4
	78	54	40	36	77	16	4mL <0.4 + 12ml 0.4
0.4	80	56	41	37	80	16	
	90	64	46	40	95	19	Lower incisors first visible
	100	73	51	44	115	21	
	110	82	55	47	138	24	Eyes opening
Transition	112	84	56	48	144	24	18mL 0.4 + 6ml 0.6
	115	87	57	49	153	24	12mL 0.4 + 12ml 0.6
	118	90	59	50	163	24	6mL 0.4 + 18ml 0.6
0.6	120	92	60	51	170	24	
	130	103	65	54	218	28	
	140	114	70	58	270	32	Fine hair growth
Transition	142	116	71	58	282	32	24mL 0.6 + 8ml >0.7
	145	119	72	59	303	32	16mL 0.6 + 16ml >0.7
	148	123	74	60	325	32	8mL 0.6 + 24ml >0.7
>0.7	150	125	75	61	340	32	
	160	137	80	65	430	39	First emerging from pouch
	170	150	85	68	540	46	
	180	163	90	72	680	55	
	190	176	95	75	850	65	
	200	189	100	79	1030	75	Fully emerged from pouch
Weaning	210	Growth rate now about 15-20g per day				65	Feed volume now depends on amount of solids consumed
	230	Not Valid				45	
	250					30	Gradually increase solid food and reduce milk intake
	270					15	
	290					0	Fully weaned (approx 2.2 -3.0kg)

Other Growth Charts

Growth charts are available for a range of other macropod species including Whiptail, Tammar & Parma Wallaby, Brush-tailed, Unadorned & Yellow-footed Rock-wallaby, Red-necked and Red-Legged Pademelon, Quokka, Long-nosed & Long-footed Potoroo, Rufous, Northern, Tasmanian & Brush-tailed Bettong (Woylie). Contact Wombaroo or visit **www.wombaroo.com.au** for further information.

Red-legged Pademelon (*Thylogale stigmatica*)*

Milk	Age (days)	Tail (mm)	Foot (mm)	Head (mm)	Weight (g)	Feed (ml/day)	Notes
<0.4	40	28	21	21	36	11	
	50	35	26	25	43	13	
	60	43	32	29	52	14	Whiskers present
	70	56	37	32	62	16	
Transition	72	59	38	33	65	16	12mL <0.4 + 4ml 0.4
	75	63	39	34	70	16	8mL <0.4 + 8ml 0.4
	78	67	41	35	75	16	4mL <0.4 + 12ml 0.4
0.4	80	70	42	36	79	16	
	90	83	47	40	102	19	
	100	96	53	44	125	22	Eyes opening
	105	103	55	46	137	24	
Transition	108	107	57	47	144	24	18mL 0.4 + 6ml 0.6
	110	110	58	47	149	24	12mL 0.4 + 12ml 0.6
	113	114	60	49	157	24	6mL 0.4 + 18ml 0.6
0.6	115	117	61	49	163	24	Skin Darkening
	120	123	63	51	178	26	
	130	137	69	55	210	28	Very Fine Hair Growth
Transition	132	139	70	56	218	28	21mL 0.6 + 7ml >0.7
	135	144	71	57	230	28	14mL 0.6 + 14ml >0.7
	138	148	73	58	244	28	7mL 0.6 + 21ml >0.7
>0.7	140	150	74	59	255	28	
	150	164	79	62	300	30	Emerging from pouch
	160	177	84	66	350	33	
	170	189	90	70	410	38	
	180	200	95	74	480	42	
	190	210	100	77	560	48	Fully emerged from pouch
Weaning	200	Growth rate now about 15g per day				45	Milk volume now depends on amount of solids consumed
	210	Not Valid				40	
	220					30	Gradually increase solid food and reduce milk intake until fully weaned
	240					15	
	260					0	Fully weaned (approx 1.5 -2.5kg)

* May also be used as a guideline for Red-necked Pademelon (*Thylogale thetis*)

Whiptail Wallaby *(Macropus parryi)*

Milk	Age (days)	Tail (mm)	Foot (mm)	Head (mm)	Weight (g)	Feed (ml/day)	Notes
<0.4	60	48	25	30	30	9	
	70	59	30	34	40	12	
	80	72	36	38	55	15	Whiskers present
	90	86	42	41	75	19	
	100	101	49	45	95	22	
Transition	102	104	50	46	100	22	16mL <0.4 + 6ml 0.4
	105	109	53	47	109	22	11mL <0.4 + 11ml 0.4
	108	113	55	48	119	22	6mL <0.4 + 16ml 0.4
0.4	110	116	56	49	125	22	
	120	134	64	53	170	28	
	130	153	72	56	220	34	Eyes opening
	140	173	81	60	280	40	
	150	194	90	64	350	50	
Transition	152	199	92	65	368	50	40mL 0.4 + 10ml 0.6
	155	206	96	66	395	50	25mL 0.4 + 35ml 0.6
	158	212	99	67	422	50	10mL 0.4 + 40ml 0.6
0.6	160	217	101	68	440	50	
	170	241	112	71	540	60	
	180	266	123	75	640	65	Fine hair covering
Transition	182	271	125	76	660	65	50mL 0.6 + 15ml >0.7
	185	279	129	77	690	65	30mL 0.6 + 35ml >0.7
	188	286	132	78	726	65	15mL 0.6 + 50ml >0.7
>0.7	190	291	134	79	750	65	
	200	317	145	83	880	70	
	210	345	158	86	1030	75	Emerging from pouch
	220	375	171	90	1200	85	
	230	405	185	93	1450	100	
	240	437	199	96	1700	115	
	250	470	213	99	1950	130	
	260	503	227	102	2200	140	Fully out of pouch
Weaning	270	Growth rate now about 25g per day				130	Feed volume now depends on amount of solids consumed
	290	Not Valid				100	
	310					75	Gradually increase solid food and reduce milk intake
	330					50	
	350					25	
	370					0	Fully weaned

Rufous Bettong *(Aepyprymnus rufescens)*

Milk	Age (days)	Tail (mm)	Foot (mm)	Weight (g)	Feed (mL/day)	Notes
0.4	55	60	30	40	10	Just releasing teat
	60	66	34	48	12	
Transition	62	69	36	52	12	9mL 0.4 + 3ml 0.6
	65	74	38	58	12	6mL 0.4 + 6ml 0.6
	68	80	40	64	12	3mL 0.4 + 9ml 0.6
0.6	70	84	42	68	12	
	75	94	49	84	14	
	80	104	56	102	16	Eyes opening
Transition	82	108	59	110	16	12mL 0.6 + 4ml >0.7
	85	115	64	124	16	8mL 0.6 + 8ml >0.7
	88	123	68	138	16	4mL 0.6 + 12ml >0.7
>0.7	90	130	71	148	18	Fully furred
	95	148	80	180	20	Emerging from pouch
	100	168	88	215	24	
	105	190	96	265	27	
	110	215	103	330	32	
	115	240	110	400	37	Fully emerged from pouch
Weaning	120	Growth rate is now about 10-15g per day			36	Milk volume now depends on amount of milk consumed
	140	Not Valid			18	Gradually increase solid food and reduce milk intake until fully weaned
	160				0	Fully weaned (approx. 750g)

Black-striped Wallaby *(Macropus dorsalis)**

Milk	Age (days)	Foot (mm)	Head (mm)	Weight (g)	Feed (mL/day)	Notes
<0.4	60	24	33	35	11	
	70	28	37	45	13	Whiskers present
	80	33	41	60	16	
Transition	82	34	42	64	16	12mL <0.4 + 4ml 0.4
	85	36	43	71	16	8mL <0.4 + 8ml 0.4
	88	38	44	78	16	4mL <0.4 + 12ml 0.4
0.4	90	39	45	83	16	
	100	45	49	110	20	
	110	52	53	140	24	Eyes opening
	115	56	55	155	26	
Transition	117	58	55	162	26	20mL 0.4 + 6ml 0.6
	120	60	57	174	26	13mL 0.4 + 13ml 0.6
	123	63	58	186	26	6mL 0.4 + 20ml 0.6
0.6	125	64	58	195	26	
	130	69	60	220	29	
	140	79	64	280	34	Fine hair covering
Transition	142	81	65	296	34	26mL 0.6 + 8ml >0.7
	145	84	66	320	34	17mL 0.6 + 17ml >0.7
	148	87	67	344	34	8mL 0.6 + 26ml >0.7
>0.7	150	89	67	360	34	
	160	99	71	460	40	Emerging from pouch
	170	107	74	575	49	
	180	115	78	720	58	
	190	121	82	900	70	
	200	126	86	1100	80	
	210	131	90	1300	90	Fully out of pouch
Weaning	230	Growth rate now about 20g per day			80	Feed volume now depends on amount of solids consumed
	250	Not Valid			60	
	270				40	Gradually increase solid food and reduce milk intake
	290				20	
	310				0	Fully weaned

* Males may be significantly larger than females, especially once emerged from the pouch.

Brush-tailed Rock Wallaby *(Petrogale penicillata)*

Milk	Age (days)	Tail (mm)	Foot (mm)	Head (mm)	Weight (g)	Feed (mL/day)	Notes
<0.4	50	47	19	29	20	7	
	60	55	23	33	29	9	Whiskers present
	70	65	28	37	40	12	
Transition	72	67	29	38	43	12	9mL <0.4 + 3ml 0.4
	75	70	31	39	47	12	3mL <0.4 + 6ml 0.4
	78	73	32	40	51	12	6mL <0.4 + 9ml 0.4
0.4	80	75	33	41	54	12	
	90	86	40	44	81	16	
	100	100	46	48	118	21	
	110	115	53	51	166	27	Eyes opening
Transition	112	118	55	52	176	28	21mL 0.4 + 7ml 0.6
	115	124	57	53	193	28	14mL 0.4 + 14ml 0.6
	118	130	59	54	211	28	7mL 0.4 + 21ml 0.6
0.6	120	134	61	54	224	29	
	130	155	69	58	293	36	
	140	180	77	60	373	42	Fine hair covering
Transition	142	185	79	61	390	42	32mL 0.6 + 10ml >0.7
	145	193	81	62	417	42	22mL 0.6 + 22ml >0.7
	148	200	83	63	444	42	10mL 0.6 + 32ml >0.7
>0.7	150	205	84	63	464	42	
	160	232	90	66	565	48	Emerging from pouch
	170	257	95	69	677	55	
	180	280	100	71	799	62	
	190	300	104	73	930	72	
	200	320	108	76	1071	80	Fully out of pouch
Weaning	210	Growth rate now about 15g per day				75	Feed volume now depends on amount of solids consumed
	220	Not Valid				60	
	230					45	Gradually increase solid food and reduce milk intake
	240					30	
	260					0	Fully weaned

Long-nosed Potoroo *(Potorous tridactylus)*

Milk	Age (days)	Tail (mm)	Foot (mm)	Head (mm)	Weight (g)	Feed (mL/day)	Notes
0.4	55	35	20	33	23	6	Just releasing teat
	60	40	22	35	25	7	Lower incisors erupting
	65	45	24	38	27	7	
	70	50	27	40	30	8	
Transition	72	53	28	41	32	8	6mL 0.4 + 2ml 0.6
	75	56	30	43	36	8	4mL 0.4 + 4ml 0.6
	78	59	32	44	41	8	2mL 0.4 + 6ml 0.6
0.6	80	62	34	45	45	9	
	85	72	39	48	58	10	Eyes opening
	90	88	45	50	72	12	Lightly furred
Transition	92	94	47	51	79	12	9mL 0.6 + 3ml >0.7
	95	103	51	53	91	12	6mL 0.6 + 6ml >0.7
	98	114	55	54	102	12	3mL 0.6 + 9ml >0.7
>0.7	100	120	57	55	110	13	
	105	130	60	58	130	16	
	110	140	63	60	155	18	Emerging from pouch
	115	145	65	62	185	21	
	120	150	67	64	220	24	
	125	155	70	66	260	27	
	130	160	72	68	290	29	Fully emerged from pouch
Weaning	140	Growth rate is now about 5g per day				24	Milk volume now depends on amount of milk consumed
	150	Not Valid				16	
	160					8	Gradually increase solid food and reduce milk intake until fully weaned
	170					0	Fully weaned (approx. 500g)

Carnivorous Marsupials, Bandicoots and Bilbies

The milk of carnivorous marsupials, bandicoots and bilbies undergoes similar nutritional changes as that which occurs in macropods. This involves a progressive increase in total solids, fat and protein from early to late lactation while carbohydrate increases in mid lactation and then declines to very low levels during late lactation.

It is not practical to produce a multi-stage milk replacer for these animals as most have short pouch lives and young that come into care tend to be at the late lactation stage. We recommended feeding them **Kangaroo Milk Replacer >0.7** as this is a suitable high energy formula which many carers will have on hand or find readily available.

Bandicoots are known to have particularly high levels of energy in their milk and are very fast-growing. To cater for this we recommend the addition of up to 10% additional fat in the form of **The Good Oil for Animals** ie 10ml per 100ml of >0.7 Kangaroo Milk Replacer (page 44). The Good Oil may also be beneficial for carnivorous marsupials such as antechinus, phascogales, quolls & devils as it contains elevated levels of essential fatty acids (EPA & DHA) which are thought to be present in the milk of these species. Depending on age, young Tasmanian Devil joeys may be started on either Kangaroo 0.4 or 0.6 formula and then transitioned on to the >0.7 as they get older.

Contact Wombaroo or visit **www.wombaroo.com.au** for further information on growth rates of different species of bandicoots and carnivorous marsupials.

Feed Table Using Kangaroo >0.7

Body Weight (g)	Feed Volume (ml/day)	Body Weight (g)	Feed Volume (ml/day)	Body Weight (g)	Feed Volume (ml/day)
1	0.4	30	5.5	175	20
2	0.7	40	6.8	200	22
3	1.0	50	8.0	250	26
4	1.2	60	9.2	300	30
5	1.4	70	10	350	33
7	1.8	80	11	400	37
10	2.4	90	12	450	40
15	3.3	100	13	500	44
20	4.0	125	16	550	47
25	4.8	150	18	600	50

Milk for Possums

Suitable for all species of possums & gliders.

Possum Milk Replacer <0.8	Analysis	
For joeys with less than 80% of pouch life completed. Furless. Pink skin. Eyes closed to just opened. Ears drooped. Faeces: Yellow custard to toothpaste consistency. **Pack size: 160g, 800g.**	Solids	160g/litre
	Protein	34%
	Fat	15%
	Carbohydrate	39%
	Energy	3.0MJ/litre

Possum Milk Replacer >0.8	Analysis	
For joeys with greater than 80% of pouch life completed. Fur: Short soft to dense long. Spends time out of pouch. Faeces: Toothpaste to soft then firm green pellets. **Pack Size: 250g, 1.25kg, 5kg.**	Solids	250g/litre
	Protein	32%
	Fat	33%
	Carbohydrate	26%
	Energy	5.6MJ/litre

Supplement Feeding Adult Possums and Gliders

In the wild, omnivorous species such as brushtails, pygmy possums and sugar gliders obtain additional protein from browse, pollen and insects. In captivity, dietary protein may be enhanced by the addition of **Wombaroo High Protein Supplement** (see page 40) and **Wombaroo Small Carnivore Food** (see page 41). Strictly folivorous species such as Ringtails and Greater Gliders should be maintained predominantly on native browse (eg young eucalypt leaves). These specialist species obtain extra protein by consuming their own cecal pellets, and do not usually require supplementary foods.

Common Ringtail Possum *(Pseudocheirus peregrinus)**

Milk	Age (days)	Tail (mm)	Head (mm)	Weight (g)	Feed (mL/day)	Notes
<0.8	60	75	25	35	9	
	70	90	28	38	10	
	80	105	32	42	10	
	90	120	35	52	12	Eyes opening
Transition	92	123	35	54	12	9mL <0.8 + 3ml >0.8
	95	128	36	57	12	6mL <0.8 + 6ml >0.8
	98	132	37	60	12	3mL <0.8 + 9ml >0.8
>0.8	100	135	38	62	12	
	110	150	41	74	12	Emerging from pouch
	120	165	45	90	14	
	130	180	48	110	16	Fully out of pouch
	140	195	51	135	18	
Weaning	160	Growth rate now about 3-6g per day			12	Eating significant leaf
	180	Not Valid			0	Fully weaned (approx 310g)
	210					Release Age (approx 490g)

*The Western Ringtail (*Pseudocheirus occidentalis*) has a shorter pouch life and faster growth rate, first emerging from the pouch at about 95 days (125g), fully out of the pouch around 104 days (130-150g), and weaning at a heavier weight (approx.550g).

Common Brushtail Possum *(Trichosurus vulpecula)*

Milk	Age (days)	Tail (mm)	Foot (mm)	Head (mm)	Weight (g)	Feed (mL/day)	Notes
<0.8	80	67	21	36	42	10	
	90	82	26	41	58	13	
	100	98	30	45	80	17	Fine fur visible
	110	116	35	49	105	20	Eyes opening
Transition	112	120	36	50	112	20	15mL <0.8 + 5ml >0.8
	115	125	38	51	125	20	10mL <0.8 + 10ml >0.8
	118	131	40	53	140	20	15mL <0.8 + 5ml >0.8
>0.8	120	135	41	54	150	20	Emerging from pouch
	130	155	47	58	210	26	Fully Furred
	140	168	52	61	290	32	
	150	181	56	64	390	40	Fully out of pouch
Weaning	160	Growth rate now about 7-15 g per day				40	Feed volume now depends on amount of solids consumed
	180	Not Valid				20	
	200					0	Fully weaned
	250						Release Age

Sugar Glider *(Petaurus breviceps)*

Milk	Age (days)	Head (mm)	Leg (mm)	Weight (g)	Feed (mL/day)	Notes
<0.8	40	17	12	3	1.4	Pink skin, eyeslits present
	50	21	15	6	2.4	Skin Darkening
Transition	52	21	16	7	3	2mL <0.8 + 1ml >0.8
	55	22	18	9	3	1.5mL <0.8 + 1.5ml >0.8
	58	23	19	10	3	1mL <0.8 + 2ml >0.8
>0.8	60	23	20	12	3	Emerging from pouch, finely furred
	70	26	25	22	5	Eyes opening, fully furred
	80	29	30	33	7	Fully out of puch (left in nest)
	90	32	35	44	8	
	100	35	39	54	9	Emerging from nest
	120	Growth rate now around 1g per day			0	Fully weaned (approx 75-90g)

Squirrel Glider *(Petaurus norfolcensis)*

Milk	Age (days)	Head (mm)	Leg (mm)	Weight (g)	Feed (mL/day)	Notes
<0.8	40	18	11	4	1.8	Pink skin, eyeslits present
	50	20	14	8	3	
	60	24	18	16	5	Skin darkening
Transition	62	25	19	18	5	3.5mL <0.8 + 1.5ml >0.8
	65	26	20	21	5	2.5mL <0.8 + 2.5ml >0.8
	68	27	21	23	5	1.5mL <0.8 + 3.5ml >0.8
>0.8	70	27	22	25	5	Emerging from pouch, finely furred
	80	30	27	40	8	Eyes opening, fully furred
	90	33	32	55	10	Fully out of pouch (left in nest)
	100	36	36	71	11	
	110	39	40	85	13	Emerging from nest
	130	Growth rate now around 1.5g per day			0	Fully weaned (approx 90-135g)

Other Growth Charts

Growth charts are available for several other possum species including Mountain/ Short-eared Brushtail (Bobuck), Herbert River Ringtail, Mountain Pygmy Possum and Feathertail Glider. Contact Wombaroo or visit **www.wombaroo.com.au** for further information.

Milk for Wombats

Wombat Milk Replacer <0.4	Analysis	
For joeys with less than 40% of pouch life completed. Furless. Pink skin. Eyes closed. Ears drooped to erect. Faeces: Yellow custard to toothpaste consistency. **Pack size: 140g, 700g.**	Solids	140g/litre
	Protein	36%
	Fat	14%
	Carbohydrate	39%
	Energy	2.6MJ/litre

Wombat Milk Replacer 0.4	Analysis	
For joeys with 40% of pouch life completed. Furless to fine fur. Eyes just open. Ears erect. Faeces: toothpaste consistency. **Pack Size: 190g, 950g, 5kg.**	Solids	190g/litre
	Protein	34%
	Fat	22%
	Carbohydrate	33%
	Energy	3.8MJ/litre

Wombat Milk Replacer >0.6	Analysis	
For joeys with greater than 60% of pouch life completed. Fur: Short to dense long fur. Spends time out of pouch. Faeces: Toothpaste to soft then firm green pellets. **Pack size:** **250g, 1.25kg, 5kg, 10kg, 20kg.**	Solids	250g/litre
	Protein	32%
	Fat	42%
	Carbohydrate	14%
	Energy	6.1MJ/litre

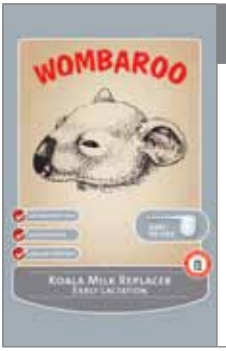
Southern Hairy-Nosed Wombat *(Lasiorhinus latifrons)*

Milk	Age (days)	Head (mm)	Weight (g)	Feed (mL/day)	Notes
<0.4	60	29	42	12	
	70	33	60	16	
	80	37	78	20	
	90	41	104	23	
	100	44	132	28	Incisors present, eyelashes growing
Transition	102	45	138	28	21mL <0.4 + 7ml 0.4
	105	46	146	28	14mL <0.4 + 14ml 0.4
	108	48	154	28	7mL <0.4 + 21ml 0.4
0.4	110	48	161	28	
	120	52	200	29	Eyes opening
	130	56	255	34	
	140	60	330	42	
	150	64	410	50	Fine fur visible
Transition	155	66	450	50	40mL 0.4 + 10ml 0.6
	160	68	500	50	25mL 0.4 + 25ml 0.6
	165	70	560	50	10mL 0.4 + 40ml 0.6
>0.6	170	72	620	50	
	180	76	750	60	
	190	80	880	70	
	200	84	1025	80	Emerging from pouch
	210	88	1200	90	Thick Fur
	220	92	1380	100	
	230	96	1600	110	
	240	100	1900	120	
	250	103	2250	135	
	260	107	2600	150	
	270	111	2950	160	Fully emerged from pouch
Weaning	280	Growth rate now about 35g per day		160	Feed volume now depends on amount of solids consumed
	290			150	
	310			100	Gradually increase solid food and reduce milk intake
	330			50	
	350			0	Fully weaned (approx 6-7 kg)

Common Wombat *(Vombatus ursinus)*

Milk	Age (days)	BodyLength (mm)	Weight (g)	Feed (mL/day)	Notes
<0.4	60	110	45	13	
	70	125	65	17	
	80	138	85	21	
	90	150	120	27	
	100	157	180	36	
	110	163	270	50	Incisors present, eyelashes growing
Transition	112	164	290	50	35mL <0.4 + 15ml 0.4
	115	166	320	50	25mL <0.4 + 25ml 0.4
	118	168	355	50	15mL <0.4 + 35ml 0.4
0.4	120	169	380	50	
	130	175	510	60	Eyes opening
	140	182	650	70	
	150	188	800	85	
	160	195	960	100	Fine fur visible
Transition	165	198	1050	100	75mL 0.4 + 25ml 0.6
	170	201	1140	100	50mL 0.4 + 50ml 0.6
	175	205	1240	100	25mL 0.4 + 75ml 0.6
>0.6	180	208	1340	100	
	190	214	1580	110	
	200	221	1880	120	
	210	228	2200	135	
	220	234	2520	150	Emerging from pouch
	230	241	2880	155	Thick Fur
	240	247	3260	175	
	250	254	3660	190	
	260	260	4060	200	
	270	267	4500	220	
	280	273	4950	240	
	290	280	5400	250	Fully emerged
Weaning	300	Growth rate now about 40g per day		240	Feed volume now depends on amount of solids consumed
	320			180	
	340			120	Gradually increase solid food and reduce milk intake
	360			60	
	380			0	Fully weaned (approx 8-10 kg)

Milk for Koalas



Koala Milk Replacer Early Lactation	Analysis	
For joeys less than 160 days old. Furless to fine fur. Eyes closed to just open.	Solids	220g/litre
	Protein	22%
	Fat	35%
	Carbohydrate	30%
Pack size: 180g, 900g.	Energy	5.0MJ/litre

Koala Milk Replacer Late Lactation	Analysis	
For joeys older than 180 days until weaning. Emerging or fully-emerged with short to dense long fur. Teeth erupted and nibbling on leaves. Leaf represents an increasing part of the diet from 270 days.	Solids	320g/litre
	Protein	32%
	Fat	43%
	Carbohydrate	14%
Pack size: 240g, 1.2kg, 5kg & 10kg.	Energy	7.8MJ/litre

Age Estimation

Age estimation of koalas is based on head length, from tip of nose to nuchal crest at rear of skull (best measured with vernier calipers). Regional and sex differences present considerable variation in koala body weight and growth rate. Presented here are two average growth charts, one for smaller animals (typical of northern or QLD animals), the other for larger animals (typical of southern or Victorian animals).
If a particular animal does not fit one chart then it may fall between the charts, or outside either chart.

Feed Guidelines

Select the correct Wombaroo formula for age and feed milk volume according to body weight. Weigh joeys regularly to monitor growth. Leaf should be offered from 6 months (180 days) of age. From about 10 months (300 days), if eating sufficient leaf and gaining weight, milk volume can be gradually reduced until fully weaned at 1 year of age.
At this stage at least 10% body weight in leaves should be consumed per day.

Koala (*Phascolarctos cinereus adustus*) – Smaller or Northern Animals

Milk	Age (days)	Head Length (mm)	Body Weight (g)	Feed Volume (mL/day)	Notes
Early Lactation	60	27	42	6	
	70	30	46	7	
	80	33	51	7	
	90	36	60	8	
	100	39	72	9	First Fur
	110	42	88	11	
	120	44	109	13	
	130	47	135	15	
	140	49	167	17	
	150	52	200	20	Eyes open, head appears out of pouch
	160	54	233	22	
Transition	165	55	250	22	17ml Early + 5ml Late
	170	56	266	22	11ml Early + 11ml Late
	175	57	283	22	5ml Early + 17ml Late
Late Lactation	180	59	300	22	Fully-furred, front teeth erupted. Nibbling leaves
	190	61	340	23	Should be receiving pap from a healthy adult animal
	200	65	390	25	
	210	68	450	28	Adult-type fur. Carried on mother's front
	220	71	530	32	
	230	73	610	35	
	240	75	700	40	
	250	77	820	44	Fully-emerged. Carried on mother's back
	260	79	950	49	
	270	82	1100	55	Milk volume now depends on amount of leaf eaten
	290	86	1450	70	100g of leaf per day
	310	90	1750	80	
	330	93	2050	50	Start weaning, 200g of leaf per day
	350	97	2250	25	
	370	100	2400	0	Fully weaned, 250g of leaf per day

Koala (*Phascolarctos cinereus victor*) – Larger or Southern Animals

Milk	Age (days)	Head Length (mm)	Body Weight (g)	Feed Volume (mL/day)	Notes
Early Lactation	60	28	45	6	
	70	31	50	7	
	80	35	60	8	
	90	37	70	9	
	100	40	100	12	First Fur
	110	43	130	14	
	120	46	160	17	
	130	48	190	19	
	140	51	220	21	
	150	54	250	23	Eyes open, head appears out of pouch
	160	56	310	27	
Transition	165	58	345	28	21ml Early + 7ml Late
	170	59	380	28	14ml Early + 14ml Late
	175	60	415	28	7ml Early + 21ml Late
Late Lactation	180	61	450	28	Fully-furred, front teeth erupted Nibbling leaves
	190	64	520	31	Should be receiving pap from a healthy adult animal
	200	67	600	35	
	210	70	700	40	Adult-type fur. Carried on mother's front.
	220	73	820	44	
	230	76	950	49	
	240	78	1100	55	
	250	80	1230	60	Fully-emerged. Carried on mother's back
	260	82	1360	64	
	270	84	1500	70	Milk volume now depends on amount of leaf eaten
	290	88	1900	83	150g of leaf per day
	310	93	2250	95	
	330	97	2600	60	Start weaning, 250g of leaf per day
	350	101	2900	30	
	370	104	3200	0	Fully weaned, 300g of leaf per day

Milk for Echidna

Also used for Platypus.

Echidna Milk Replacer Early Lactation	Analysis	
For young less than 30 days old. Furless. Pinkish-grey skin. Eyes closed. Pouch bound. Faeces: Custard to toothpaste consistency. **Pack size: 210g**	Solids	210g/litre
	Protein	34%
	Fat	38%
	Carbohydrate	16%
	Energy	4.9MJ/litre

Echidna Milk Replacer Late Lactation	Analysis	
For young greater than 50 days old. Fur: By 60 days finely furred with spines emerging. Faeces: Toothpaste to soft then firm pellets. **Pack size: 250g, 1.25kg**	Solids	360g/litre
	Protein	32%
	Fat	42%
	Carbohydrate	13%
	Energy	8.8MJ/litre

Age Estimation

Individual echidnas show considerable variation in body weight and growth rate with age. Echidna young leave the pouch at similar ages (around 45-60 days) but at very different sizes. Offspring of larger females tend to have a faster growth rate and are heavier at than those of smaller females. The following growth chart therefore provides two columns of weight for age, one for smaller animals, the other for larger animals. If a particular animal does not fit one weight range then it may fall between the columns, or outside either weight range.

Feeding Guidelines

Echidna can suckle vigorously and the high nutrient content of the milk means that young are fed infrequently. In the wild burrow young (>50 days) are only suckled by their mother approximately once every 5 days. (Rismiller PD and McKelvey MW, 2009. Activity and behaviour of lactating echidnas. *Aust J Zoology.)*

Digestion of milk is slow so the contents of the stomach need to be fully emptied before the next feed. For Early Lactation Echidnas we recommend to feed every 36 hours, and for Late Lactation Echidnas the feed intervals should be at least 2 days apart. This time frame may be further extended as the animal gets older.

Short-Beaked Echidna *(Tachyglossus aculeatus)*

Milk	Age (days)	Body Length (mm)	Small Animals		Large Animals		Notes
			Weight (g)	Feed[1] (mL/day)	Weight (g)	Feed[1] (mL/day)	
Early	10	55	7	6	10	7	
	15	70	20	9	25	10	
	20	85	39	12	45	12	
	25	100	60	14	65	14	
	30	115	82	15	95	16	
Transition	35	129	104	20	130	20	15mL Early + 5ml Late
	40	143	126	20	168	20	10mL Early + 10ml Late
	45	157	148	20	208	20	5mL Early + 15ml Late
Late	50	170	170	20	250	23	Fine fur/spines may be present
	60	Not Valid	215	22	345	26	Emerged from pouch
	80		305	25	540	31	
	100		395	28	750	35	
	120		485	30	970	39	Introduce Solid Food
	150		620	32	1300	43	Start Weaning
	180		755	35	1670	48	Fully weaned (180-210 days)[2]

Notes
1. Feed is given as average **daily** volume, so multiply this number by the number of days between each feed.
2. Tasmanian animals tend to have a faster growth rate and wean earlier (around 150 days).

Weaning

Echidnas should be fully weaned at about 6 to 7 months of age and the body weight at this time may be anywhere from 700g to 2kg. Prior to weaning solid food may be introduced into the diet. Start by mixing small amounts of **Wombaroo Small Carnivore Food** into the milk. Over the next month, slowly increase the amount of solids while decreasing the amount of milk. During this time the mix should change in consistency from a thin porridge to a thick paste. This will prepare the young for introduction to the adult diet.

Introducing Adult Diet

Mix about 9 parts of **Wombaroo Small Carnivore Food** (page 41) with 1 part of finely crushed termite mound or similar soil material, including some termites if possible. Slowly mix with water to the desired consistency.

MILK FOR EUTHERIAN MAMMALS

Eutherian mammals develop their young in the womb and give birth to more highly advanced young than marsupials. The young are initially nourished with colostrum to provide immunity, which then develops into full milk within about 48 hours of birth. Milk composition does not change significantly during lactation, so a single species-specific formula is suitable for hand-rearing. All of the domesticated, feral and exotic mammals found in Australia are eutherians. The most commonly encountered native eutherians are flying foxes, insectivorous bats and native rodents. Wombaroo makes a range of specific milk replacers to cater for most species of eutherian mammals including Dog, Cat, Rabbit, Guinea Pig, Horse, Sheep, Alpaca, Pig & Deer, plus a range of specialty formulas used by zoos and wildlife parks.

Milk for Native Rodents

We recommend **Wombaroo Dog Milk Replacer** for native rodents. It has a protein, fat and energy content reasonably similar to that of rodent milk and has been used successfully to rear a number of native species including Hopping Mice, Bush Rats and Water Rats.

Feed Table Using Wombaroo Dog Milk Replacer For Native Rodents

Body Weight (g)	Feed Volume (ml/day)	Body Weight (g)	Feed Volume (ml/day)	Body Weight (g)	Feed Volume (ml/day)
1	0.9	6	3.1	20	6.9
2	1.5	8	3.8	30	9.1
3	1.9	10	4.4	40	11
4	2.4	15	5.7	50	13

Milk for Flying Foxes (Fruit Bats)

Flying Fox Milk Replacer	Analysis	
A nutritionally balanced milk substitute for orphaned pups. Contains calcium for bones and vitamin C for skin & joints. Neonates may benefit from receiving Impact Colostrum Supplement. **Pack size: 140g, 1kg, 5kg & 10kg.**	Solids	140g/litre
	Protein	27%
	Fat	15%
	Carbohydrate	45%
	Energy	2.6MJ/litre

Grey-Headed Flying Fox *(Pteropus poliocephalus)**

Age (days)	Arm (mm)	Leg (mm)	Weight (g)	Feed (mL/day)	Notes
2	59	31	75	27	5 Feeds per day
4	62	33	79	28	
8	67	36	88	30	
12	72	39	98	32	
16	77	41	108	35	
20	82	43	118	38	
24	86	45	128	40	
28	90	47	138	42	4 feeds per day
32	94	48	148	44	
36	98	49	159	46	
40	102	50	170	48	
44	105	51	181	50	Introduce pureed apple
48	108	52	192	52	
52	111	53	203	54	
56	114	54	214	57	Introduce diced fruit with High Protein Supplement
60	117	55	225	59	
66	121	56	243	45	Start Weaning - milk volume now depends on amount of fruit eaten
72	125	57	261	30	
78	128	58	279	15	
84	131	59	297	0	

*May also be used for similar-sized species such as Black Flying Fox *(P. Alecto)*.

Weaning

When pups are about 6-7 weeks old introduce pureed apple between milk feeds. By 8-10 weeks they should be eating diced fruit (non-fibrous fruits such as apple or pear) coated with **Wombaroo High Protein Supplement**. Continue to increase solids and reduce the milk in the diet until they are fully weaned by about 12 weeks. At this stage young flying foxes should receive 20g (3 Wombaroo scoops) of High Protein Supplement over 300g of fresh cut fruit per animal.

Milk for Insectivorous Bats (Microbats)

Bat Milk Replacer	Analysis	
A nutritionally balanced milk substitute for orphaned pups. Elevated protein & energy content for rapid growth rate. Neonates may benefit from receiving Impact Colostrum Supplement. **Pack size: 165g (makes 500ml).**	Solids	330g/litre
	Protein	34%
	Fat	43%
	Carbohydrate	13%
	Energy	8.0MJ/litre

Gould's Wattled Bat *(Chalinolobus gouldii)**

Age (days)	Forearm (mm)	Weight (g)	Feed (mL/day)	Notes
1	21.0	3.0	1.0	Furless, 2 hourly feeds
3	24.0	3.5	1.1	Eyes Opening
5	26.0	4.0	1.2	3 hourly feeds
7	28.0	4.5	1.3	Fur growing on head & neck
9	29.5	5.2	1.4	Fur growing on belly
11	31.0	5.9	1.6	
14	33.0	7.0	1.8	Thickly-furred, 4 hourly feeds
17	35.0	8.5	2.1	
20	37.0	10.0	2.4	Introduce solid food (mealworms)
24	39.5	11.7	2.7	5 hourly feeds
28	41.5	13.1	2.8	
32	43.5	14.1	2.4	Gradually reduce milk intake and increase solid food
36	45.5	14.5	1.6	7 hourly feeds, start self-feeding
42	47.0	15.0	0.0	Fully Weaned (adult size)

*Growth rate & developmental stages may be used as a guideline for other similar-sized species of microbat.

Weaning

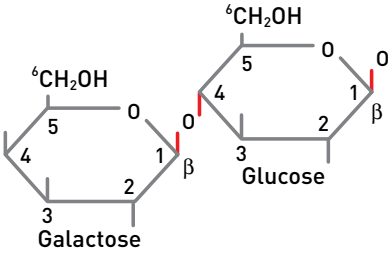
When pups are about 20 days old (fully-furred) they can be offered small mealworms with the heads removed and contents squeezed into the mouth. By about 28 days they should be able to eat whole mealworms, and milk volumes may be gradually reduced as insect consumption increases. Once self-feeding, bats may be encouraged to eat **Wombaroo Small Carnivore Food**, made up as a moist crumble, supplemented with a variety of live insects.

Formula One Low Lactose Milk

Formula One	Analysis	
Low-lactose milk formula that can be used for a range of different species including puppies, kittens, lambs, piglets, calves, foals, cria & marsupials. Use as an emergency milk replacer. **Pack size: 65g (Shake 'n' Make), 500g, 1kg, 5kg, 10kg, 20kg.**	Solids	125g/litre
	Protein	24%
	Fat	30%
	Carbohydrate	36%
	Energy	2.8MJ/litre

About Low Lactose Milks

Lactose is a disaccharide or "double sugar", made from the simple sugars galactose and glucose. It is the main carbohydrate present in the milk of cows, goats, horses & humans. However, many species have low levels of lactose in their milk, and do not digest it readily due to reduced activity of the enzyme lactase. The use of a low-lactose milk formula is therefore preferable to using cow's milk formulas, especially for those animals that suffer from lactose-induced diarrhoea.



Low-lactose milk products are normally prepared from cow's milk, but with the lactose broken down into its component sugars. This process does not alter the nature or composition of protein or fat in the milk, which can be quite inappropriate for other mammal species. For example, cow's milk contains deficient levels of whey protein, taurine, unsaturated fat & essential fatty acids compared to the milk of many other species.

Formula One is a superior low-lactose milk product because it is made from fortified ingredients to produce a milk that is low in lactose, but with an improved nutritional profile compared to cow's milk products.

We recommend to use Formula One as an emergency milk replacer for any species of animal until the correct species-specific Wombaroo milk can be administered.

Formula One is available in various pack sizes but includes a convenient Shake 'n' Make bottle which is pre-measured to make up 500mL of formula, so is ideal for emergency use.

Wombaroo Kangaroo Pellets

Wombaroo Kangaroo Pellets	Analysis	
A specialised supplement for kangaroos, wallabies, wombats and other native herbivores High in fibre & antioxidants. Low in starch & oxalates. Fortified with essential amino acids, fatty acids, vitamins and minerals. **Pack size: 5kg, 20kg.**	Protein	14%
	Fat	5%
	Fibre	22%
	Energy	9.0 MJ/kg

Australian herbivores have evolved to eat a wide range of native grasses, plants and foliage. This provides a naturally high fibre diet, rich in anti-oxidants.
In captivity, these animals are often fed with pellets or muesli made from cereal grains with a high starch content. This can lead to dental problems (eg Lumpy Jaw) and poor digestive health.

Wombaroo Kangaroo Pellets have the following benefits:

High in Fibre: The abrasive fibre and large pellet size promotes chewing action which helps maintain dental condition. The inclusion of soluble fibre (*mannan-oligosaccharides*) promotes the growth of beneficial gut bacteria. The low starch content helps reduce the dental and digestive problems associated with excessive consumption of cereal grains.

High in Antioxidants: Animals kept in captivity are prone to stress, which can lead to disease, infections and a compromised immune system. Wombaroo Pellets are fortified with antioxidants including vitamin E, selenium and carotenoids to help eliminate the free radicals produced by oxidative stress.

Low in Oxalates: Some commercial ingredients and exotic plants contain high levels of oxalates e.g. lucerne, lupins and wheat bran. Oxalates can bind with dietary metals to form insoluble precipitates such as calcium oxalate crystals found in urinary tract stones. A low oxalate diet may therefore be beneficial for urinary tract health.

Directions for Feeding

Feed **Wombaroo Kangaroo Pellets** as a supplement to pasture, hay and native browse. Water intake may increase when feeding pellets, so always ensure that fresh water is available. Introduce pellets gradually into the diet to avoid sudden digestive upset.

Avoid feeding large amounts of high-sugar fruit (e.g. apples & pears), high starch foods (e.g. grains, bread, potatoes) or high-oxalate fodder (e.g. lucerne). These items can effectively be replaced with **Wombaroo Kangaroo Pellets**.

Feed rate depends on body weight, body condition and quality of other foods consumed. The table below is based on the assumption that **Wombaroo Kangaroo Pellets** make-up 15% of the total dry matter intake of the diet. The remainder of the diet should consist of grass, hay, pasture & browse, and would vary depending on the individual species' requirements.

Feed Table – Wombaroo Kangaroo Pellets

Weight (kg)	Feed (g/day)	Weight (kg)	Feed (g/day)	Weight (kg)	Feed (g/day)	Weight (kg)	Feed (g/day)
0.5	5	6	35	16	75	45	160
1	10	8	40	20	85	50	175
2	15	10	45	25	100	55	190
3	20	15	50	30	120	60	200
4	25	15	60	35	135	65	210
5	30	15	70	40	150	70	220

1 metric cup = approx. 120g of Wombaroo Pellets.

Converting to Wombaroo Kangaroo Pellets

Captive animals may become accustomed to eating large amounts of inappropriate foods like cereal grains, fruits, vegetables or lucerne hay. When converting over to **Wombaroo Kangaroo Pellets** these foods should be removed from the diet. This will help encourage intake of the **Wombaroo Pellets**.

When converting animals on to pellets it is preferable that:

- Animals are in good body condition and housed in a low-stress environment
- Weather conditions are mild (avoid extremes in heat or cold)
- Good quality pasture, hay and browse is provided
- Plenty of fresh water is provided.

Older animals tend to become set in their ways and can be difficult to convert over to new food items. Young animals can be more easily weaned on to pellets.

Pellets as a Weaning Food

Hand-reared joeys may be weaned on to pellets by soaking them in milk formula, initially making a sloppy mash. Gradually reduce the quantity of liquid as the joey weans on to the solid diet.

High Protein Supplement

High Protein Supplement	Analysis	
Used to boost the protein content in the captive diet of fruit, nectar and sap-eating animals including flying foxes, possums and sugar gliders. Fortified with essential amino acids, fatty acids, vitamins & minerals. **Pack size: 250g, 1kg, 5kg.**	Protein	52%
	Fat	12%
	Carbohydrate	25%
	Energy	17 MJ/kg

Directions for Use

Fruit-mix: Disperse 15g (2 level scoops) of powder per 150g of fruit or vegetables.

Mix powder well with diced or pureed fruits and vegetables. A small amount of water may be added to moisten the mix. Prepare fresh daily.

Liquid-mix: Add 15g (2 level scoops) of powder to 40mL of warm water.

Mix powder well with the water. Pour liquid-mix over dry foods including semi-moist fruits, nuts, biscuits, pellets or kibble. Use at the rate of 10ml of **liquid-mix** per 25g of dried food. Store liquid-mix refrigerated for a day or frozen for up to 2 weeks.

Frugivorous (Fruit-eating) Animals: In captivity, animals are usually fed commercially grown fruits (e.g. apples & pears), which have a lower protein, vitamin & mineral content compared to many wild native fruits. To provide a balanced diet, any fruit & vegetables fed out should be supplemented with **High Protein Supplement.**

Possums & Gliders: For species that eat fruit & vegetables in captivity, feed as per the **fruit-mix** directions. For animals offered dry or semi-moist foods, feed as per the **liquid-mix** directions. For insectivorous species (e.g. Sugar Gliders, Pygmy Possums) also include up to 20% of prepared **Wombaroo Small Carnivore Food** plus a variety of insects in their diet.

Flying Foxes: Disperse 15g (2 scoops) of powder over 300g of fresh cut apple per adult animal. Increase the amount to 20g (3 scoops) per animal when feeding pregnant or nursing females, juveniles and debilitated animals.

Other Uses: High Protein Supplement can be substituted for the high protein baby cereal used in many food recipes for animals and birds. Use only half the quantity of High Protein Supplement because of its superior protein quality and quantity.

Small Carnivore Food

Small Carnivore Food	Analysis	
A live food substitute for sugar gliders, bandicoots, carnivorous marsupials, rodents, echidna and any other animals which include insects as a part of their diet. Fortified with essential amino acids, fatty acids, vitamins & minerals. **Pack size: 250g, 1kg, 5kg.**	Protein	38%
	Fat	12%
	Carbohydrate	32%
	Energy	16 MJ/kg

Directions for Use

Mix 15g (2 level scoops) of powder with 10ml of water.

Slowly add the water, while mixing to form a moist crumbly food. Do not make into a paste. To encourage intake mix in with live insects such as crickets, moths, cockroaches and mealworms. Store prepared food refrigerated for a day or frozen for up to 2 weeks.

Dunnarts, Antechinus, Kowari & Quolls: Small Carnivore Food can represent up to 80% of the total diet. Supplement with crickets, moths, grasshoppers, spiders and day old mice or chicks.

Sugar Gliders, Pygmy Possums & Bandicoots: These are omnivorous species and Small Carnivore Food can represent up to 20% of the total diet. Also feed **Wombaroo High Protein Supplement** dispersed over fruit.

Echidna & Numbat: Mix prepared **Small Carnivore Food** with about 10% crushed termite mound and some live termites. Extra water may be added to make into a liquid slurry.

Hopping mice, Rats & Mice: Small Carnivore Food can represent 10-20% of the total diet.

Insectivorous Bats: Feed as a maintenance diet while supplementing with moths, beetles and a few mealworms.

Feeding Live Food

Live food is important nutritionally, but also helps maintain natural foraging behaviour in captive animals. There are considerable differences in composition between mature and immature (larval stage) of insects. Animals that prey on mature insects such as moths, beetles and crickets should not be fed large numbers of larval stage insects such as mealworms, as these contain higher levels of fat and can lead to obesity. The nutritional value of feeder insects may be improved by maintaining them on **Passwell Insect Booster.**

Reptile Supplement

Reptile Supplement	Analysis	
Balanced diet for captive reptiles including bearded dragons, blue-tongued lizards, turtles and snakes. Use to boost dietary protein, vitamin, calcium and mineral intake. **Pack size: 250g, 1kg, 5kg.**	Protein	55%
	Fat	14%
	Carbohydrate	11%
	Energy	17 MJ/kg

Directions for Use

Meat-mix: Mix 10g (1 level scoop) of powder with 20g minced meat, fish or hard-boiled egg.

Add extra water to moisten if necessary. Mix in live insects to encourage intake.

Veg-mix: Mix 10g (1 level scoop) of powder with 40g finely diced fruit or vegetables.

Soft Pellets: Mix 20g (2 level scoops) of powder to 12mL of warm water.

Slowly add the water and mix into a putty-like consistency. Break-off small pieces and roll into soft pellets for feeding. Drinking water should always be available.

Liquid Slurry: Add 10g (1 level scoop) of powder with 15mL of warm water.

Slowly add water and mix to make a slurry of the required consistency. Let the mix stand for 2 minutes to absorb all the water. If too thick, add a little more water and continue mixing. Feed at about 30°C using a syringe with large bore. Use as a force-feeding formula for sick or injured reptiles.

Feed Recommendations

Turtles: Feed a variety of live food supplemented with Meat-mix or Soft Pellets. Avoid contaminating the tank by removing any uneaten food. Do not overfeed.

Bearded Dragons, Blue-tongued Lizards & Larger Skinks: Feed a variety of live food and plant material supplemented with Veg-mix, Meat-mix or Soft Pellets.

Goannas & Snakes: Feed whole-body prey items stuffed with supplement at the rate of 5g per 50g carcass weight. Cavities in prey may be stuffed by preparing as a slurry and using a syringe.

Insect Booster

Insect Booster	Analysis	
Improves the nutritional value of feeder insects such as crickets, woodies and mealworms. Nutrients are incorporated into the insect's body tissue to improve their calcium, vitamin & mineral content.	Protein	13%
	Fat	5%
	Calcium	15%
	Vitamin E	1600mg/kg
Pack size: 300g, 5kg, 10kg, 20kg.	Vitamin D_3	65µg/kg

About Feeding Insects

Insectivorous animals kept in captivity usually lack the diversity and quality of a natural diet in the wild. Feeder insects are often maintained on nutrient-poor substrates (e.g. bran) which can lead to dietary deficiency. Insects have no skeletal structure and are generally a poor source of calcium.

Improving Insect Nutrition

By maintaining live feeder insects on **Insect Booster**, the nutritional value of the captive diet is enhanced, including a significantly higher calcium to phosphorus ratio, and elevated vitamin & mineral content. This is more effective than simply "gut-loading" insects raised on inadequate diets or dusting with calcium powder.

Directions for Use

For best results, supply **Insect Booster** to the feeder insects for 7-14 days prior to feeding out to animals. This maximises the uptake of nutrients (e.g. calcium) into the body tissue of the insect. However, supplying **Insect Booster** to insects for as little as 2-3 days before feeding out will still have some nutritional benefit. Moisture should always be available to insects and can be supplied as a piece of wet sponge, fruit or vegetable.

Adult Insects (including crickets & woodies): Supply **Insect Booster** as a dry powder in a shallow bowl or plate.

Juvenile Insects (e.g. mealworms & fly pupae): Make a 50/50 mixture of **Insect Booster** with bran and supply as the substrate in which the pupae live.

The Good Oil for Animals

The Good Oil for Animals	Analysis	
Omega-3 & 6 fatty acid supplement used for: • Improving the energy content and fatty acid profile in the milk of fast-growing marsupials (bandicoots, carnivorous marsupials). • Animals with essential fatty acid deficiency to help promote a healthy skin, coat and cell membranes. • Malnourished late lactation marsupials to help increase weight gain prior to weaning. **Pack size: 250mL, 1L, 5L.**	Fat	100%
	Oleic Acid	410mg/mL
	Linoleic Acid	290mg/mL
	α-linolenic Acid	110mg/mL
	EPA (omega 3)	25mg/mL
	DHA (omega 3)	12mg/mL
	Vitamin A	30µg/mL
	Vitamin D_3	2µg/mL
	Vitamin E	3mg/mL

Dosage for Marsupials: Use at the rate of up to 10mL added per 100mL of milk formula and mix in thoroughly. Introduce gradually to avoid digestive upset. Do not over-supplement, as this will dilute the concentration of other nutrients in the milk and lead to nutritional imbalance.

Note that all **Wombaroo** Milk formulas already contain sufficient fatty acid content for their target species. Supplementation with additional **Good Oil for Animals** is only recommended in the specific cases outlined above.

HAND-REARING ACCESSORIES

Bottle and Teats

Teat Selection: Teats should resemble mother's in shape and length for mouth comfort, fit and correct tooth eruption. Marsupial teats get longer as the joey grows, so progression to longer teats is important.

Hole Size: There is no hole in the teats, so the carer can make a hole to suit the age of the animal. Pierce the tip of the teat with a hot needle to make a hole about 1mm in diameter, or for large animals, cut a hole with scissors. If the hole is too small, excessive sucking will quickly weaken the tip and the end will blow out. If the hole is too large, excessive milk flow may increase the risk of the joey aspirating milk into the lungs. The hole should be large enough for milk to drip out slowly, when the bottle is inverted.

Bottle and Teats

Feeding Technique: Small animals can be fed using a syringe with a teat pulled over the end to give greater control of milk flow with the plunger. Guidance should be obtained from experienced carers on correct feeding technique for different animals.

Care & Storage: Latex is a natural product, and degrades with use. Deterioration can be slowed by storing teats in an opaque, airtight container. Teats should be washed in warm soapy water immediately after use, dried and stored as above. Some carers sterilise by boiling or using infant sterilising solutions.

A range of latex teats are available with a sleeve to fit bottles with a neck diameter of 18-24mm. The 100 mL plastic bottle fit these teats and has graduations in mL.

STM Teat	MTM Teat	TM Teat	FM Teat	Bottle	
Small in-pouch kangaroos, wallabies, possums.	In-pouch kangaroos, wallabies, koalas.	Out of pouch kangaroos and wallabies.	Out of pouch kangaroos, wombats, koalas.	100 ml Graduated Bottle.	
SD Teat	**LD Teat**	**C Teat**	**F Teat**	**P Teat**	**D Teat**
Small dogs, possums, gliders.	Large dogs, possums, wombats, koalas.	Cats, rabbits, carnivorous marsupials.	Flying fox, some breeds of dog.	Small mammals, cats, rabbits.	Deer, 26mm sleeve to fit larger bottles.

Cosy Heat Pad

Cosy Heat Pad	Specifications	
Provides warmth for sick, young or debilitated animals, reptiles and birds.	Size	260mm x 360mm
	Material	Soft PVC Cover
	Voltage	240 volts
	Power	10 watts

Applications

- **Artificial pouches for orphaned marsupials:** Place pad at back of pouch and put insulation between pad and animal.
- **Birds & Animals:** Place pad underneath or inside box or hospital cage.
- **Reptiles:** Place at one end of the enclosure so reptile can move on or off the heated area. Cover with layer of sand or flat rock.
- **Veterinarians:** use on operating tables and in recovery rooms.

Directions for Use

The **Cosy Heat Pad** works by gradually heating up the area under where the animal sits. The heater produces a temperature on the pad surface of about 15-20°C above room temperature.

When room temperature is less than 10°C.

Animals should be as close as practicable to the pad surface.

When room temperature exceeds 10°C.

Animals should be insulated from the pad surface with layers of woollen fabric or other insulating material. The thickness of insulation required will depend on the room temperature and should be adjusted so that the animal is comfortable.

Monitor the temperature where the animal rests with a thermometer. It should be between 25°C and 35°C, depending on the age and type of animal. Seek veterinary advice if unsure of your animal's needs.

Heat stress can occur if the temperature is too high.

The device is fitted with a cut-off switch which limits the surface temperature of the pad, preventing excessively high temperatures, but it is still recommended to monitor temperature at all times.

Cleaning

The outer PVC cover can be cleaned with a damp cloth or sponge. Unplug the device from the power outlet when cleaning. Do not immerse the pad in water.

APPENDIX 1

Storage of Milk Powders & Food Products

Good storage conditions can help prevent spoilage of food products.

Moisture

Exposure to moisture and air can be a cause of microbial contamination. To avoid this, store dry powders in an air tight container once opened. Ensure hands and utensils are thoroughly washed and dried before using products.

Temperature

High temperatures can accelerate the oxidation of fats & oils, causing them to go rancid. This can create a noticeable change in texture, odour, colour, and taste. Prolonged exposure to hot conditions during shipping and storage may therefore reduce the shelf-life of the product.

"Best Before" Date

The products come with a "Best Before" of 18 months from manufacturing, so the fresher the product the better. Always check the best before date on the product before using. Over time nutrients such as vitamins & minerals can degrade, so we do not guarantee the nutritional composition beyond this date. While some products may still be usable after the best before date, this is done at the consumer's own risk.

Storage of Dry Powders

- **Store in a cool, dry place, below 30°C.**
- **Once opened, store in an air tight container.**

It is usually not necessary to store powdered products in the refrigerator, unless conditions are particularly hot or humid (e.g. tropical climates). If storing in the refrigerator, ensure the product is kept in an air tight container to avoid condensation of water droplets into the powder.

We generally do not advise storing milk powder in the freezer, due to the formation of ice crystals within the milk powder. These can disrupt the emulsion of fat in the milk and cause lumpiness and separation when trying to reconstitute the milk powder in water.

Storage of Reconstituted Milk & Foods

Once made up, milk and foods should be stored in the fridge for a day, or frozen for up to 2 weeks. When small quantities of milk are required, it is more convenient to make up larger batches (i.e. 500mL-1 Litre) and freeze-off into ice-cube trays. Once the ice-cubes have set, pop them out into an air-tight container, and keep stored in the freezer. The smaller quantities can then be thawed out as required. Do not refreeze thawed milk.

APPENDIX 2

Underweight or Malnourished Joeys

Many joeys that come into care are malnourished or have a compromised immune system. Along with proper nutrition, these animals may require veterinary care such as fluid therapy and ongoing disease treatment. It is very difficult to achieve healthy weight gain in a joey with an untreated illness.

If a joey is severely underweight when it first comes into care, ensure that rehydration has been carried out before feeding milk.

Underweight or malnourished animals may benefit from a course of **Impact Colostrum Supplement** (see page 32). Colostrum contains high levels of immunoglobulins and antibacterials, which may aid immunity and intestinal protection which in turn can help with metabolism of nutrients.

Underweight joeys should still be aged accurately to ensure the correct stage of Wombaroo Milk is being administered. The growth of bones is not usually retarded unless nutrition is extremely restricted for a long period, so head, foot and tail measurements are still useful for age determination. However, body weight is quickly affected by poor nutrition, so should not be used for age estimation. Developmental milestones (e.g. eyes open, fur growth etc.) outlined on pages 2 and 3 may also be useful in age determination "by eye".

Feed volume should initially be based on the actual body weight of the joey.

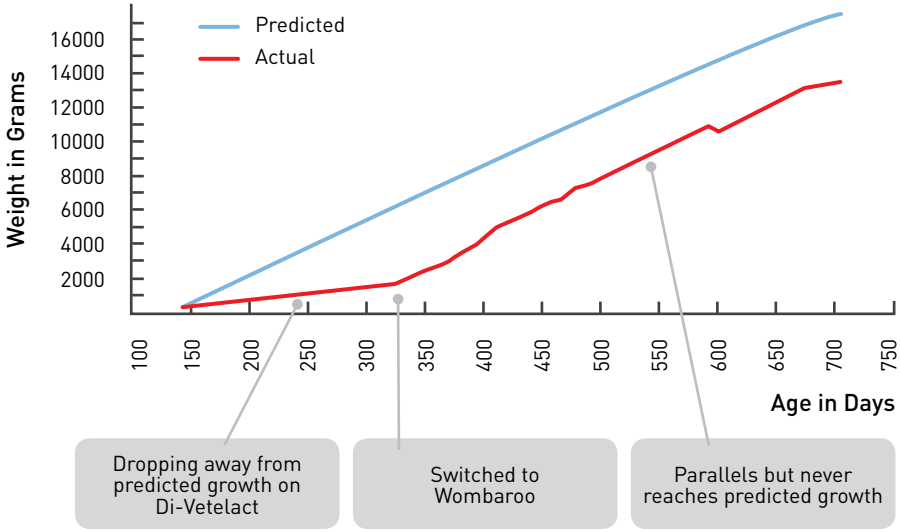
Once the joey is established on a consistent feeding regime, the daily feed volume may be gradually increased by upto 20% above the normal feed volume for that joey's weight. For example a 1kg Eastern Grey joey that would normally be on 100mL per day, may be increased to 120mL/day. This higher feed volume is designed to provide a controlled increase in daily energy intake so that an improvement in growth rate may be achieved. Take care not to increase the volume too fast or the animal may start to scour. If the animal has control of its bowels, even though the faeces are a little looser than normal then the increased feed volume is being tolerated. If it starts to scour uncontrollably, then the increase in volume has been too rapid.

Carers are sometimes reluctant to transition their joey to the next stage of Wombaroo because it is underweight. However joeys should be transitioned based on age as their digestive physiology develops regardless of their body weight. In fact, by holding it back on a formula designed for younger animals it may be missing out on essential nutrients required for its stage of development. An example of this is a kangaroo joey going from 0.6 formula to >0.7, which is a critical stage for increased growth and energy demands.

In practice, an underweight joey may not catch-up to its "theoretical" growth curve, especially if has been maintained on an unsuitable diet for a long period of time. Below is a chart showing the actual growth against the predicted theoretical growth for an Eastern Grey Kangaroo initially fed on a generic formula (Di-Vetelact™) then later switched to a specific formula suitable for its age and species (Wombaroo Kangaroo Milk Replacer >0.7). The change to Wombaroo arrests the decline in growth and then the animal parallels the expected growth line but doesn't catch up. In this circumstance an earlier switch to Wombaroo along with a controlled increase in feed volume may have been enough to close the gap.

Online Animal Record System

Animal Growth History



Reference

Chart reproduced with permission from Peter Richards (Long Grass Nature Refuge) from "Animal Husbandry Software for Australian Wildlife Carers." National Wildlife Rehabilitation Conference 2006.

APPENDIX 3

Dehydration & Drinking Water

There is currently no published data on the water requirements of juvenile marsupials. However, since milk is the only source of water in the diet of pouch-bound marsupials, it is reasonable to assume that mother's milk adequately supplies the water requirements of young animals. For this reason, Wombaroo Milk Replacers are formulated to match the milk concentration and feed volumes that are naturally produced by lactating female marsupials. Mother-reared joeys do not usually receive additional water intake until they start emerging from the pouch. Conditions in the pouch are high in humidity and are at optimum temperature such that water losses from the joey are minimised.

Maintenance Water Requirements

Animals have a "maintenance" water requirement which supplies their basic needs for normal biological activity. This varies depending on the species and the size of the animal. In clinical veterinary practice, maintenance fluid requirements in small animal patients are often defined as 60mL/kg/day (6% bodyweight) for smaller dogs and 40mL/kg/day (4% body weight) for larger dogs (DiBartola 2006). In the absence of specific values for juvenile marsupials, these numbers are often quoted as a guideline, although its likely that pouch-bound marsupials have significantly lower water requirements due to their reduced energy expenditure. Denny & Dawson (1975) found that adult macropod water turnover rate was only about two-thirds that eutherian mammals such as dogs, and this was attributed to the marsupial's substantially lower metabolic rate. On this basis, a maintenance fluid requirement for marsupials of around 4 to 5% of body weight is probably appropriate.

Water quantities consumed in the milk for a typical kangaroo joey fed Wombaroo are given in the table below:

Milk Formula	Joey Weight (g)	Milk Fed (mL)	Water in milk (mL)	Water as % body weight
<0.4	250	45	43	17
0.4	500	63	57	11
0.6	1300	105	89	6.9
>0.7	1800	120	96	5.3

From the final column in the above table it can be seen that all stages of Wombaroo Milk Replacers provide fluid levels that meet or exceed the guidelines of 4-5% body weight predicted for marsupials.

Joeys at the 0.6 or younger stages, receive fluid from their milk well in excess of their maintenance water requirements, and therefore do not usually require additional water, unless they are significantly dehydrated. Joeys at the >0.7 stage are starting to emerge from the pouch (or are at least leaning out of the pouch), so should have free access to bowls of water, as well as fresh grass, which can be sprayed with water. In this way, joeys can start to regulate their own water intake, and not just rely on the water present in the milk. Additionally, the marsupial kidney at this age is developing its ability to concentrate urine, which helps to conserve water and further reduces the maintenance requirement.

Dehydration in Hand-Reared Joeys

Dehydration in hand-reared joeys occurs through respiration, which is directly linked to energy expenditure, as well as exposure to temperatures which exceed the thermoneutral zone. Husbandry conditions in captivity should mimic as closely as possible those in mother-raised joeys in order to avoid dehydration. However, often animals are kept at higher temperatures, lower humidity and with much more activity and stress (over handling) than they would have in the wild. These factors can all lead to dehydration, and the need to provide additional water, over and above that which is provided in the milk.

It is important to monitor joeys and determine if they have become dehydrated, especially during hot weather.

Provide additional drinks of water in hot weather, if the joey is showing signs of dehydration and when joeys begin to emerge from the pouch and become more active.

Healthy young animals will readily drink water when thirsty. Marginally dehydrated animals may only require an additional 1-2% of their body weight per day in water orally (ie 10-20mL/kg body weight). Severely dehydrated animals may require over 5% (50mL/kg) additional fluids, but in these cases it may be preferable to administer fluids subcutaneously under veterinary supervision.

If providing drinking water, do not add large volumes of extra water into the milk, as this dilutes energy intake and may reduce absorption of nutrients. If possible, give drinking water separately, between milk feeds.

References

Denny, MJS & TJ Dawson (1975). Comparative metabolism of tritiated water by macropodid marsupials. *American Journal of Physiology*. 228, 6, 1794-1799.

DiBartola, SP (2006). *Fluid, Electrolyte, and Acid-Base Disorders in Small Animal Practice*. Third Edition. Saunders Elsevier. p21-22.

APPENDIX 4

Calcium & Bone Fractures

Calcium is an essential mineral required for the healthy growth and development of bones. Mineralisation of marsupial joey bones relies on available calcium levels, balanced with other nutrients such as phosphorus and vitamin D_3.
Calcium concentrations in marsupial milk tend to increase from around 1.5g/litre in early lactation to over 4g/litre in late lactation (compared to only 1.1g/litre in unfortified cow's milk). These increases occur in line with increasing energy content of the milk, so its useful to standardise calcium concentrations as weight per unit of milk energy (ie mg/MJ):

Species	Calcium (mg/MJ)	Reference
Red Kangaroo	500-700	Lemon & Barker 1967, Poole et al 1982
Grey Kangaroo	400-800	Poole et al 1982
Tammar Wallaby	375-550	Green et al 1980, Green & Renfree 1982, Green 1984
Red-necked Wallaby	400-700	Green 1984, Merchant et al 1987

In all cases the reported quantity of calcium in macropod milk is greater than 375 mg/MJ. In addition, Walker & Vickery (1988) boosted their calcium levels to 486 mg/MJ after experiencing fractures at 307 mg/MJ. At all stages Wombaroo formulae contain greater than 500 mg/MJ calcium, balanced with phosphorus and Vitamin D_3 levels. It is noteworthy that some other commonly used milk replacers have deficient levels of calcium compared to those naturally present in marsupial milk.

Incidence of Bone Fractures

Bone mineralisation progresses when the joey leaves the pouch and load bearing occurs. Joeys need to gradually increase the level of load bearing to strengthen bones. Even if calcium levels in the milk are sufficient, pouch bound joeys are prone to fractures due to their low level of bone mineralisation. Problems are exacerbated if husbandry practices induce premature load bearing e.g. over-activity of young, excess movement in the artificial pouch or falls from an unsecured pouch opening. In the wild the mother tightly controls movement and level of activity in the pouch-bound young and captive husbandry needs to mimic this as closely as possible to minimise the incidence of fractures.

Reference

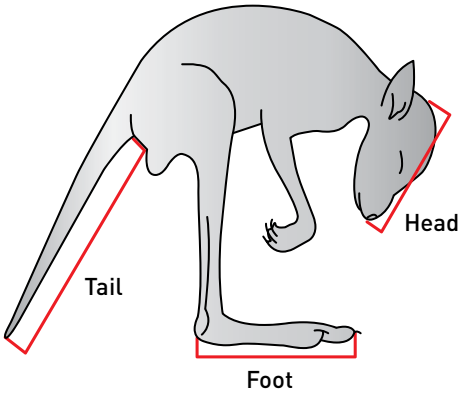
Walker, DM & K Vickery (1988). Tolerance of pouch young kangaroos (Macropodidae) for cow's milk and milk replacers containing different amounts of glucose and lactose. *Aust. Mammal.* 11: 125-133.

APPENDIX 5

Body Measurements for Age Determination

The following figure outlines the standard body measurements used to age joeys in the Wombaroo growth charts. Note that body weight is not an accurate indicator of age.

Source: Sharman GB, Frith HJ & Calaby JH (1964). Growth of the pouch young, tooth eruption and age determination in the red kangaroo, *Megaleia rufa*. CSIRO Wildlife Research 9, 20-49.

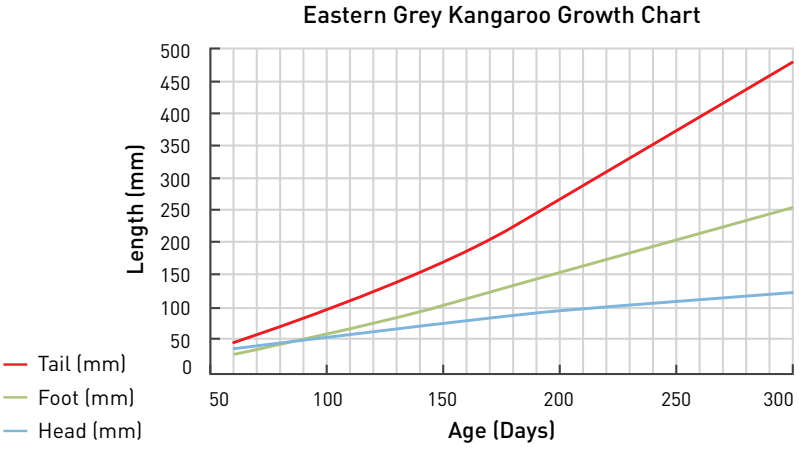


Head Length: Best measured with vernier calipers, from tip of the nose to the back of the skull. Head length is generally the most accurate indicator of an animal's age.

Foot Length: From the back of the heel to the end of the longest toe (excluding the nail). Measured with calipers, a ruler or tape measure.

Tail Length: Underside from the base to the tip (excluding any hair protruding from the tip). Measured with a ruler or tape measure.

Measuring the foot length of a joey with calipers.



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