

Husbandry Manual For



Common Name: Green tree frog

Scientific Name: Litoria caerulea

(Amphibia: Family): Hylidae

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Date of Preparation: 13/8/07

Western Sydney Institute of TAFE, Richmond

Course Name and Number: Cert 3 Captive animals
1068

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DISCLAIMER

The information held within this Husbandry Manual should only be used as a guide. Views and opinions expressed by the author may not necessarily be that of others working with such species. The information held within can only be used as a general guide in the husbandry and care of the species outline within this Husbandry Manual.



The Author *Brad Harper* with 4 of his pet *Litoria caerulea*

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OCCUPATIONAL HEALTH AND SAFETY RISKS

Risk Assessment for *Litoria caerulea* (Green tree frog)

Litoria caerulea possess no risk to humans.
Therefore *Litoria caerulea* is classed as a low risk or innocuous species.

Care should be given when handling this animal as to not injure the animal through rough handling or the contamination of chemicals from hands to the frog. Always handle animals with wet hands.

Animals can become habituated to feeding routines. Frogs may leap out of enclosures during feeding times or general husbandry routines and injure themselves.

Care needs to be taken when cleaning and performing maintenance on enclosures as there is often water near electricity, small to large wooden branches (possible eye damage and splinters), and the enclosures are often small in size.

Personal protective equipment that should be used when handling amphibians, using cleaning equipment/ chemicals are:

- Enclosed footwear
- Protective gloves
- Protective eye wear (goggles)
- Protective clothes



3 x *Litoria caerulea*

Chapter 1

1 Introduction

The Australian Green Tree Frog, (*Litoria caerulea*) is a species of tree frog native to Australia and New Guinea, with introduced populations in New Zealand and the United States. The species belongs to the genus *Litoria*. It is physiologically similar to some species of the genus, particularly the Magnificent Tree Frog (*Litoria splendida*) and the Giant Tree Frog (*Litoria infrafrenata*).

Due to its physical and behavioural traits, the Green Tree Frog has become one of the most recognizable frogs in its region, and is a popular exotic pet throughout the world. The skin secretions of the frog have antibacterial and antiviral properties that may prove useful in pharmaceutical preparations.

The Green Tree Frog shares the *Litoria* genus with dozens of frog species endemic to Australasia. The common name of the species, "White's Tree Frog", is in honor of John White's first description in 1790. The Green Tree Frog was the first Australian frog scientifically classified.

The species was originally called the "blue frog" (*Rana caerulea*) despite its green colour. The original specimens White sent to England were damaged by the preservative and appeared blue. The colour of the frog is caused by blue and green pigments covered in a yellow layer; the preservative destroyed the yellow layer and left the frog with a blue appearance. The specific epithet, *caerulea*, which is Latin for blue, has remained.

The Green Tree Frog can be used as a training species for other critically endangered Amphibian species. Due to the frog's ability to adapt to captivity and its ability to handle various environmental conditions in captivity, this species would be well suited sort out husbandry routines, environmental conditions, and staff training for other species.

The Author has over 12 years experience working with Wildlife including Amphibians. Brad has a Diploma in Animal Technology, Associate Diploma in Animal Technology, and a Certificate in Animal Attending. Brad has work in Zoos and Wildlife Parks for much of his working career. He also has been working as a Technician with Laboratory Rodent Breeding Facilities for over 5 years.

Chapter 2

2 Taxonomy

2.1 **Nomenclature**

Class: *Amphibia*

Order: *Anura*

Family: *Hylidae*

Subfamily: *Pelodyadinae*

Genus: *Litoria*

Species: *Litoria caerulea*

2.2 **Subspecies**

There are no Sub Species for *L. caerulea*

2.3 **Recent Synonyms**

There have been no recent synonyms for *L. caerulea*

2.4 **Other Common Names**

Other common names for Green tree frogs are

- Whites tree frog
- Dumpy tree frog



2x *Litoria caerulea*

Chapter 3

3 Natural History

3.1 Morphometrics

3.1.1 Mass And Basic Body Measurements

Length- 7-11.5cm

Mass- Up to 400gms in captivity.

3.1.2 Sexual Dimorphism

Males 66-77mm

Females 60-110mm

It is often difficult to tell the difference between males and females, except reproductive animals. Males develop dark pads (nuptial pads) on the inside of the thumbs to assist in gripping the female while mating takes place. Only males will croak voluntarily, females may give a distress call when handled roughly or to warn off an amorous male.

Males are also said to have loose skin around the throat, used for calls. This can be very difficult to tell in some frogs; so cannot be used as the only method for sexing.

3.1.3 Distinguishing Features

Similar species are *L. gilleni* and *L. splendida* all have enlarged head glands as in *L. caerulea*. *L. cavernicola* is also very similar to *L. caerulea*.

L. gilleni tends to be smaller in size. It also appears to replace the distribution of *L. caerulea* around the Alice Springs region.

L. splendida unlike *L. caerulea* has skin glands that cover the entire head region.

L. cavernicola also resembles *L. caerulea* but lacks the large fold of skin that overhangs the tympanum (ear disc). The vomerine teeth of *L. cavernicola* are behind the choanae rather than in between as in *L. caerulea*



Photo of *L. splendida*

3.2 *Distribution and Habitat*

Distribution map



Distribution Map of *Litoria caerulea*
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(Distribution of *L. caerulea* (in black) on the map of Australia.)

L. caerulea is native to northern and eastern regions of Australia and to southern New Guinea. The distribution is limited mostly to areas with warm, wet tropical climate.

In New Guinea, *L. caerulea* is restricted to the drier, southern region.

There have been reports of sightings in Northern New Guinea, New Zealand, and the United States, This is thought to be from human introduction through the pet trade.

3.3 *Conservation Status*

IUCN classification: not listed

L. caerulea is a common species. It is still common in parts of its natural habitat.

3.4 Longevity

3.4.1 In the Wild

Average age- 10 years

Maximum age- 12years or more

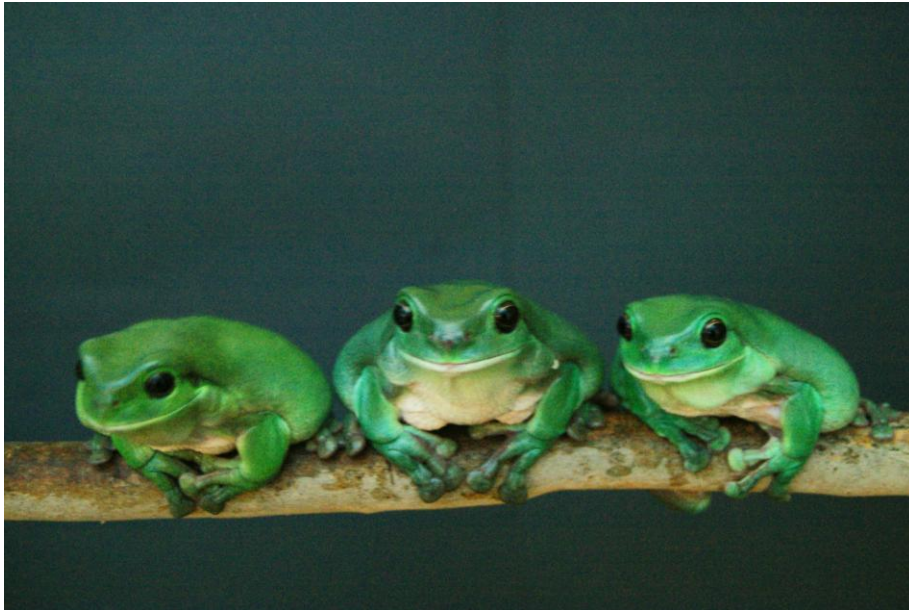
3.4.2 In Captivity

Maximum age- 23 years

Average age- 10-12 years

3.4.3 Techniques Used to Determine Age in Adults

There are no current ways to determine the age of adults. It is only possible to tell the sexual maturity of a male. This will occur at 2 years of age when the males develop dark pads on the inside of the thumbs. Males of age will start to call after heavy summer rains from November through to February.



3x *Litoria caerulea*

Chapter 4

4 Housing Requirements

4.1 Exhibit/Enclosure Design

Ruff surfaces such as Wire mesh- can cause bruising and lacerations. Glass aquariums are usually preferred for it's smoother surface. Also any sharp corners should be avoided as they can cause damage to the skin of the frog.

Rotten branches- can harbor pests and diseases. They can also not be strong enough for the frogs to sit or jump on. The rotten timber will also need to be changed around more regularly. To avoid this fresh "green" timber should be used where possible.

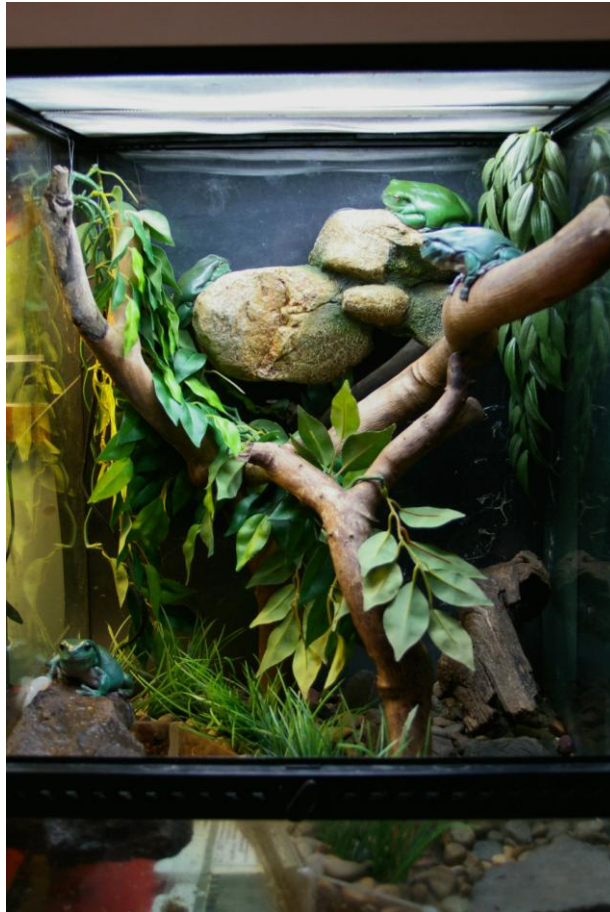
Over crowding- can cause stress on individual animals. Smaller animals can suffer when feeding as large frogs can eat all the food before the smaller ones get a chance to feed. Over crowding well also increase the amount of waste material in an enclosure. This will cause an increase of disease and also increase the amount of cleaning that needs to be done. *L. caerulea* excretes a large amount of ammonia with it waste material. Over crowding will also increase the levels of ammonia.

Tap water- should be boiled or treated to remove any contaminates.

Loose furnishings- should be secured, as *L. caerulea* can be very strong, any loose furnishings could cause injury to the amphibian. So all branches rocks or logs need to be secured so to stop injuries.

Humidity too high- high humidity will cause fungal out breaks with in the enclosure. This can also lead to disease in *L. caerulea*

Large enough for frogs to jump/ move around- enough space is required so that *L. caerulea* has enough space to complete a full leap. This will stop injuries from hitting the walls of the enclosure. If housed together space will reduce stress and allow for room for feeding and hiding.



One of 2 enclosures of *L. caerulea* owned by the author

4.2 Holding Area Design

Holding areas need to be easily used and safe for the frogs. Most holding areas contain simple furnishings such as a single branch and water either in a pond or covering the entire floor surface. These holding areas are generally used for short periods of time and not long periods of time.

Off exhibit holding areas are simple in design with fake plants, a water pond and a couple of branches with little or no ground substrate. These holding areas need to be easily cleaned but contain all the essential needs of the frogs (fresh clean water, branches to sit and climb, temperature controlled).

4.3 Spatial Requirements

There are no current regulations that deal specifically with Amphibians. The only regulation is the Exhibited Animals Act. This Act states that an animal needs to be able to freely move around its exhibit.

A good rule when housing *L. caerulea* is one adult frog for 114L tank. Two frogs can happily move around also in 114L tank. As a guide add 38L for every frog after that. It is possible to house *L. caerulea* in smaller exhibits, but

this will increase the ammonia and waste levels, causing more regular cleaning of the enclosure.

4.4 Position of Enclosures

As *L. caerulea* needs to be kept warm and at a constant temperature, it is best if they are kept inside and not outside. The enclosures also need to be escape proof with tight lids and sides. The requirement for a constant temperature and the popular use of glass tanks make the enclosures not suitable for outside displays.

The enclosure should be kept out of direct sunlight as this may over heat the enclosure during the warmer months.

4.5 Weather Protection

The enclosure for *L. caerulea* needs to be kept inside out of direct weather conditions. Exposure to extreme heat or extreme cold may cause the death of the animals.

Wet weather can cause flooding or increase the humidity within the enclosure. If the enclosure gets too wet it is possible for *L. caerulea* to drown though this is not very common.

Direct sunlight from outside may also increase the enclosure temperature and overheat the animals causing unnecessary stress and lead to loss of the animals.

4.6 Temperature Requirements

L. caerulea is best kept at an average temperature of 24-27C during the day, with lower temperatures able to be tolerated overnight.

Longer low periods of temperature can be endured when planning to breed *L. caerulea*, but this should only be done with healthy specimens, as it places the frogs under stress and they may become vulnerable to infection.

4.7 Substrate

A selection of different substrate can be used.

Depending on what types of plants are to be used in the Exhibit (either live or fake) will determine the type of substrate used.

Live plants will need a well drained soil as soil in aquariums tend to get water logged and thus become ideal areas for bacteria and fungi to grow. This can be stopped by placing holes in the base of the exhibit and covering it with mesh. Place 20mm of rock or coarse gravel then 50mm of soil for the plants to grow.

For exhibits that use fake plants, place 30mm of fine gravel, topped with 20mm of larger rocks or coarse gravel. This is often the preferred choice for sub straight as soils can contain harmful bacteria or fungi.

4.8 Nest boxes and/or Bedding Material

When breeding *L. caerulea* you need to provide a large enough water bowl for the eggs to be laid in, this water source should be a minimum of 60mm depth and minimum of 4lt in volume. This will allow for the eggs to be laid and enough room for the frogs to move around, as up to 2000 eggs are laid in clumps a rock may be useful for the eggs to be attached to or to allow the female to rest on during laying.

4.9 Enclosure Furnishings

The most common types of enclosure furnishings are branches, large rocks, ponds and/ or waterfalls, and fake or live plants/ foliage.

Branches- needs to be large enough for the specimens to sit on comfortably as well as strong enough to carry the weight of the frog/s. Branches should be easily cleaned and changed regularly to ensure that there is no build up of waste materials and that the branches are clean to stop the development of fungi or bacteria growth.

Large rocks- most substrate is of large pebbles but the use of larger rocks throughout an enclosure, will allow the frogs to sit and sun themselves in an elevated position. It also gives the male a place to call from during mating seasons. Rocks can also be used to create a barrier to ponds and be used around the edge of water bowls to hide the edges.

Ponds/ water falls- *L. caerulea* needs constant access to clean fresh water at all times. Although *L. caerulea* is a tree frog and has been known to survive in dry areas, this lack of clean fresh water supply can put stress on the frog. The use of a waterfall or pond pump will keep the enclosure's humidity at a comfortable level and there is no need for the daily water spraying to create this humidity.

Water must be decontaminated by either boiling and then cooling the water before use, leaving in direct sun for a number of days or the use of chemical agents such as the ones used for conditioning water for fish tanks. This will remove any chemicals in the water such as chlorine. Rainwater has unknown pollutants and chemicals in it so should be avoided if possible. Tap water is usually best to use if distilled water is not available.

Plants and foliage- Need to be cleaned and any diseases and insects to be removed before planting in enclosures if using live plants. The plants need to be able to survive damage from the frog/s and also from live food that may escape during feeding (crickets, cockroaches). Soil will need to be treated to remove any bacteria or fungi, as this is a great place for a lot of harmful bacteria and fungi to live and grow. Treatment of the soil can be done by drying the soil in the sun before use.

The use of fake plants and foliage can be easier for maintenance as well as hygiene. The plants need to securely attach so that they can handle to movement of the frogs but be easily accessed for cleaning and maintenance.

Behavioral and environmental enrichment furniture- Can be used during feeding of the frogs.

Enrichment can be, a fake rock with a hole in it that releases crickets randomly at different times that can be placed throughout the enclosure just for feeding.

The uses of different sized branches so the frogs can stretch limbs when moving around, these branches still need to be safe.

Heating rocks can be used but due to the uneven heat give off by these rocks it is best to only use them during cooler weather and not as the primary heat supply.

Large hollow logs or rock crevasse can be used so the frogs have somewhere to hide if they feel threatened, but not too large or deep as it will restrict the view of the public and hinder capture by keepers.

The use of different types of foods such as mice, crickets, mealworms, cockroaches, silk worms, can be fed to *L. caerulea* to stimulate hunting behaviour. Food can also be fed as live or dead, and by different methods such as hand feeding or allowing the live food to move freely around the enclosure. Free moving food should be monitored so to not injure the frogs. It is illegal in New South Wales to feed live mammals to any animals in captivity without approval from the Department of Primary Industry.



Picture of some of the Enrichment furnishings in an enclosure with *L. caerulea*

Chapter 5

5 General Husbandry

5.1 Hygiene and Cleaning

Daily-

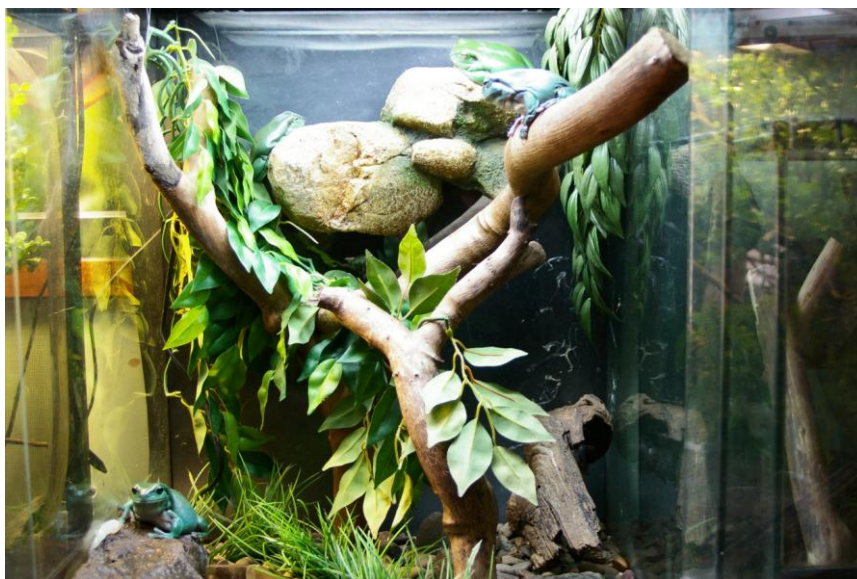
- Feed all animals including making sure that all animals get enough to eat
- General faeces pick up
- Removal of excess food
- Check the enclosure for any loose furnishings
- Visual health checks of all animals within the enclosure
- Any medical treatments

Weekly-

- Cleaning of water pond and replace water with fresh clean water
- Clean feed bowls
- Physical health check of all animals
- Any medical treatments

Monthly/ less regularly-

- Cleaning of enclosure can be done monthly or less regularly depending on the number of frogs held.
- Removal of furnishings and disinfecting enclosure
- Cleaning and disinfecting of enclosure furnishing including cleaning of logs, plants, and rocks
- Veterinary health check



Enclosure of *L. caerulea*

Safe chemicals that can be used- Disinfectant chemicals for hands and equipment, and enclosures must be effective against bacteria and fungi. Chloramine and Chlorhexidine based products are both effective against both fungi and bacteria. They are also suitable for use on hands, footwear and enclosures. All cleaning chemicals should be diluted down to ensure that they don't possess any danger to the health of the frogs and or the keepers. Follow manufacturers instructions before using any disinfectant chemicals. A good veterinary grade disinfectant that can be used is F10sc. This product when used effectively can be very effective against viruses and bacteria. Follow manufactures instruction before using this product as well as read and follow the Material Safety Data Sheet (MSDS).

Chemicals that should not be used- Bleach and alcohol are effective against fungi and bacteria. These chemicals are not as safe to use, as they are corrosive and hazardous in nature. The manufacturers instructions should be followed when using these solutions and than rinsed well after use to ensure that no residue is left behind.

If using methanol you should either immerse equipment in 70% methanol for 30min or dip in 100% methanol than flame for 10 seconds or boil in water for 10 minutes.

Fresh bleach diluted to 5% can be used effectively against viruses. Equipment that is not easily disinfected can be cleaned using medical standard 70% isopropyl alcohol wipes and allowed to dry.

Routine treatments- for a list of routine treatments please refer to Chapter 8.3

5.2 Record Keeping

Daily-

- Animal behavior
- Temperature/ humidity readings
- Water fall/ pump turned on/ off
- Daily record sheet
- Any broken or loose furnishings
- Any routine medical treatments

Weekly-

- Feeding day including amount fed for each animal as well as type of food fed
- Water change
- Enclosure cleaned
- Furnishings disinfected
- Any routine medical treatment

Monthly/ less regularly-

- Change of enclosure light globe and starter
- Heating turned on/off depending on season
- Veterinary visit and report

5.3 Methods of Identification

Photo ID of individual frogs can be used to identify which animal is in which enclosure. This method should also be combined with a description of markings and any individual. Toe clipping, ID tags, and tattooing can be fatal to frogs so a more passive form of identification should be used. Most enclosures will contain a small group of frogs so identifying individuals is made a little easier.



2 different *L. caerulea* (both female)

5.4 Routine Data Collection

Feeding times-

- Amounts fed
- Time of feedings (Afternoon/ morning)
- If any frog didn't feed
- Water changes (date of when the water was changed, and by who)

Breeding activity-

- Any activity that relates to breeding behavior
- The day and times of calling
- Males grasping females
- Any miss mating (females reject males advances)
- Time and date at which the eggs are first noticed

Sex descriptions- juvenile animals or any frogs that have not been sexed.

- Calling
- Development of the nuptial pads on the inside of the male's thumbs
- Mating behavior should also be recorded including which animals are involved.

General behavior- any behavior that is seen during the day by keepers should be recorded. If there is a change in general behavior this could mean a change in the health status of the frogs.



One of the Author's enclosures for *L. caerulea*

Chapter 6

6 Feeding Requirements

6.1 *Diet in the Wild*

In the wild most frogs are almost totally insectivores. The common diet of wild *L. caerulea* is, small mammals and birds, cockroaches, grasshoppers, slaters, moths, flies, crickets, spiders, and lizards.

6.2 *Captive Diet*

The captive diet of *L. caerulea* is very similar to that in the wild, if it fits in their mouth they will eat it. This can also include other frogs.

A varied diet is very important; as *L. caerulea* can be fussy feeders a variety of different foods should be offered. You can purchase live and frozen foods from commercial suppliers such as *Pisces Enterprises Pty Ltd*. Although this company will not supply individual customers they will supply Zoos and Wildlife parks if orders are over a set amount.

The common diet used in captivity is, small mice, cockroaches, grasshoppers, mealworms, slaters, moths, and worms. Live foods are preferred but dead food can be given by wiggling it at the end of a pair of forceps. Food should also be treated with mineral and calcium powder supplements every alternate feed.

In captivity the tendency to use substitute foods is one, which should be avoided. The most common dietary problems seen in frogs are related to lack of calcium or too much protein in the diet. Most frogs have not evolved to cope with a diet high in protein and the tendency to feed them only on young mice; this will put extra strain on the frogs' organs, particularly the kidneys. If mice are used regularly they will lead to gout, irreversible kidney damage and ultimately death.

Juveniles will happily eat flies, moths, small crickets and cockroaches, and should have food available to them at all times. If young frogs are kept warm and offered plentiful food they will reach breeding size in about 8-12 months. Adults should be offered about 10-20% of their own body size in food spread over 2-3 feeds each week. During winter or when the enclosure temperatures are reduced frogs will need less food. The amount of food fed during colder months will depend on the animal's behaviour if the frogs are staying active than you need to feed them more often but if the frogs are reducing activity than you can feed them less often. You can use the enclosure temperatures as a guide as to what your frog's behaviour is. If the enclosure temperature during colder months does not drop the same as the outside temperature, than you can feed *L. caerulea* every third or fourth week. If temperatures in the enclosure drop the same as outside temperatures than feeding *L. caerulea* less often than three or four weeks could be maintained. It is important to increase and reduce food in both quantity and frequency with the changing temperatures of the

enclosure. Remove any drowned insects so as not to foul the water, or feed your frogs individually by holding the insects on tweezers.



L. caerulea eating a cricket

6.3 Supplements

Calcium powders should be mixed in equal quantities with a multivitamin powder then dusted on food before feeding. Place the insects in a plastic bag with a pinch of calcium/multivitamin powder and shake it till the food is well coated. If you use these supplements on every alternate feed nutritional deficiency can be avoided. Do not mix large quantities of this mixture at a time. It does not store well after mixing as the calcium can denature the vitamins (refrigeration will slow this process).

6.4 Presentation of Food

As *L. caerulea* are fussy eaters, all foods should be offered live except for small mice, these should be killed before offering.

There are enrichment-feeding tools that can be used to feed *L. caerulea* such as feeder rocks or logs. The logs, or rocks are filled with the live foods and placed into the enclosure. As the insects find the opening to the rock or log the insect is released. The timing of when the insect is released is not constant and frogs have to wait till they appear. These tools have to be moved around the enclosure so that the frogs don't just sit in front of the rock or log all the time. The other methods for feeding *L. caerulea* are presenting the food using tongs to each individual animal. Some of the larger specimens can be fed using your hands.

Chapter 7

7 Handling and Transport

As there is no standards found for the capture and transportation directly aimed at Amphibians, the following is based on the knowledge and experience of the Author.

7.1 Timing of Capture and Handling

The timing of capture I have found best to be made mid morning before transportation. If capture is made in mid afternoon the time of transport should be minimized as *L. caerulea* is more active in mid to late afternoons and transporting them at this time will increase stress.

Before handling any frogs, hands should be rinsed with water as to stop any chemicals from the handler's hands coming in contact with the frog. Handling should be kept to a minimum as frogs stress easily when handled. Handling should be as careful as possible as frogs can be injured very easily.

7.2 Catching Bags

Bags should not be used to capture frogs. Frogs are small enough to be caught by hand. This is the safest way for both the frog and the keeper.

7.3 Capture and Restraint Techniques

Capture of *L. caerulea* should be done as quickly as possible as to reduce the risk of stress, also injuring from jumping into furniture/ glass sides within the enclosure. For a more detail description of capture and restraint of *L. caerulea* see Chapter 8 of this husbandry manual.

The easiest way to capture any frog is to quickly but gently place your whole hand over the frog to reduce the risk of it jumping. From this position, move your hand down the frog till you are proximal of the hind legs. Using your fingers grasp them so the hind legs are held straight, stopping the frog from being able to use them.

This technique I have found to be the safest way of stopping frogs from being able to jump, if they are able to use their back legs it will enable them to jump and possibly injure themselves or escape. For frogs that are handled often, they may be able to be handled with an open hand but a careful eye should be on them at all time incase the frog tries to jump of out of the hand.

7.4 Weighing and Examination

When weighing frogs an escape proof container with a secure lid should be used. If the container is see through then the frog may become stressed, although this also allows the keeper to see the stress levels of the frog. Weighing should be quick and limit the stress levels.

Examination of *L. caerulea* is best made as a distal examination while active. If a closer examination is required a restraint such the one in A.3 (held proximal to hind legs) should be used. This will allow for a full body examination and or sample collection.

7.5 Release

When releasing *L. caerulea* into a container or enclosure, care should be made not to injure the frog or to allow it to injure itself when released. Place the frog on the floor of the enclosure away from corners, and any objects that it could injure itself when escaping from your hands.

The quickest and easiest way to release frogs is to remove it from the transport box by hand and place it in a suitable location within the enclosure where it will not injure itself.



4x *L. caerulea* at home with in their enclosure

7.6 Transport Requirements

7.6.1 Box Design

Transport boxes need to be able to carry water. The lid needs to be secure as *L. caerulea* are strong and able to open lids when held in small areas. The boxes air vents should be in the lid only to allow for water splashing during transport.

The dimensions of the box should be relevant to the size of the frog being transported. The floor dimensions should be large enough for the frog to move around freely but not large enough for a full jump. The height of the box should allow for the frog to climb out of the water but not high that the box becomes top heavy or easily knocked over from the shifting of water.

The material that the box is made out of should be strong and durable to allow for movement and possible stacking and strong enough so that the box will not be damaged easily. The corners of the box should be kept as smooth as possible to stop injury to the frog during transport.

Often a double box is used for transport this allows for water to splash out of the container and humidity not to be lost. This type of box is more expensive as it is of a larger size.

7.6.2 Furnishings

All furniture in the transport box should be fixed, so not to move around and possibly crush the frog during transport. A platform in the transport box will allow the frog to get up out of the water and allow it to rest without trying to hang onto the walls. *L. caerulea* do not like being in water for extended periods of time.

The use of branches is ok but can be broken or damaged during rough transport. If branches break without knowledge it may cause injury to the frog, so a platform or secure rock is a better solution.

7.6.3 Water and Food

As frogs do not drink water but absorb it through their skin, clean fresh water should be used on the base of the transport container. Preferably the same type of water used for the enclosure. Depending on the size of the box an average of 10- 20mm of water should be enough for transport.

As the base of the box will be covered with water no food should be transported with the frogs. The shipments should not be any longer than 24-48hrs. As frog's only need to be fed every other day shipment should be arranged for the period between feeds as the stress of moving could stop the frog from eating or regurgitate its food.

7.6.4 Animals per Box

The number of animals in each transport box depends on the box size and the size of the frogs to be transported. As *L. caerulea* is a social frog and can be found in numbers in the wild, shipping them in larger number is easier than some other species that can be territorial at times, although transporting animals of different size should be avoided as this will increase stress levels and the larger frogs may eat the smaller frogs during transport.

Each box needs to allow for the movement of each frog for jumping and general movement. Numbers per box can be from one up to ten individuals if the box allows. Any more than ten per box can cause stress due to over crowding, and the transport water will become to contaminated from excretations.



L. caerulea enclosure

7.6.5 *Timing of Transportation*

The time of transport should not be during mid to late evening. This is the time when the frogs are most active. Shipment should be limited to mid to late morning where possible and not during the middle of the day when it is the hottest. This timing of movement is when the frogs are least active and are more likely to be settled during transport.

Transportation of frogs should be in an air conditioned vehicle and for the shortest period of time possible. Transportation of mature frogs should be avoided during breeding season as this may cause slow breeding or no breeding at all. Transportation of frogs should not be directly after feeding and not directly before. The stress of moving can cause the frogs to either stop feeding or regurgitate their food.

7.6.6 *Release from Box*

The quickest and easiest way to release frogs is to remove it from the transport box is by hand and place it in a suitable location within the enclosure where it will not injure itself. Place the frog on the floor of the enclosure away from corners, and any objects that it could injure itself when escaping from your hands.



3x *L. caerulea*, 1 male (center) 2 female

Chapter 8

8 Health Requirements

8.1 Daily Health Checks

All animals should be observed daily for signs of illness, injury, or abnormal behavior by a person trained to recognize such signs. Unexpected deaths and signs of illness, distress, or other deviations from normal in animals should be reported promptly to ensure appropriate and timely delivery of veterinary medical care. Adherence to this recommendation is critical to the maintenance of good health for both individual animals and animal colonies. Manipulate enclosures as necessary to observe appearance and behavior of animals. Descriptions of the animal health and environment checks follow.

General observations of the Amphibian

- Excessive weight loss/emaciation or weight gain/obesity
- Unusual growths or swellings
- Unusual posture, activity, lethargy
- Skin irritation, lacerations, lesions, or ulcers
- Bleeding or discharge from an orifice
- Unusual faeces
- Difficulty breathing
- Unusual locomotion
- Convulsions/seizures
- Fungus
- Skin discoloration
- Edema/bloat
- Dehydration (sunken eyes, loss of skin elasticity)
- Abnormal skin shedding
- Eyelid swelling

- Vomiting
- Mucus

Environment Check. Primary (cage/tank) and secondary (room) enclosures should be evaluated for the following:

- Temperature extremes
- Inadequate supply of food, water, or applicable nutrients
- Decreased food, water, or nutrient consumption
- Lack of faeces or urine
- Broken enclosure
- Excessively soiled enclosure
- Unusual odors
- Humidity extremes
- Water level
- Water condition/quality
- Water oxygenation
- Organism accumulation
- Water filtration
- Water temperature
- Water quality
- Photoperiod abnormalities
- External heat source
- Basking area is clean and secure

8.2 Detailed Physical Examination

8.2.1 Chemical Restraint

Some frogs may be difficult to fully evaluate when they are completely awake. Different plans of anesthesia are routinely used in the evaluation and treatment of amphibians.

Many anesthetics are not recommended for use on amphibians due to adverse side effects, not readily available, or produce equivocal results. These anesthetics are, urethane, chloroform, ether, phencyclidine, acepromazine, and procaine hydrochloride. Cooling of the frog for hypothermic restraint is not recommended due to its probable lack of analgesia as well as potential long-term immunosuppressive effects. In addition the slower reaction time of the hypothermic animal may mask pain reflexes, thus obscuring the true plane of anesthesia achieved.

Many other forms of anesthetics can be used for amphibians; this includes Ketamine hydrochloride, Isoflurane, Methoxyflurane and Tricaine methanesulfonate.

8.2.1.1 Preparation of the Frog

The risk of regurgitation of stomach contents is extremely rare event in amphibians as the larynx is usually closed when an amphibian is anesthetised. Some vets despite the lack of a prolonged fast of the frog that is to be anesthetised have not noted aspiration pneumonia due to the anesthesia. However, although regurgitation of food is not common it should always be taken into account when anesthetising frogs, as this can be a physiologically demanding event due to the loss of ingesta and associated gastric secretions. If at all possible the stomach should be empty of ingesta before the frog is anesthetised.

In large to medium specimens a fasting time of 48 hours will allow for adequate digestion of the stomach contents. If the frogs diet contains rodents than a fast time of 7 days has been recommended. For smaller specimens (under 20g) can be safely fasted for 4 hours prior to anesthesia. If the temperature is lower than the optimal body temperature than a longer fast time should be allowed. The length of time fasting is also governed by the animal's condition.

If the frog is only going to be anesthetised for a short period of time or if the procedure cannot be held off than a fast time does not need to be given. If the frog is going to be anesthetised for a long procedure than a fast should be given at the recommended time lengths.

8.2.1.2 Anesthetic Monitoring

Monitoring of the heart rate, pulmonic respiratory rate if present and blood oxygen saturation are recommended during use of anesthesia.

The heart rate may be visible and simply counting the pulse rate can determine its rate. As many amphibians breathe through both lungs and through their skin the respiration movement may cease if the amphibian is maintained under anesthesia for long periods of time.

Normal respiration movements may not return if the frog is maintained on pure oxygen after surgery. The room's ventilation should be used for recovery of any amphibian.

There are small clips that can be purchased for the use in monitoring blood oxygen saturation in frogs that connect to the toes or tails, or probes can be placed directly in the heart or in the lungs. In general amphibians have lower blood oxygen saturation than expected for mammals.

8.2.1.3 **Injectable Anesthetics**

For injectable anesthetic dosing in amphibians is performed by the use of water baths that the frog is placed in. It is vital that sufficient air is provided so that the animals can breath normally during induction. The frog should be constantly monitored during this time to stop the risk of drowning.

Once the frog is under necessary plane of sedation it can be moved to a fresh water bowl so as not to overdose the frog. If the frog starts to awaken from the anesthetic than a bath with 50% induction solution should be used to lower the plan of sedation. Simply washing the frog with distilled water can help to wash away any anesthetic that is being secreted by the frog instead of waiting for it to be metabolized.

Tricaine methanesulfonate.

Due to the low pH of this anesthetic a buffered solution should be made up using distilled water to create a pH of 7.0- 7.4. Dose rates ranging from 0.5 g/L to 5.0 g/L have been recorded for induction of amphibians. It has been proven that if the solution is at the optimal pH then a lower dose rate can be used. Induction rates of 0.2 g/L in buffered solution for tadpoles, 1 g/L for adult frogs a high does may be needed. The time it takes for induction of anesthesia of 1 g/L is approximately 30minutes but will vary from animal to animal.

Ketamine hydrochloride

Ketamine has been discouraged by some as an anesthetic due to the fact it is injected into the dorsal lymph sacs. Others have reported no such issues and a more favorable affect when used.

A favorable plan of anesthesia for frogs can be obtained within 15 min at 70- 100mg/kg inter- muscular injection. Although at this rate random muscle movements were still present, most procedures can be carried out. Recovery is completed within 12 hours. Lower rates have been recommended for minor procedures.

8.2.1.4 Inhalant Anesthetics

Often the term inhalant anesthetic is used for reptiles, birds, and mammals. The distinction between injectable and inhalation anesthetics is blurred when used for amphibians. Although inhalant anesthetics can be used it is easier to use injectable anesthetics if available due to the waste of anesthetics with the use of chambers and the variable does rates that is achieved. The recovery time is also longer than injectable anesthetics.

Induction can also be achieved by bubbling the anesthetic through water, interbation- although difficult due to the narrow throat size of frogs, or direct application to the skin of the frog.

Isoflurane

A flow through chamber with a scavenger tube is recommended for Isoflurane due to its volatility. A 5% saturation at a low oxygen flow rate will induce unconsciousness within 5- 20 minutes and an anesthetic plan for approximately 40 minutes and a recovery time of 1 and a half hours. Respiration rate is depressed through deep anesthesia and early recovery, but heart rate is minimally reduced.

Methoxyflurane

Can be used in a manner similar to Isoflurane. Induction can be through soaking a cotton ball with 10% Methoxyflurane and placing it in a 4 liter glass jar with breathing holes in the lid. This method can be used due to the lower volatility than Isoflurane. The jar method creates results within 5 minutes for approximately 40 minutes sedation and a 7-hour recovery time. Respiration rate is depressed through deep anesthesia and early recovery, but heart rate is minimally reduced.

8.2.2 Physical Examination

When handling frogs, safety of the handler and the comfort and safety of the animal must be taken into account.

The skin of *L. caerulea* is thought to produce secretions that may contain potentially toxic compounds. The secretions have been the focus of intensive research into the medicinal properties of the chemicals that are secreted. Moistened powder-free latex gloves should be worn whenever handling frogs. The gloves should be removed and discarded into a waste bin after use to minimize the contamination to other keepers or equipment. Gloves are also important for the protection of the frog. A frog will struggle when physically restrained, and ridges of the keeper's hands may damage the thin skin of the frog, latex gloves are smooth and cause less damage. The gloves need to be rinsed with distilled water to remove any powder and a water-soluble non-toxic gel or lubricant used. This is important as the gel or lubricants will reduce skin damage and reduce any injuries handling may cause. A shallow fresh clean water bowl should be available when handling frogs to moistening them throughout the examination or transport.

Frogs may struggle during capture and restraint. While some specimens may become resigned to restraint and cease to struggle, some frogs will produce an explosive burst of energy either through leaping or biting the handler to escape, an incautious handler may loosen their grip if not prepared for this type of behaviour. This behaviour can be differentiated from signs of true distress. The handler must remain on guard to prevent escape at all times. Proceed with caution if a frog appears unnaturally stressed by restraint. Other defensive reactions to restraint are inflation, biting, release calls, writhing, rolling. Examination of small amphibians is facilitated using a clear glass jar, a deli cup with transparent lid, or a plastic bag. This will allow for a more detailed examination. Special attention should be given to the ventrum. Capillary blush can be the sign of a more serious underlying problem or simply reflect an agitated animal.

Large specimens may be manually restrained without difficulty. The frog should be grasped immediately anterior to the hind limbs, and a second grip around the forelegs if required. Medium-sized frogs can be handled the same as large specimens but can also be gripped in a fist for access to the abdominal cavity or cloaca. Small frogs can be restrained with a loose grip, but chemical restraint is recommended instead to reduce the risk of traumatic injuries. Small frogs can have their hind legs secured between the handler's thumb and forefingers so that the animal lays across the palm facing the handler's little finger. This technique works well for frogs that are calm when handled, it is not recommended if the frog is active or agitated as they may injure their hind limbs attempting to jump free of the handler's grip.



Hand restraint of a large *L. caerulea*

Tadpoles should be handled sparingly, and careful attention given to keeping their skin moist. If the skin changes texture and becomes wrinkled, or if the tail tip begins to curl, the tadpole is too dry and must be immediately moistened or returned to its aquatic environment.

8.3 Routine Treatments

Most routine treatments described for frogs are focused on prevention of any disease outbreaks.

- Quarantine of new animals
- Regular cleaning and disinfecting of enclosure and furnishing
- Regular faecal waste removal
- Sterilization of equipment used for feeding
- Feeding clean reportable food sources will also help reduce disease transmission.
- Mineral additives added to the food for amphibians if the nutritional value is not known for the feed source or if the nutritional value needs to be increased due to increase of growth, the onset of breeding, or recovery from disease.
- Correct light source of UV A and B needed to maintain natural metabolic activities.

8.4 Known Health Problems

There are many different known health problems of frogs. These can be Bacterial, Mycoses, Protozoa and Metazoa, Trauma, Idiopathic Syndromes, and Nutritional Disorders. The following is a list of the different forms of health problems associated with amphibians. For further information on any of these health problems please seek professional advice.

Bacterial- Bacterial Infections often are difficult to recognize in a colony of amphibians until the disease has progressed to the point of mortality in specimens.

Etiology- The main causes for Bacterial outbreaks are Shipment and poor husbandry practices, including inadequate housing, poor food quality, and poor water quality.

Clinical signs- As many clinical signs are the same for different bacterial infections. This is a list of signs that can be noted by keepers. If any of the signs are observed seek veterinary advise immediately.

Superficial ulcers, abscesses, lesions, discoloration, necrosis, atrophy, circling, head tilt, inability to right themselves, anorexia, bloating, cloudy eyes, blood colour of the limbs, wasting even though they have good appetite, lethargy, and ceased shedding

Treatment- The bacteria that are detectable are the ones that are easily tested for and antibiotics are readily available for. Seek veterinary advise before treatment.

Prevention- To prevent bacteria outbreaks you need good hygiene of enclosures and equipment as well as strict husbandry routines, healthy nutritious diets of a variety of foods with mineral/ vitamin supplements.

Forms of Infections:

Localized Infections: Superficial wounds, Ulcers and abscesses, Epithelial Disorders, Rostra Injuries, Neurological Infections, Ocular Infections.

Systemic Infections: Bacterial Dermatosepticemia (red leg syndrome), *Mycobacterium spp*, *Chlamydia*, Rickettsia.

Nonpathogenic Isolates with Zoonotic Potential: *Leptospira*, *Listeria*, *Salmonella*, *Edwardsiella*, *Yersinia*.

Mycoses- Although moist soils of the interface between Aquatic and terrestrial environments provide favorable conditions for a diversity of possible pathogenic fungi; there is little documentation that connects this to Fungal diseases in frogs. Most frogs live a solitary life so the risk of infection is low. When frogs are either housed in higher than natural numbers, brought together for mating, and housed together as tadpoles and metamorphic specimens, the rate of outbreaks increases.

Although there has been an opinion that many species of fungi that infect amphibians are not Zoonotic, the potential of the fungi to become Zoonotic is high. All potential strategies to avoid the possible Zoonotic infection should be followed. Facemasks and latex gloves should always be worn when handling amphibians, especially when handling quarantined animals.

Etiology- The main causes for a fungal outbreaks are poor husbandry practices, including inadequate housing, and poor water quality, housed in higher than natural numbers, introduction of different animals for mating, and housing together of tadpoles and metamorphic specimen.

Clinical signs- As many clinical signs are the same for different fungal infections. This is a list of signs that can be noted by keepers. If any of the signs are observed seek veterinary advise immediately.

Superficial ulcers, discoloration, hunching or arching of the back, increased urination, inability to right themselves, anorexia, cloudy eyes, lethargy, increased or ceased shedding, and sitting in water for long periods of time,

Treatment- The fungi that are detectable are the ones that are easily tested for and antifungal drugs are readily available for. Seek veterinary advise before treatment.

Prevention- To prevent fungal outbreaks you need good hygiene of enclosures and equipment as well as strict husbandry routines, healthy nutritious diets of a variety of foods with mineral/ vitamin supplements.

Forms of Infection:

Localized Mycoses: Mycotic Dermatitis, Mycotic Myositis, Mycotic Hepatitis, Mycotic Pneumonia, and Mycotic Mycoses.

Systemic Mycoses: Egg Mass and Laval Mycoses, Chromomycosis, Zygomycoses, and Candidiasis.

Protozoa and Metazoa- Protozoa and metazoa frequently use amphibians as host, yet clinical disease is relatively rare. There is a wide range of inter relationships, ranging from harmless or even beneficial to parasitic where the protozoa or metazoa is dependant on the amphibian for nutrients. Since most amphibians and protozoa and metazoa have coevolved, it is unusual to find infections in clinically healthy amphibians, and treatment is not always advisable or necessary.

Etiology- The main causes for protozoa and metazoa outbreaks are Shipment and poor husbandry practices, including inadequate housing, poor food quality, and poor water quality.

Clinical signs- There is not many clinical signs for protozoa and metazoa infections. Keepers can collect faecal samples and check for obvious signs of infection, do blood smears, and faecal flotation. By viewing the samples under a microscope the keeper can visually see if an infections is occurring. If any signs of protozoa and metazoa are observed seek veterinary advise immediately.

Treatment- Period. If required the use of anthelmintics and moving the infected frog/s to a clean enclosure straight after each treatment. This should be done two or three times to become effective in breaking the life cycles. Seek veterinary advise before treatment.

Prevention- To prevent protozoa and metazoa outbreaks you need good hygiene of enclosures and equipment as well as strict husbandry routines, healthy nutritious diets of a variety of foods with mineral/ vitamin supplements, and strict quarantine protocols.

Forms of Infection:

Ciliates both in the Gastrointestinal tract, Urinary Bladder and External Ciliates, Opalinids, Flagellates all Ectoparasitic, Blood and Intestinal, Amoebae, Apicomplexa both in the blood and tissue, Microsporidia, *Dermocystidium* the protozoan- type fungi, Myxosporea, Monogenea, Digenean Trematodes, Cestodes, Nematodes, Acanthocephala, Leeches, Arthropods including Crustaceans (Branchiurans, Pentastomids), Arachnids (mites, Ticks), and Insects, Mollusca,

Trauma- Most trauma injuries are associated with poor or inadequate housing and capture techniques of keepers. Frogs need large areas to live and room for full movement. Many trauma injuries develop from poor enclosure design and understanding of the frogs needs.

Etiology- The main causes for trauma are poor husbandry practices, including inadequate housing, animals housed in higher than natural numbers, introduction of different animals for mating, and housing together of tadpoles and metamorphic specimen in high numbers.

Clinical signs- Many signs of trauma that are the same for other types of disease. This is a list of signs that can be noted by keepers. If any of the signs are observed seek veterinary advise immediately.

Superficial ulcers and lesions, discoloration, abnormal position of the back and limbs, decreased urination, inability to right themselves, anorexia, cloudy eyes, lethargy, increased or ceased shedding, loss of limb/s, and rapid loss of condition.

Treatment- The best treatment of trauma is prevention. If trauma does occur initially cleaning of the wound with saline solution followed by antibiotic treatment will stop any secondary bacterial infection. Cooling or warming of enclosure so to maintain ambient temperatures during treatment will assist with recovery. Seek veterinary advise before treatment.

Prevention- To prevent trauma, keepers need strict husbandry routines, provide healthy nutritious diets of a variety of foods with mineral/vitamin supplements. Housing the frogs the correct size enclosures that allow for full range of movement, are also safe to live in, and are not overcrowded will assist in the prevention of nutritional disorders.

Forms of trauma:

Abrasions, Lacerations, Traumatic Amputations, Skeletal Fractures, Hyperthermia, Hypothermia, dehydration and Desiccation, Drowning, Electric Shock.

Nutritional Disorders- A variety of nutritional problems have been seen in captive amphibians. The typical focus is on the analysis of nutrients in the diet offered, but the impact of water quality upon the development of these disorders still needs to be look at.

Etiology- The main cause for nutritional disorders are poor husbandry practices, including inadequate housing, including poor food quality, and poor water quality. Animals housed in higher than natural numbers, and housing together of tadpoles and metamorphic specimen in high numbers will increase competition for food.

Clinical signs- Many signs of nutritional disorders are the same for other types of disease. This is a list of signs that can be noted by keepers. If any of the signs are observed seek veterinary advise immediately.

Discoloration of the skin, abnormal position of the spin and limbs, increased or decreased urination and production of faeces, inability to right themselves, anorexia, cloudy eyes, lethargy, increased or ceased shedding, and rapid loss of condition.

Treatment- The best treatment of nutritional disorders is prevention. If nutritional disorders do occur initial antibiotic treatment will stop any bacteria infection that could develop due to the disorder. Feeding of food covered with mineral/ vitamin supplements can aid in early conditions. Cooling or warming of enclosure so to maintain ambient temperatures during treatment will assist with recovery. Seek veterinary advise before treatment.

Prevention- To prevent nutritional disorders keepers' need strict husbandry routines provide healthy nutritious diets of a variety of foods with mineral/ vitamin supplements. Housing the frogs the correct size enclosures that allow for full range of movement, are also safe to live in, and are not overcrowded will assist in the prevention of nutritional disorders.

Forms of Infection:

Metabolic Bone Disorders, Hypervitaminosis D3, Thiamine Deficiency, Steatitis, renal Calculi, Obesity, Gastric overload and Impaction, Scoliosis, Spindly Leg, Paralysis, corneal Lipidosis (Lipid Keratopathy), Cachexia.

Idiopathic Syndromes- Despite aggressive diagnostic efforts, the underlying cause of many of an amphibian's illness may remain unknown. A necropsy may show essentially normal results, or results that are in conflict with the findings from amphibians with similar- appearing clinical signs. There are several idiopathic syndromes that have received considerable attention, and while some have yet to have classification within standard pathologic diseases such as nutritional, or infectious, undoubtedly other idiopathic syndromes will be discovered and reported as interest in amphibian medicine expands.

Etiology- The main cause for any idiopathic syndrome is poor husbandry practices, including inadequate housing, including poor food quality, and poor water quality. Animals housed in higher than natural numbers, and housing together of tadpoles and metamorphic specimen in high numbers.

Clinical signs- Many signs of idiopathic syndromes are the same for other types of disease. This is a list of signs that can be noted by keepers. If any of the signs are observed seek veterinary advise immediately.

Discoloration of the skin, abnormal position of the spin and limbs, increased or decreased urination and production of faeces, inability to right themselves, anorexia, cloudy eyes, lethargy, increased or ceased shedding, and rapid loss of condition. Superficial ulcers, abscesses, lesions, necrosis, atrophy, circling, head tilt, bloating, blood colour of the limbs, wasting even though they have good appetite and sitting in water for long periods of time,

Treatment- the best treatment of idiopathic syndromes is prevention. If any idiopathic syndrome do occur initial antibiotic treatment will stop any bacteria infection that could develop due to the disorder. Feeding of food covered with mineral/ vitamin supplements can aid in early conditions. Cooling or warming of enclosure so to maintain ambient temperatures during treatment will assist with recovery. Seek veterinary advise before treatment.

Prevention- to prevent any idiopathic syndrome keepers' need strict husbandry routines provide healthy nutritious diets of a variety of foods with mineral/ vitamin supplements. Housing the frogs in the correct size enclosures that allow for full range of movement, are also safe to live in, and are not overcrowded will assist in the prevention of nutritional disorders.

Forms of Infection:

Spindly Leg, Postmetamorphic Death Syndrome, Gout, Molchpest, Edema Syndrome, Prolapses of the Rectal, Cloacal, and Gastric organs

8.5 Quarantine Requirements

A minimum of 30 days is recommended for the quarantine period of any amphibian. But often a 60-day quarantine period is a more reasonable length of time needed for quarantine. Wild caught or amphibians from uncertain sources should be quarantined for a 90-day period. If any illness is discovered a further 14 days should be added to the quarantine period after the animal returns to a display of good health. If any animal dies during quarantine the rest of the animals should not be released until final test results are available.

Clean relative empty enclosures should be used for quarantine of amphibians. Clean plastic boxes or glass tanks are suitable as they can be disinfected easily. Flooring should be of moist paper towel or cloth so to easily collect faecal samples for testing. If the amphibian shows signs of stress then plastic plants and logs can be added but should be thrown away after the amphibian has been released from quarantine.

Faecal samples should be collected every 3 weeks for testing for infections. If the results returned are positive than a 2-week collection should be carried out. If the tests returned are negative, testing should still be carried out for the entire quarantine period before being released to ensure the results are correct. Routine testing of the entire collection should be carried out for the next 6 months following release from quarantine to ensure the continuation of the health of the animals. All equipment used for quarantine should be sterilized between enclosures and different equipment used for the permanent collection. It is best if the quarantined animals are housed in a separate room away from the permanent collection but if this is not possible then strict husbandry routines need to be in place. All quarantine enclosures need to be serviced after the permanent collection and all efforts are made to reduce cross contamination. Overcrowding in quarantine enclosures should be avoided as this increases stress level of individuals and the transmission of parasites or disease is increased.



L. caerulea under quarantine

Chapter 9

9 Behaviour

9.1 Activity

L. caerulea is very docile. They are nocturnal and come out in early evenings to call (in spring and summer) and hunt at night. During the day they find cool, dark, and moist areas to sleep. During winter, *L. caerulea* do not call and are not usually seen.

Depending on their location, *L. caerulea* occupy various habitats. Typically, they are found in the canopy of trees near a still-water source. However, they can survive in swamps (among the reeds) or in grasslands in cooler climates. *L. caerulea* is well known for inhabiting water sources inside houses, such as sinks or toilets. They can also be found on windows eating insects. They will occupy tanks, downpipes, and gutters, as these have a high humidity and are usually cooler than the external environment. The frogs are drawn to downpipes and tanks during mating season, as the fixtures amplify their call.

L. caerulea is mainly an arboreal species. Most live in areas with vegetation ranging from low grasses and shrubs to the top canopy in tropical rain forests. These amphibians display limited burrowing abilities.

L. caerulea has the ability to withstand a large temperature gradient of up to 50C and body temps as high as 38C and 0.8C body temp above the nocturnal temperature.



4x *L. caerulea* on a branch

9.2 Social Behaviour

L. caerulea is not as sociable as many other animal species. There is no social interaction between individuals outside of the breeding season, although males will call to show their location to any others within the area outside the breeding season. Groups of individuals can be seen in areas that have sufficient food supply, such as houses and amenities blocks where numbers will congregate at night to feed on insects that are attracted to the lights.

They can be housed as either single are in large numbers if the enclosure has sufficient space and enough food is supplied. Individuals that are housed together should be of similar size due the feeding habits of this amphibian. *L. caerulea* has been known to eat other frogs including its own species, for this species it is well known that if it fits into its mouth it will be eaten.



L. caerulea showing social interaction

9.3 Reproductive Behaviour

The species' call is a low, slow cawk- cawk- cawk, repeated many times. For most of the year, they call from high positions, such as trees and gutters. During mating season the frogs descend, although remaining slightly elevated, and call close to still-water sources, whether temporary or permanent. Like many frogs, *L. caerulea* call not only to attract a mate but also to show their location to others who may be in the area. They have been observed calling to advertise their location outside the mating season, usually after rain, for reasons that are uncertain to researchers. They will emit a stress call whenever they are in danger, such as when predators are close or when a person steps on a log in which a frog resides.

Prior to the mating season in late spring to summer, the male develops a black nuptial pad on the inner surface of the thumb. This aids amplexus by allowing the male to continue a grip on its mate for the duration of amplexus. The male calls (individually) to attract a female, and the two typically meet at a still-water source.

During amplexus, the male mounts the female. The female then expels her eggs at such a speed that the sperm is forced into the egg. A large spawn of about 200 to 300 eggs is left in the water, approximately a half meter from the frogs. The eggs sink and attach themselves to submerged objects. The two frogs can remain in amplexus for about two days, during which the process is repeated many times, resulting in the laying of an average of 2000 to 3000 eggs. An egg hatches three days after it is laid. The water must be 28-38 degrees Celsius and 5 to 50 centimeters deep for the eggs and tadpoles to survive. Metamorphosis takes between two and three months, and sexual development about two years.

9.4 Bathing

L. caerulea occurs near permanent water in some of the driest parts of arid Australia. It is therefore not important to maintain a high humidity. A fresh bowl of clean water is enough moisture that is required.

With fresh water supplied continuously the amphibian will visit the water whenever is necessary. If a waterfall is made within the enclosure the amphibian will often sit on top of this while it is running. Although the amphibian can swim extremely well these frogs will prefer to just sit on the edge of the water bowl or pond to bath.

9.5 Behavioral Problems

L. caerulea adapts to captivity very quickly although it still demonstrates its natural behaviours.

L. caerulea is conditioned to gorge itself on prey when it available. Thus building up fat reserves for when prey is not available. This feeding cycle is used to prepare the body of hibernation, and reproductive activities. In captivity the environment is more controlled although *L. caerulea* will still gorge itself on prey foods when possible. If *L. caerulea* is housed in a group situation there is the possibility of the individual eating all the food before the others can. Hand feeding individuals is a way to monitor feeding and control the amounts fed. Most obesity in frogs is seen in *L. caerulea*.

If individuals of different sizes are housed together there is the possibility of the larger individual eating the other smaller individuals. If one large individual is housed with a number of other small individual you can lose the colony over night and have the largest specimen remaining in the morning.

9.6 **Signs of Stress**

- Pacing
- Abnormal Shedding
- Diarrhea/ bowel movements
- Abnormal vocalization when approached or handled
- Increased activity or Inactivity/ sluggishness
- Loss of appetite
- Depression
- Sitting at the bottom of the cage, listlessness
- Restlessness, distraction, agitation
- Listlessness, unusual passivity

Causes of stress

- Unusual noises
- Unknown places
- Confusing or inconsistent training or handling
- People exhibiting strange or unusual behavior
- Unpredictable or rough handling
- Unusual odors
- Being crowded by people or other animals
- A resident or staff member being nervous or acting in a strange way from the animals perspective
- Extreme indoor and outdoor temperatures
- Housing or resting area in an inappropriate place, not able to get adequate rest as a result
- Inadequate exercise or mental stimulation
- Inadequate diet for species
- Humans 'anthropomorphizing' animal behavior thus causing behavior problems
- Inappropriate or excessive feeding of animals

9.7 Behavioral Enrichment

Enrichment that can be used to stimulate natural behaviour in *L. caerulea*:

- Large fresh water pond with waterfall
- Natural substrate such as leaf mulch, mosses, gravel (care should be made as to the which substrate is used and the sterility)
- Natural logs and branches climbing
- Natural light cycles and UV ranges
- Leaves and plants for hiding (either natural or fake)
- Rain chamber to stimulate environmental conditions (separate tank would be required for this)
- Live foods of different sizes and types (feeding of rodents should be kept to a minimum).
- Cooling during winter to stimulate hibernation.
- Inter gender housing to stimulate breeding
- Use of hollow logs for hiding.
- Large rocks for sitting on, climbing
- Alternating feeding by rotating between hand feeding and live foods.
- Alternate feeding patterns (time of day and day of feed) and the amount fed.

9.8 Introductions and Removals

There are no removal procedure for *L. caerulea* as they adapt quickly to new captive environments. For breeding purposes the removal of pairs to a rain chamber is often done to stimulate amplexus and spawning. *L. caerulea* should not be left in the rain tanks for long periods of time as these tanks are only designed for breeding and not the long term housing of amphibians.

All introductions should follow the strict quarantine requirements set out in chapter 8 before any new individual is introduced. All new individuals should also be of the same relative size to the rest of the collection to stop cannibalism.

9.9 Interspecies Compatibility

L. caerulea can be housed together without any problems as long as all individuals are of the same size and the enclosure is large enough to support a large group.

Both males and females can be housed together without too many issues. During breeding season individual pairs are best removed to breed as others held in the same enclosure will interrupt the amplexus and stop breeding.

9.10 Interspecies Compatibility

Although *L. caerulea* in the wild is found in the same areas as many other amphibians it is not always possible to do this in captivity.

Other species of amphibian can be housed with *L. caerulea* as long as they are of similar size. As soon as one species is larger than the other there is a possibility of cannibalism and they should be separated.

Species such as the Magnificent Green Tree Frog *L. splendida* are housed together with *L. caerulea*. *L. splendida* has similar housing requirements, the amphibians' behaviour is similar, and adult size is the same. Although these two species are often displayed together with descriptive signage and diagrams it is often hard for public to tell the difference between the two species so should be avoided if possible.

The risk of introduction of disease into the collection is also of concern. Strict quarantine routines should be enforced. Also some species may not be as competitive for food and may become malnourished or stressed. Hand feeding should be used to monitor all amphibians within the enclosure.

9.11 Suitability to Captivity

L. caerulea is very well suited for captivity given its passive behaviour to humans and its ability to adapt well to captivity. Captive specimens have lived for 20 plus years without problems. They are easily handled and are excellent as a training species for staff as these amphibians are able to withstand some mistakes with husbandry that other species of amphibian would not.

Due to this ability to withstand poor husbandry compared to other species, ease of handling and husbandry requirements *L. caerulea* is now one of the most popular amphibians species for new hobbyists.



4x captive bred *L. caerulea*

Chapter 10

10 Breeding

Fertilization of a *L. caerulea* eggs is external with the male stimulating the release of the female's eggs by grasping her around her body in a grip known as amplexus. At the moment the female releases her eggs, the male deposits sperm into the water to fertilize them. Spawn is the term used to describe the fertilized eggs and the jelly that surrounds them.



The two *L. caerulea* are in amplexus.

10.1 Mating System

To succeed with breeding *L. caerulea* it is usually necessary to construct a separate tank known as a breeding chamber, or rain chamber. As the name suggests a rain chamber is a small tank, usually only three feet long with a large amount of water sprayed around to stimulate rain.

Unlike display tanks rain tanks must be heavily populated to allow maximum competition at breeding time. The normal ratio is 2 or 3 males to 1 female and in this size tank it is best to put 2 females and 4 males. The frogs only spend a couple of days in the rain tank and they will not need to be fed during this time and so cleaning routines should be minimal.

To set up a rain tank you will need a small water pump connected to a spray bar for 9 hours each evening. In the rain tank the water level is about one third of the total height of the tank, simulating the real wet season and the conditions that the frogs would experience in nature. It is important to have various branches or rocks above the water level to allow the frogs to 'escape' the water if necessary.

10.2 Ease of Breeding

It can be difficult to breed *L. caerulea* in captivity for the beginner. Once breeding is established it becomes easier to manage captive breeding pairs. This species is easier to breed if correct husbandry conditions are maintained and animals are housed in as close to natural conditions as possible.

10.3 Reproductive Condition

10.3.1 Females

Females need to be at least 2 years old before they are able to successfully breed. At this time the female should be allowed to hibernate over the cooler months and will stop feeding for long periods. At the onset of spring when the weather starts to warm up, the females will become more active. At this stage the females should be offered food twice a week so that they are able to build body condition ready to start producing eggs.

Females may respond to male calls by making “quieter” calls in reply to the males. For mating to occur female should be moved to a rain tank, this stimulates the heavy summer rains of the wild. The rain tank should also contain males that will start to call and stimulate mating behaviour in the female.

10.3.2 Males

Males need the same conditions for breeding as the females. When males are ready to breed, they develop black nuptial pads on their hands that are used to grasp the female during amplexus. Males will also call more regular and louder than the females. For males to be stimulated to call ready for breeding, audio recordings of *L. caerulea* can be played and this will stimulate calling and eventually breeding.

10.4 Techniques Used to Control Breeding

To control breeding of *L. caerulea* males and females can be housed separately. If eggs are produced, the eggs and/ or tadpoles can be used for food to other aquatic species such as turtles.

10.5 Occurrence of Hybrids

There is no known Hybrid breeding of *L. caerulea*. Due to the female responding to the specific call of the male *L. caerulea* to stimulate breeding, hybrid breeding between species is not likely. Possibilities of hybrid breeding with closely related species such as *L. splendida* could be possible in a lab environment but this has yet to be tested.

10.6 Timing of Breeding

Breeding occurs in Australia from spring through to summer (from November to February). Conditioning of parents such as increasing feeding, will start from early September as the weather starts to warm up after winter. Once the male starts showing interest in the females, the females are in peak conditions for breeding and show interest in the males, than breeding animals can be introduced to a rain tank for breeding.

10.7 Age at First Breeding and Last Breeding

The first time as to when *L. caerulea* can be bred should be no earlier than 2 years of age, although males will call before this time. Breeding amphibians are often not bred for the first breeding year so that they can be put through a winter hibernation to bring on mating behaviour. This then makes the first breeding season when the amphibian is 3 years of age. Although there is no documentation as to when *L. caerulea* will stop breeding, due to the captive life span not being known, breeding of *L. caerulea* should be stopped if the amphibian is losing condition or egg production drops.

10.8 Ability to Breed Every Year

L. caerulea is able to breed every year once they have reached sexual maturity. If conditions are correct more than one clutch of eggs is possible but rare.

10.9 Ability to Breed More than Once Per Year

In captivity *L. caerulea* can be bred more than once a year. It is possible to breed *L. caerulea* all year round if optimal breeding conditions are maintained. This is possible through hormone injections to both males and females, although possible it is not recommended due to the large population in the wild. The use of hormones can be used as practice for the recovery of other endangered species such as the corroboree frog *Pseudophryne corroboree*.

10.10 Nesting, Hollow or Other Requirements

In order to allow frogs to breed they will need to have some partially submerged water plants within the rain tank. This will help the frogs to stay afloat while mating and thus increase the number of fertilised eggs. The water pump in the rain tank should be turned off during spawning.

The placement of the tank is important; the best position for the tank is in a quiet area where very few people will be walking past or bumping the tank. If this is not possible an alternative is to hang an old sheet or towel over the tank to minimize the disturbance. It is important that the frogs are not interrupted while breeding. If this does occur the majority of the eggs will go unfertilised, and all your hard work will be wasted.

10.11 Breeding Diet

During the period before breeding, the adult frogs will feed up to twice a week to build their body condition ready for breeding. This should be allowed in the feeding routine. The type of food fed does not change from the natural diet, only the amount and frequency is increased. Due to the nutritional needs of breeding *L. caerulea* a mineral powder supplement can be placed over the food before being fed to the amphibians.

10.12 Incubation Period

The eggs take about 1 to 3 days to hatch, and metamorphosis can occur in 2 to 3 weeks under good conditions. Young frogs mature in about two years.

10.13 Clutch Size

Clutch sizes of 200 to 2000 have been reported, the size variation of the clutch may be due to the age and condition of the female at breeding. The rate at which the eggs hatch will depend on the ability of the male to fertilize the eggs as the female produces them.

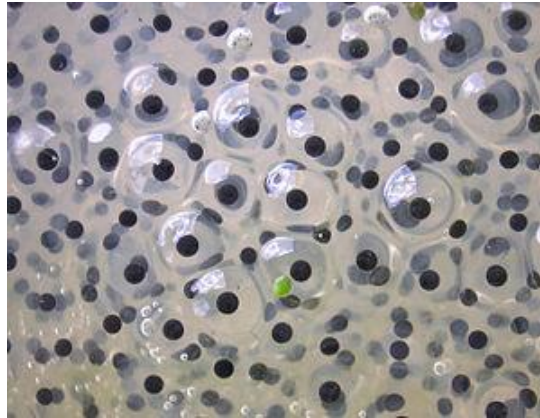
10.14 Age at Weaning

There is no parental care from the adult amphibians. Once the eggs are laid they are left to develop alone. When the tadpoles morph onto land as frogs the parents may even eat them.

10.15 Age of Removal from Parents

Due to the requirements of a rain chamber to breed *L. caerulea* is vital that the parents are moved out of the rain tank once the eggs are laid. If eggs are laid in the parent's enclosure either the parents or very carefully the eggs are removed using a soft net, this will stop the eggs from being damaged if the parents' swim in the water

10.16 Growth and Development



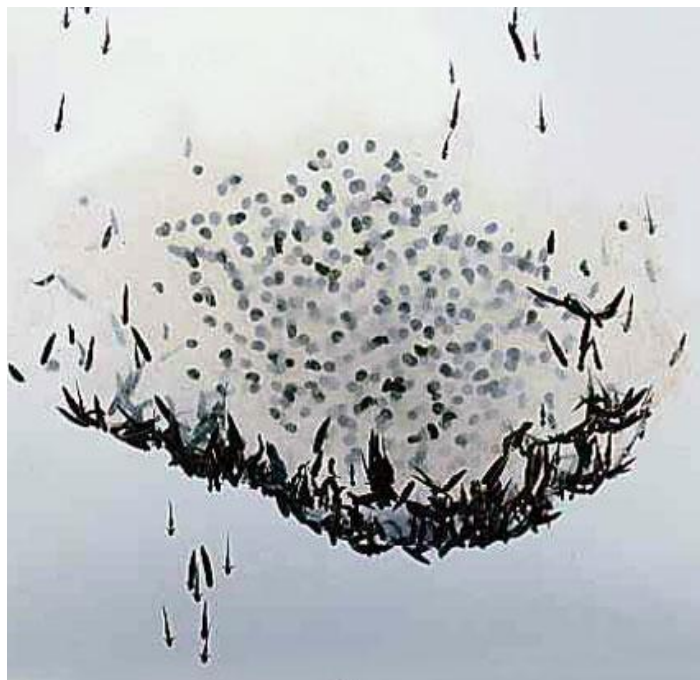
Only hours old: *L. caerulea* eggs attached to a water plant. As the eggs are sticky, they will also attach to plants and rocks in the pond.



12-hour-old *L. caerulea* fertilized eggs. Note they have changed from round balls to a definite shape with contours.



The egg sac around them is still clearly visible. They are about 2-3 mm long. Water temperature is kept at 29C.



By about 20 hours the egg sac is absorbed/broken down and the eggs start to sink. The tadpoles will be free swimming within the next 12 hours.



Day 2: The *L. caerulea* eggs have now absorbed their egg sac and dispersed into the water. The tadpoles are now 5 mm long and look more like a tadpole. The tadpoles at this stage keep still, but will wriggle and dart around occasionally.



Day 3: The tadpoles are now 8 mm long and a lot more active than the day before. You can see that their tail has grown longer and they now have the distinct tadpole body, mouth, eyes, fins and tail. At this time you can start introducing the tadpoles to food.



Day 4: The tadpoles now swim freely and explore everything in search of food. They are now about 10 mm long and 2-3 mm wide. As *L. caerulea* tadpoles prefer still water you should not use filters and aerators for as long as possible. Tadpoles will eat their own faeces hence another reason not to filter the water.



Day 5: The tadpoles have grown a little more. Tadpoles are primarily herbivores and they have a long coiled intestine to digest their food. They will also eat some protein in the form of insects that fall into the water etc. They are now 11-12 mm long and about 3 mm at their widest body.



Day 6: There has been little change in the tadpoles. It is now just a matter of feeding, keeping the temperature at or about 30C and monitoring water quality.



Day 7: The *L. caerulea* tadpoles have their first water change. Adding green algae for the tadpoles to eat tends to cloud the water. A partial water change can be done as this prevents different growth rates and deterioration in the health of some tadpoles.



Day 14: Growth rate variations.

Temperature is not the only factor that affects the green tree frog tadpole growth.

The more tadpoles, the more they are cramped for space, the slower the growth, the smaller they stay. Given lots of room, and the tadpoles will have a fast rate of growth.



Day 21: The first limbs are observed. The limbs in the tadpole develop simultaneously. The hind limbs develop outside the body and hence are the first to be observed. The tadpoles are now about 50mm long and 12-16mm at their widest body.



Day 26: The first forearm is observed. The tadpoles look a little thinner as they start losing or absorbing their fat and the head takes on a more defined structure. When the green tree frog tadpoles reach this stage transfer them to a holding tub that contains water graduated from 2-3 cm deep to zero together with a couple of rocks. This makes it easier for the frog to climb out onto land.



Day 27: The green tree frog tadpoles are absorbing their tails. The tadpoles are now taking on an obvious frog form. They now have arms and legs; their lungs are nearly developed and are in their final stages of metamorphosis.



Day 28: The frog has now emerged from the water. The tail is nearly all absorbed and its lungs are now well developed. It's tiny, not much bigger than a five-cent piece.



Day 60: The baby frogs are now just miniature versions of the adults. The frogs are eating a diet of small cockroaches and flies and growing and putting on weight. They have grown to about 32-35mm

Chapter 11

11 Artificial Rearing

11.1 Incubator Type

Rearing tanks should be a clean glass aquarium. Glass is suitable as it is easily cleaned and the eggs are easily visible.

The number of tadpoles kept depends on how much tank space is available. It has been recommended more than 15 full size tadpoles per 4 liters.

11.2 Incubation Temperature and Humidity

The water should be kept at 28°C to 29°C. There should be a good UV lamp over the tank set on 12 hours on and 12 hours off.

11.3 Desired % Egg Mass Loss

Embryonic mortality averages 0.233 and varies between clutches. The date of spawning has a significant effect on embryonic mortality. Spawn produced late in the season appears to suffer higher mortality.

11.4 Hatching Temperature and Humidity

Due to the eggs having to be kept in water, the hatching conditions are the same as chapter 11.2. "The water should be kept at 28°C to 29°C. There should be a good UV lamp over the tank set on 12 hours on and 12 hours off."

11.5 Normal Pip to Hatch Interval

From day 0 till the completion of metamorphosis is an average of 60 days. This will vary depending on water conditions such as temperature and the amount of space each tadpole has to live in.

11.6 Diet and Feeding Routine

Feed the tadpoles' bloodworms, fish flakes, algae wafers. Feed what the tadpoles can eat in about 40 minutes. The Tadpoles should be fed 3 times a day. Any uneaten food will pollute the water so should be removed as soon as possible after the tadpoles have finished eating.

As the tadpoles grow keep feeding three times a day and adjusting food as required.

11.7 Specific Requirements

Due to the ability of *L. caerulea* to adapt to different conditions, the basic housing requirements for tadpoles can be given. Water should be kept clean and provide oxygen, change 1/3 of the water every 2 weeks, and remove any uneaten food whenever possible.

11.8 Data Recording

As tadpole husbandry is similar to that of any other aquatic species, the data collected each day will be very similar. The following is a list of information that can be recorded

General data recording for tadpoles

- Weight loss/emaciation or weight gain
- Date of spawning
- Unusual posture, activity, lethargy
- Skin irritation, lacerations, lesions, or ulcers
- Development stages
- Unusual locomotion
- Skin discoloration

Environment data recordings:

- Date of feeding, water change
- Food, water, or nutrient consumption
- Excessively soiled enclosure that is not due for cleaning
- Unusual odors
- Water level
- Water condition/quality
- Water oxygenation
- Water filtration
- Water temperature
- Photoperiod abnormalities
- External heat source are kept to minimum

11.9 Identification Methods

Juvenile amphibians are unable to be individually identified. Due to this each tank of eggs, tadpoles, or frogs should be label with date of when they where laid, or hatched. Once the frogs are full-grown it will be easier to identify individuals by markings and gender.



Author's second enclosure of *L. caerulea*

11.10 Hygiene

Strict hygiene should be followed at all times.

Sterilizing of equipment used for feeding, and rocks used in hatching tanks for tadpoles, should be carried out on a regular basis. Cleaning of one 1/3 of the tanks water every 2 weeks is sufficient to keep the water clean and the tadpole healthy.

Due to the large number of newly morphed frogs housed together, increased cleaning routines will need to be in place to keep the rearing tanks clean and the frogs healthy.

11.11 Behavioural Considerations

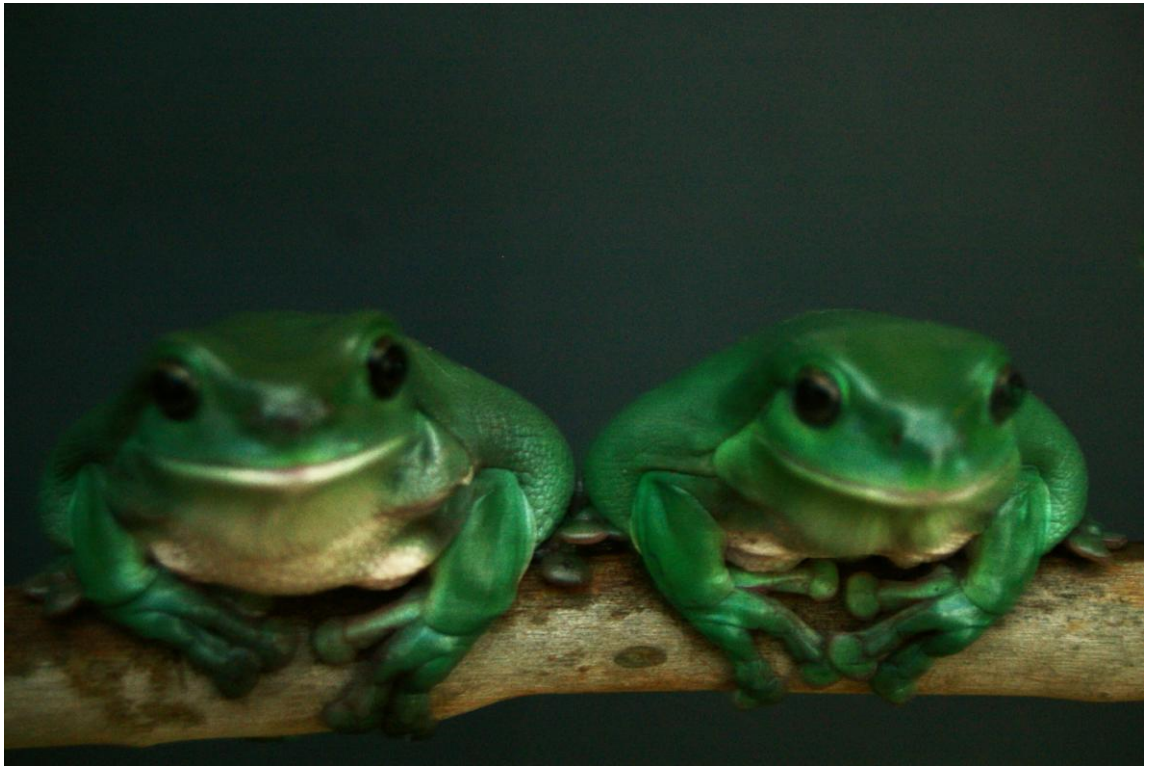
As large numbers of juvenile frogs hatch at the same time, but morph into frogs at different rates; this can create housing problems where smaller frogs are eaten or unable to feed properly due to competition from larger individuals.

At this point when there are different sizes within the same clutch, separation of individuals into size related enclosures would be necessary.

11.12 Weaning

As detailed in Chapter 10.14

“There is no parental care from the adult amphibians. Once the eggs are laid they are left to develop alone. When the tadpoles morph onto land as frogs the parents may even eat them”.



L. caerulea close up

12 Acknowledgements

Reviewers: I wish to thank the following people for their time and thoughts that went towards the development of this husbandry manual, Graeme Phipps Head Teacher Captive Animals Richmond collage of TAFE, Amy Boardman Classmate Cert 3 Captive Animals

Others: I wish to thank the following people for their support that resulted in this Husbandry Manual, My Parents John and Vicki, Sisters Louise and Erin, Rob Burns for his resources and knowledge, Tara Gunter for her industry and husbandry knowledge.

13 References

General Standards for Exhibiting Animals in New South Wales (*Exhibited Animals Protection Act 1986*)

Prevention of Cruelty to Animals Act 1979

National Parks and Wildlife Act 1974

Cogger, H.G (2000) *Reptile and Amphibians of Australia* Sixth edition
Reed New Holland Publishers (Australia) Pty Ltd page 132, 155

Tamotsu Kusano, Aki Sakai and Sumio Hatanaka: *Natural Egg Mortality and Clutch Size of the Japanese Tree frog, Rhacophorus arboreus (Amphibia: Rhacophoridae)*
Department of Biology, Faculty of Science, Tokyo Metropolitan University
(Accepted: 25-Oct-2005)

Vincent, L (1999) *Litoria caerulea* James Cook University
<http://www.jcu.edu.au/school/tbiol/zoology/herp/Litoriacerulea.PDF>

Wells, K.D (2007) *The Ecology and Behaviour of Amphibians*
The University of Chicago Press, Chicago and London 2:86, 92- 93, 105, 3:145

Wright, K.M, Whitaker, B.R (2001) *Amphibian Medicine and Captive Husbandry*
Krieger Publishing Company, Malabar, Florida.

<http://frogs.org.au/arc>

http://au.geocities.com/litoria_caerulea_2000/

<http://www.hylid.clara.co.uk/caer.htm>

<http://dictionary.reference.com/browse/Vomerine>

14 Bibliography

National Code of Practice for the Storage and Handling of Workplace Dangerous Goods [NOHSC:2017(2001)]

National Code of Practice for the Control of Workplace Hazardous Substances [NOHSC:2007(1994)]

National Code of Practice for the Labelling of Workplace Substances [NOHSC:2012(1994)]

National Code of Practice for the Preparation of Material Safety Data Sheets 2nd Edition [NOHSC:2011(2003)]

Mader, D.R. (2006) *Reptile Medicine and Surgery* Elsevier's Health Sciences Philadelphia, PA, USA: second edition

Williams, C.R. Wallman, J.F. Tyler, M.J. *Toxicity of green tree frog (Litoria caerulea) skin secretion to the blowflies Calliphora stygia (Fabricius) and Lucilia cuprina (Wiedemann) (Diptera: Calliphoridae)*

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<http://www.arazpa.org.au>

<http://www.ascc.gov.au/>

<http://www.e-pond.info/>

<http://www.frogsaustralia.net.au>

<http://frogwatch.museum.wa.gov.au>

<http://En.wikipedia.org>

15 Glossary

| | |
|-----------------------|---|
| Abdominal cavity- | The space within the mid-body. |
| Amplexus- | The Copulatory behaviour of frogs in which the male sits on the female back and grasps her with his forelimbs. In amplexus, the cloacae of the male and female are depressed, and sperm and eggs are extruded simultaneously. |
| Analgesia- | A drug that provides pain relief. |
| Anesthesia- | Drugs that renders a patient unconscious for surgical procedures. |
| Anterior- | Pertaining to or toward the head or forward end of the body. |
| Anthelmintics - | An agent that destroys or causes the expulsion of parasitic intestinal worms. |
| Amorous- | Showing or expressing emotion |
| Anthropomorphizing- | Placing human emotion onto the behaviours of an other organism. |
| Arboreal species- | A species that lives predominantly in trees. |
| Aspiration pneumonia- | Inflammation of the lungs due to inhaling fluid or a foreign body into the bronchi and lungs, often after vomiting. |
| Atrophy- | The physiologic or pathologic reduction in size of a cell, tissue, organ, or region in the body. |
| Bloat- | To expand or distend, as with air, water, etc.; cause to swell |
| Cannibalism- | Eating one's own kind. |
| Capillary blush- | The name given to the reddish effect of the skin due to increased blood flow to the area. |
| Choanae- | The rear nasal opening. |
| Cloaca- | A common chamber for the passage of faeces, urine, and reproductive material. |
| Convulsions- | An intense, paroxysmal, involuntary muscular contraction. |
| Distal examination- | To examine an organism from a distance without physically touching or moving the organism. |

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| Distilled water- | Water that has been filtered so that all minerals and contaminants are removed. |
| Edema- | Excessive accumulation of fluids in cells, tissues, or cavities of the body that results in swelling. |
| Emaciation- | Abnormal thinness caused by lack of nutrition or by disease |
| Equivocal- | Uncertain significance; not determined |
| Excreta- | Waste matter eliminated (excreted) from the body, especially faeces and urine. |
| External Fertilization- | The condition in which the sperm and ovum come in contact external to the reproductive tract or cloaca of a female. |
| Hibernation- | The act of spending the cold winter months in a state of inactive. This is a mammal term and is no longer used with reptiles. |
| Hypothermic restraint- | A restraint that reduces the body's temperature to render an organism immobilized. |
| Immunosuppressive- | The action of inactivating a specific antibody by various agents to permit the acceptance of a foreign substance by an organism. |
| Induction solution- | a combination of anesthetic and distilled water that is used to induce unconsciousness. |
| Ingesta- | Substances that have been ingested. |
| Inhalant anesthetic- | An anesthetic drug that is breathed into the lungs. |
| Insectivores- | An insect-eating organism, although commonly used for an organism that eats any arthropod. |
| Interbation- | To insert a tube into the larynx or the like. |
| Inter- muscular injection- | An injection that is placed into the muscle tissue. |
| Lacerations- | A jagged wound or cut. |
| Lesions- | A wound or injury. |
| Lethargy- | Pathologic drowsiness. |
| Listlessness- | Having or showing little or no interest in anything. |

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|-------------------------|--|
| Malnourished- | The state of having poor nourishment that results from improper diet. |
| Medicinal- | Having the properties of a medicine. |
| Metamorphosis- | A profound change in form from one stage to the next in the life history of an organism. |
| Morph- | A particular body form or coloured group of individuals. Morph is used regularly in discussion of polymorphisms and variation of individuals within a population of species. |
| Mucus- | Fluids that are excreted by the mucous membrane; the membrane lining body cavities that come in contact with air |
| Mycoses- | A disease caused by a fungus. |
| Necrosis- | The death or dying of cell, tissue, organ, or region in the body. |
| Nocturnal- | Active at night. |
| Nuptial pad- | The black area of the male frogs thumb that is used to assist in grasping the female during amplexus. |
| Nutritional deficiency- | Alternate description to malnourished. |
| Orifice- | An opening or aperture. |
| Oxygen saturation- | The amount of oxygen that is contained within an organism |
| Photoperiod- | The number of daylight hours best suited to an organism for proper growth and maturation. |
| Plane of sedation- | Description of the level of sedation in which an organism is in during anesthesia. |
| Proximal- | Situated toward the point of origin or attachment. |
| Pulmonic respiratory- | To breath through lungs. |
| Reproduction- | The natural process among organisms by which new individuals are generated and the species perpetuated |
| Scavenger tube- | A tube that is part of an anesthetic machine, which removes the expelled gases from an organism. |
| Sedation- | The calming of mental excitement or abatement of physiological function, |

| | |
|--------------------|---|
| Seizures- | A sudden attack, spasm, or convulsion |
| Spawning- | The eggs of aquatic animals such as bivalve mollusks, fishes, and amphibians. |
| Tympanum- | Ear drum. |
| Ulcer- | An open sore on the skin or mucous membrane that often discharges pus. |
| Ventrum- | Situated on or toward the lower, abdominal plane of the body; equivalent to the front |
| Vomerine teeth- | A thin flat bone forming the inferior and posterior part of the nasal septum and dividing the nostrils in most vertebrates. This bone forms part of the jaw line in amphibians. |
| Water baths- | A tub or container used in medical institutions to immerse objects to maintain temperatures. Can be used with induction solution to sedate small organisms. |
| Water oxygenation- | To add oxygen to water or increase the amount of oxygen available in water. |
| Zoonoses- | Diseases that may be transmitted to man from animals or animals to man. |

16 Appendix

Live foods-

Pisces Enterprises Pty Ltd
PO Box 200 Kenmore QLD 4069
Email: info@piscesenterprises.com
Tel: 1800 351 839
Fax: (07) 3374-2393

Cleaning Chemicals- due to laws outlined for MSDS that require them to be updated every 4-5 years, this husbandry manual does not contain relevant MSDS for any chemicals mentioned. For an up to date MSDS for any chemical, you can request it from the suppliers when chemicals are purchased.

F10sc Disinfectant-

Chemical Essentials Pty Ltd.
13 Abelia Street
Doncaster East VIC 3109
Tel: 03 9841 9901
Fax: 03 9841 9909
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