Veterinary Management of Seabirds

Larry Vogelnest
Taronga Zoo
Veterinary and Quarantine Centre
PO Box 20, Mosman 2088

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1. Introduction

Seabirds have always fascinated humans. The majority of these birds make a home of the vast expanses of ocean and some are seldom seen. Many are strictly pelagic (birds whose entire lives, except when nesting, are spent at sea) and do not as a rule even fly near the coast and generally breed in inaccessible places. Their ability to survive in inhospitable conditions, unusual reproductive strategies, longevity and long migrations imparts upon them a sense of mystery. Birds such as the wandering albatross have fascinated humans for centuries and are the subject of many stories and myths.

Seabirds have become highly specialised to take advantage of the unique ecological niches that they inhabit. They have developed unique anatomical and physiological adaptations to their specialised modes of survival. Included in this group are species capable of prolonged flight to those that are incapable of flight. Some species are strong swimmers and poorly adapted to terrestrial life and others rarely swim. Despite being diverse in many respects these birds have some common traits. These birds are overwhelmingly aquatic and some are strictly marine. Most are colonial, nesting in congregations of varying size and social structure. Most are strictly piscivorous, living on high protein diets of fish, squid, cephalopods, krill, marine plankton and crustaceans. Some eat carrion and others prey on the chicks and eggs of other birds. As a group these birds are difficult to maintain in captivity. They require intensive management and extensive investment in resources such as facilities, staff and food.

Perhaps it is these unique and fascinating qualities that make us feel more compelled to help and treat these birds. Species that are seldom encountered may also be presented when blown off course by storms. Unfortunately as a group, because of their specialised requirements they are less suited to rescue, treatment and rehabilitation. They inhabit fragile ecological niches that are becoming increasingly threatened by anthropogenic activities such as fishing, tourism and pollution. Also because of the gregarious nature of some species, disease can easily spread through a population. It is therefore critical that when a decision is made to treat, rehabilitate and release a seabird that not only is the welfare of that individual considered but also the health and welfare of the population into which it is being released.

The primary aim of rescue and treatment of any wildlife should be rehabilitation and release. This is particularly important for seabirds as many do not do well in captivity. An early assessment of prognosis and suitability for release must be made. This is essential to avoid unnecessary suffering and stress on a wild bird in captivity. It also avoids disappointment after substantial effort and emotional attachment to the bird. If the prognosis is poor or the bird is unsuitable for release a decision to euthanase must be made quickly. If a bird is unsuitable for release but has legitimate educational or scientific value if kept in captivity and providing it is a species suited to captivity, approval to do so can be sought from the relevant wildlife authority.

When making an assessment, veterinarians must keep in mind that the release of a bird back into the wild must always be in the best interest of the bird, the population and the ecosystem. No bird should be released that is not completely healthy, has any physical impairment and is not fully restored to normal capacity to survive (Walraven 1994). In the past many attempts have been made to restore animals by the application of prostheses, particularly bird's beaks. These animals should not be released as it is unlikely that any prosthesis will remain attached for the natural expected life of the animal.

Prior to release all birds must undergo a thorough clinical examination and health assessment as well as an assessment by an experienced rehabilitator. The majority of wildlife releases are undertaken with complete lack of awareness or little regard for disease risks. The released bird may be exposed to diseases to which it has not yet developed immunity. Birds being rehabilitated may be exposed to new pathogens while in captivity and act as carriers when released, transmitting disease into a wild population with potentially devastating consequences for the population and the ecosystem in which it exists. Pathogens may be carried by released birds without causing disease in that species but cause severe disease in other species. Infectious disease may also be introduced to wild populations when birds with endemic disease are released into an area where those diseases do not occur. The release of a bird back into the wild is a stressful time for the bird as well as other birds in the area due to competition. It is when birds are stressed that disease can have a significant impact.

Adequate disease risk assessment presents considerable difficulty for two reasons. Firstly there are few reliable tests for the detection of many wildlife pathogens and secondly many species of wild animals carry infectious agents of which we have little knowledge or are not even aware of (Kirkwood and Sainsbury 1995). For these reasons appropriate measures must be taken to reduce risk of disease. These include quarantine, clinical assessment, laboratory tests (haematology, biochemistry, serology, faecal examination, microbiology), other disease screening and prophylactic procedures and treatments (Sikarskie 1992, Viggers et al 1993, Woodforde 1993, Kirkwood and Sainsbury 1995). An understanding of disease processes and the measures required to prevent their transmission and spread is essential for all veterinarians involved in wildlife rehabilitation and release.

Three major groups of Australian birds are classified as seabirds (see Appendix A). The penguins, belonging to the order Sphenesciformes, are flightless in air, have an upright stance on land, and have wings modified into flippers. The albatrosses, shearwaters, petrels and their allies belong to the order Procellariiformes, or "tube-noses" – a term referring to their shared characteristic of having nostrils situated in external tubes on the upper surface of the bill. The third group, the

Pelecaniformes are not obviously related but share a number of features in common, most obviously the fact that all four toes are joined by a single web. All three groups are aquatic, and the majority are adapted to a marine or pelagic existence (especially the penguins, albatrosses and shearwaters). This is also true but to a lesser extent of the cormorants, boobies and pelicans, as these birds are also found in freshwater habitats. A few species, particularly the darter are out of place in this group as they are almost exclusively freshwater birds and are seldom or rarely seen at sea. Gulls, terns and wading birds are often associated with the sea because of the preference they show for mudflats, estuaries and similar coastal environments (Lindsey 1986). These are however birds of the seashore rather than of the sea and are not covered in this paper. Much of the literature on seabirds refers to species of the Northern Hemisphere. These notes primarily refer to seabirds of Australia.

2. Anatomical and Physiological Adaptations of Clinical Significance

The **limbs** (wings and legs) of many species of seabirds have evolved to allow for great manoeuvrability in certain environments but little or none in others. Penguins, which are highly adapted for aquatic survival, have compact, heavy boned "wings" that have been modified into flippers allowing for great speed and manoeuvrability in water. Underwater, penguins are wing-propelled swimmers, basically flying under water. The feet are used for steering. The thoracic vertebrae of penguins are more mobile than other birds, allowing for rapid twists and turns while pursuing prey. Diving petrels (*Pelecanoididae*) have adaptations similar to penguins and other wing-propelled swimmers of the Northern Hemisphere, allowing for manoeuvrability under water. Penguins have also retained reasonable manoeuvrability on land – some species are very good climbers and walk long distances, but cannot fly. Few seabirds however have legs and feet designed to cope with long periods spent on land. Birds well adapted for swimming have legs set further caudally on the body so leg muscles cause minimal disturbance to streamlining yet allow control of steering. Birds such as shearwaters, petrels, tropic birds and frigate birds have become so specialised for aquatic and aerial life that they are effectively helpless on land. On land they shuffle about on their tarsometatarsi. This may be misdiagnosed as leg weakness. They cannot physically lift their bodies off he ground, predisposing then to decubital ulcers of the pectoral area and legs if maintained out of water for prolonged periods without support or padding (Pokras 1996). The feet of many species of seabird are poorly adapted to constant weight bearing on land and easily develop pododermatitis when confined to land (see 8.7). All seabirds have webbed feet and some have sharp elongated claws. Cormorants, once submerged in water use their feet for propulsion. These birds have an elongate projection of the tibia proximal to the stifle (the cnemial tuberosity). This tuberosity provides a remarkable lever-arm for action of the quadriceps muscles, allowing for a more powerful kick. The wings of pelagic species are adapted to enable soaring and gliding in flight. These birds have an extremely well developed propatagium. The propatagium is a triangular fold of skin at the leading edge of the wing running between the shoulder and carpal joints. In the cranial free edge is the elastic propatagial ligament. The metapatagium is the fold of skin on the trailing edge of the wing between the trunk and brachium. This propatagialis complex acts as an elastic band that locks the wing in extension without muscular effort. This allows soaring birds to stay in the air for weeks at a time, even sleeping on the wing (King and McLelland 1984). The anatomical configuration that makes it possible for these birds to sustain prolonged flight also makes it very difficult for these birds to become airborne from the ground or water surface. These birds need to take off from cliffs or other elevations or require a headwind into which they can face and gain lift with their wings extended. Some species such as frigate birds, which are adapted to feed from the air (dip or skim the surface or aerial piracy [kleptoparasitism – steeling food from other birds in flight]) are virtually helpless if they accidentally land in water as they are poor swimmers, have great difficulty taking off from water and have wettable plumage.

One of the most common reasons for seabirds being rescued and presented to veterinarians is that they have been found with an apparent inability to fly or walk properly. In many cases the bird is normal and has landed in an unusual place, perhaps blown toward land in a storm, or landing on ice or wet roadways apparently thinking them to be open water, with conditions unsuitable to allow it to take off. In most cases there is little wrong with these birds. They should however be examined thoroughly to rule out foreign bodies, injuries or disease. Some of these birds are also exhausted, emaciated and dehydrated after long migrations and storms.

The **feathers** of birds are arranged in tracts (pterylae) with featherless areas between (apteria). Seabirds have few if any apteria with dense tightly packed feathers. The legs are usually featherless from just proximal to the tibiotarsal-tarsometatarsal joint distally. Unlike many species of birds there is no apteria over the right jugular vein making jugular venipuncture in seabirds more difficult. The plumage over the torso of plunge divers is thick presumably to cushion the impact of a dive. The plumage of frigate birds is not water proof and once wet these birds have difficulty becoming airborne. Cormorants have only moderate waterproofing and must periodically allow their feathers to dry out. At these time cormorants are seen standing in a characteristic spread-wing posture. The long tail feathers of gannets, cormorants and pelicans can be come damaged when these birds are confined to land (Pokras 1996).

Many seabirds have **modified bills** adapted to the specific feeding strategy of the species. These include pouches (gular pouch), that stretches for the ingestion of large pray (eg. pelicans). In shearwaters the horny plates making up the outer bill are separate, while in most other species they are fused. The tube-nosed species (albatross, shearwaters and petrels) are so called because their nostrils open to the exterior through raised tubular extensions of the upper bill. The tube structure humidifies and warms air as it enters the respiratory tract. These birds also have larger olfactory lobes and it is thought that they are able to detect the odour of blood, meat and squid or fish oil floating on the water surface from long distances away. White-chinned petrels can detect dimethyl sulfide released by zooplankton grazing on phytoplankton from a distance of up to 4 kilometres. One of the most significant features of the bills of gannets, cormorants and frigate birds is the lack of external nares due to a normal extension of the keratinaceous plates of the upper bill. These birds breathe through openings near the commissures of the bill, which in gannets and cormorants is closed by moveable, horny plates during diving. The external nares of pelicans are present but significantly reduced. The salt glands of these species also open in to the mouth and salt is eliminated by an open-mouthed slinging motion. It is important that when restraining these birds the bill and particularly the commissures are not fully occluded (Figure 2) allowing for normal respiration. The bills of many seabirds are very strong and the edges razor sharp, designed for catching, tearing apart and swallowing fish and squid - another feature that must be considered when handling these birds.

Penguins have a **bifurcated trachea** that extends nearly the entire length of the neck. The point of bifurcation is variable between species but may be far enough cranially that unilateral intubation may occur when using long endotracheal tubes. Little penguins do not have a bifurcated trachea.

Modifications of the **air sacs** are common in seabirds. The air sacs of penguins are smaller and have fewer diverticuli that most flighted birds. Fewer bones are pneumatic and the air spaces in them significantly reduced. These features decrease buoyancy and improve diving efficiency. Air sacs of cormorants enter only the humerus, sternum, and a few cervical vertebrae. The left cranial thoracic air sac is absent in cormorants. Specialised air sacs extend under the skin of pelicans, gannets and boobies. These result in significant air spaces under the skin either in large sacs (gannets) or in multiple small sacs (pelicans) – almost like bubble wrap - giving a spongy or crackling sensation when palpated from the outside. This may lead one to the misdiagnosis of subcutaneous emphysema or gas producing anaerobic infection (rare in birds). These air sacs are apparently adaptations that provide cushioning from impact with the water when these birds dive from great hights to catch prey (although this is not a common feeding strategy of the Australian pelican). These and other plunge divers (tropic birds) also have thicker plumage and large subcutaneous fat deposits also presumably to cushion the impact of a dive.

A number of adaptations and peculiarities exist in the **digestive tracts** of seabirds that can be misleading if not recognised as normal. Pelicans and cormorants have vestigial tongues. Oral mucous glands are prominent in penguins but absent in pelicans. The ventriculus (gizzard) of seabirds is large, distensible and glandular and there is little gross differentiation between the proventriculus and ventriculus. There is no crop although a slight dilation of the distal oesophagus does occur in some species. The ventriculi of many seabirds may contain a number of squid beaks and fish ossicles, otoliths and lenses when otherwise empty. Cormorants and penguins swallow pebbles to adjust ballast for buoyancy. The ventriculus normally occupies a very large area of the caudal coelomic cavity, extending caudally to the cloaca – an important anatomical feature to consider when performing laparotomies on seabirds (see 6.2). The intestinal tract is usually long and in some species a spiral folding pattern of the intestinal wall occurs, much like the spiral colon in sharks – presumably increasing the surface area.

Virtually all species of procellariiforms (shearwaters and petrels) produce oils in their proventriculus. These are complex, species-specific mixtures of monoester waxes, oils, triglycerides and other organic constituents. Large quantities can be stored in the proventriculi of young and adult birds. When handled these birds may regurgitate this thick foul smelling oil. This is thought to be a means by which adult birds can provide their chicks with a high-energy food source. This oil is one of the products of the mutton bird industry where in the past it was used for greasing wooden skids and other machinery in sawmills and coal mines. It is now used in the pharmaceutical industry and in stock feeds (Lindsey 1986).

Thermoregulatory mechanisms to survive temperature extremes are common. Tropical seabirds have special vascular cooling systems for the brain, which may complicate ophthalmic surgery (Pokras 1996). Fluttering the gular pouch or sac is an important evaporative cooling mechanism in some species. The Abbott's booby of Christmas Island, Australia has been reported to evert its cloaca to increase the surface area for evaporation. Temperature regulation in seabirds mainly involves dealing with cold climates. The body feathers of most cold climate seabirds are very dense, and waterproof. These water-resistant properties are improved by oil from the uropygial (preen) gland that is spread through the feathers during preening. The feathers trap a layer of air against the skin, and air is a poor heat conductor. In very cold conditions birds increase this layer by fluffing out their feathers. Penguins and tubenoses also have a layer of subcutaneous fat for insulation. Birds adapted to cold climates have changes in blood viscosity and composition that are associated with environmental temperature changes. They also have special counter-current heat retention retia (*rete mirabile*) to the extremities, which prevent excessive heat loss. Blood flowing from the feet is warmed by the retia. The feet can be kept at a temperature close to that of the environment without any heat loss from the body. This mechanism can also be used to cool the body (Lofgren 1984). Some seabirds excrete urine and urates onto their legs (as do some other bird species) to increase cooling by evaporation. Normal body temperature of some cold climate species is lower than those of other birds.

Some exclusively marine seabirds are able to drink sea water and have developed mechanisms to deal with this excessive salt load. If freshwater is available seabirds will drink it, however even if they do not usually drink sea water, some will invariably be swallowed along with their food. In most seabirds some fresh water is obtained through the fish they eat and the metabolism of fat. The renal ultrastructure of marine birds is no different to that of other birds. They do however have special **salt glands** (also called nasal glands). The glands are paired crescent-shaped structures lying in a depression on the skull, usually located superficially just medial to each eye (Figure 1). The glands consist of a medial and lateral lobe, each with its own duct and ostium in the vestibular region of he nasal cavity. Histologically they are similar to renal tissue. Blind-ending secretory tubules radiate from a central canal. Blood is supplied to the gland via the internal ophthalmic artery. Salt passes from the blood in to the secretory tubules. The gland secretes a hypertonic (5%) solution of sodium chloride. This secretion can be seen dripping from the tip of the bill or on the nostrils, or is forcibly ejected through the nostrils by shaking the head and are signs that the bird is salt tolerant. In birds that have no external nares the secretion trickles from the internal nares in the roof of the mouth to be expelled. This tends to occur about 30 minutes after feeding. Salt glands are found in albatrosses, petrels, storm-petrels, penguins, pelicans, cormorants, gannets and shearwaters. Drinking salt water may be obligatory in some species. The size of the glands and the need for access to salt is variable between species. There is a relationship between the size of the gland and the capacity to secrete salt. A lack of access to salt does not seem to affect the health of penguins, pelicans and cormorants. Failure to provide salt to any of these birds will result in atrophy of the glands. This is primarily a concern if these birds are released back in to a marine environment and are unable to deal with the sudden salt load resulting is severe dehydration and salt toxicity. In these cases it is essential that the function of the glands be maintained through supplemental salt in the diet (see 4.3 and 8.4) (Lofgren 1984, King and McLelland 1984, Pokras 1996).

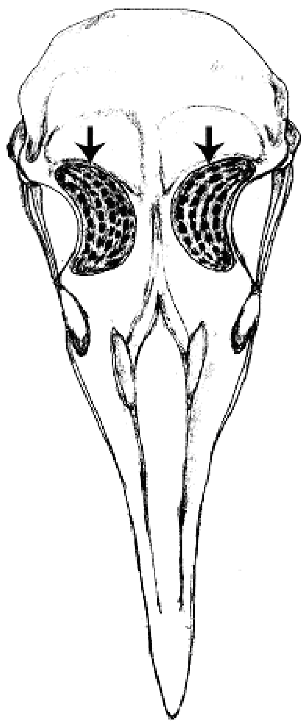

Figure 1. Seabird skull showing the position of the salt glands (arrows)

- Penguins exhibit an unusual **moult** pattern where all the feathers are lost at once. The moult usually follows a period of intense eating and weight gain and is characterised by a dramatic weight loss. During the moult penguins are confined to land and do not eat. In the little penguin this occurs in March and lasts about a month. It is during this period that little penguins are vulnerable to attack by malicious people and introduced predators such as foxes, dogs and cats (see 7.5). They also occasionally seek refuge to moult in areas populated by humans and are frequently "rescued" and presented to veterinarians, despite being normal. Birds that do not gain enough weight prior to the moult may be found emaciated during or just after the moult, particularly in areas where their food (primarily pilchards) has been depleted by fishing or disease (pilchard herpes virus).

- Some species of seabirds such as smaller petrels and shearwaters are **crepuscular or nocturnal** and may be more likely to eat at night in captivity.

- Birds that swim under water for long periods of time have higher levels of **myoglobin and haemoglobin** to assist in oxygen transportation.

3. Clinical Techniques

3.1 Haematology and biochemistry

Blood is easy to collect from most seabirds. Analysis of the sample can provide a great deal of diagnostic and prognostic information. Standard techniques used for processing avian blood are applicable to seabirds. This can be done in-house, however unless one is familiar with these techniques blood is best sent to one of a number of commercial laboratories in Australia that process avian blood.

Three veins are commonly used for venipuncture in birds – the right jugular vein, the cutaneous ulna vein and the medial metatarsal vein. Although the most useful vein for venipuncture in most avian species, the **right jugular vein** is less accessible in seabirds. This is primarily because there is no featherless tract over this vein in seabirds, making it more difficult to visualise. With practice however it can be used, and is preferred by some workers particularly with penguins where a large sample can be collected relatively quickly. The **cutaneous ulna vein** is as accessible in seabirds as it is in other birds. This vein however is fragile and haematoma formation is common. The restraint required for collection from this vein can also be difficult and stressful if the bird is conscious. The bird needs to be held on its back with a wing stretched out. Large volumes can also be difficult to collect. The preferred vein in seabirds for venipuncture is the **medial metatarsal vein**. The straight, long tarsometatarsus of seabirds makes this vein accessible and easy to visualise when the bird is appropriately restrained (see 5.1). This vein is also ideal for intravenous injections. Haematoma formation is minimal due to the tight skin over this vein. Little penguins can be difficult to bleed. The medial metatarsal vein or veins running over the dorsal surface of the feet are usually used. The right jugular vein can be used however this requires considerable practice. In some little penguins the cutaneous ulna vein is visible. Appropriate and adequate physical restrain is essential for successful venipuncture in little penguins. Larger penguin species are usually bled from the right jugular or medial metatarsal veins. When collecting blood from any bird, small gauge needles (25g or smaller) should be used to minimise haematoma formation. One or 2ml syringes should also be used to minimise negative pressure and vein collapse.

Although a great deal more data needs to be collected it appears that the responses of seabird blood cells and biochemical changes are similar to those seen in other bird species. Reference ranges for a few species of Australian seabirds are presented in Appendix B. A number of serological surveys have been done on seabirds, particularly penguins. In most of these, serological tests available for domestic poultry were used. Haemoparasites, especially protozoa, are frequently found as incidentally in seabirds blood (see 7.7.3). Avian blood collection techniques and the interpretation of haematology and biochemistry results have been well described (Vogelnest 1991, McCracken 1993, Lane 1996a, Fudge 1996a, Rupley 1997).

Marked leucocytosis occurs with inflammatory processes such as bacterial, fungal or protozoal infections, tissue trauma, stress and blood loss (bone marrow rebound). Bacterial infections are usually characterised by heterophilia and occasionally a lymphocytic response. Fungal infections also cause marked heterophlia, frequently lymphopaenia and when chronic a monocytosis. The lymphopaenia associated with these infections may be a primary response to the fungal infection or a response to increased cortisol levels due to stress or nutritional and metabolic aberrations that predispose birds to secondary fungal infection. Protozoal infections, particularly *Plasmodium,* result in marked lymphocytosis (Stoskopf and Kennedy-Stoskopf 1986).

No enzyme studies of the tissues of seabirds have been carried out. Biochemical responses seen in seabird blood must therefore be interpreted based on what is known about other species. Normal **total serum or plasma protein** levels in seabirds are low (3-5g/dl) as is the case with most bird species. Hyperproteinaemia is seen with dehydration and antibody production. Hypoproteinaemia occurs with malnutrition, inanition, severe hepatic disease, parasitism, haemorrhage and chronic disease. **Uric acid** is the major catabolic product of purine and other amino acids in birds. Seabirds, being piscivorous tend to have higher uric acid levels (see Appendix B) than birds on lower protein diets, and post-prandial elevations are common. Marked elevations are seen in birds with impaired renal function or gout. Significant tubular nephrosis must occur before elevations are seen. Uric acid is largely removed by tubular secretion, so dehydration only causes mild elevations. **Urea** levels are usually very low, but may be elevated with severe dehydration. Measuring **creatinine** is of limited use in assessing avian renal function. **Aspartate aminotransferase (AST)**, although not liver specific, seems to increase with liver disease in seabirds as it does in other bird species. Elevations are also seen with soft tissue trauma. **Bile acids** are a sensitive indicator of liver function. Elevated levels indicate impaired liver function, however food consumption may affect values. Currently, plasma bile acids are the only method to confirm hepatic disease in birds with elevated AST levels. Reference ranges for seabirds are not available and interpretation of results may be difficult. **Glucose** is the major circulating carbohydrate in birds. Although commonly measured it generally provides little diagnostic information. True hypoglycaemia is rarely seen except in severely ill birds. Birds have higher glucose levels than mammals and elevated levels may be seen with stress and postprandial sampling. To my knowledge diabetes mellitus has not been diagnosed in a seabird. It is not necessary to use fluoride oxalate to prevent glycolysis in avian blood. Avian erythrocytes consume very little glucose and it seems that they depend more on fatty acid metabolism. Dipsticks for measuring blood glucose are of no value in birds as they are calibrated for humans. **Creatine kinase (CK)** is a specific and sensitive indicator of muscle damage in seabirds as it is in other bird species. CK levels fall more rapidly than AST, which is also elevated with muscle damage.

3.2 **Microbiology** (Vogelnest and Cunningham 1991, Cunningham 1994, Vogelnest 1994, Fudge 1996b, Rupley 1997)

Although full microbiological workups (culture and susceptibility testing) are not usually done on wild birds, they can be very useful diagnostically. They also allow the clinician to direct therapy more appropriately, shortening treatment time and increasing the likelihood of a successful outcome. Basic tests (wet mounts, Gram and other stains) can easily be carried out in-house. These can provide a great deal of useful information. Samples for culture and susceptibility testing, however should be sent to a commercial laboratory experienced in dealing with avian specimens. The microbiology of seabirds does not differ significantly from other birds other than susceptibility to certain infections (see 7.7). As in other bird species samples can be collected from skin, feathers, nasal cavity and choana, sinuses, eye, trachea, air sacs, coelomic cavity, cloaca and faeces. The diagnosis of aspergillosis (see 8.6) in seabirds is particularly important and sampling from the respiratory tract is necessary for this. This can be done from the trachea or air sacs. Tracheal aspirates, washes and swabs can be taken. Ideally the bird should be anaesthetised. An appropriately sized soft sterile tube or catheter is passed through the glottis or endotracheal tube (if one is placed) into the distal trachea to a point just inside the thoracic inlet. The distance should be measured with the neck stretched prior to inserting the tube – note, some aquatic birds, not seabirds have very tortuous tracheas that may extend subcutaneously over the pectoral area or extend in to the sternum. A small volume of sterile saline (1-2ml/kg) is infused in to the trachea and quickly aspirated. Samples can also be obtained using a sterile, saline moistened swab passed down the trachea (regular or mini-tip swabs can be used). If quick there should be no interference with respiration, however if the procedure is prolonged an air sac breathing tube may be placed, and anaesthesia maintained through the tube. Some birds will tolerate these procedures without anaesthesia if carried out quickly. Great care must be taken not to traumatise the fragile tracheal mucosa. Air sac swabs and washes are performed endoscopically (see 3.5). Once visualised the air sac membrane or lesion can be swabbed using a sterile saline moistened mini-tip swab or aspirated using a catheter. A small amount of sterile saline can also be placed in to the air sac and aspirated. Biopsy forceps can also be used to collect caseous debris. Samples can be placed directly on to a glass slide and air dried, or concentrated using slow speed centrifugation, and the pronatant used to make a smear. These can be stained using a variety of stains. Stained or unstained wet mounts using a cover slip can also be used. The presence of fungal elements, multinucleated giant cells, and mixed cell or macrophagic inflammation indicated fungal infection. The most common fungal respiratory tract infection in birds is *Aspergillus*. *Aspergillus* may be identified as branching septate hyphae. Hyphae stain poorly with Wright's or Diff-Quick stains. New methylene blue or Parker ink can be used to visualise hyphae better. Basophilic staining conidiophores or spores may be seen when stained with Wright's or Diff-Quick stains (Rupely 1997).

3.3. **Urine and faecal analysis** (Vogelnest and Cunningham 1991, Vogelnest 1994, Lane 1996b)

Urine and faeces are the most readily available samples that can be collected from birds. Possibly one of the most difficult aspects of urine and faecal analysis is knowing what is normal. Seabirds tend to produce more urates than birds on lower protein diets, the faeces are darker and more voluminous and the urine volume is usually small and often difficult to detect unless the bird is placed in a situation with the specific aim of collecting the urine.

Urine may only be detected if the bird is in fact polyuric. Little information is available on urinalysis in seabirds. Possibly the most common abnormality seen is frank haematuria. This may be associated with severe urate nephrosis, although a direct association has not been confirmed.

Examination of seabird's faeces is most useful for the detection of intestinal parasites. These are primarily helminths, cestodes and protozoa (see 7.8.3). Fresh faeces should always be used for microscopic examination. A wet mount (fresh faecal smear with or without saline) and faecal flotation should be carried out on all seabirds presented. Although parasites seen may not be clinically significant, it does allow the clinician to build up a useful database on what types of parasites may be found.

3.4 Radiology

Radiology in seabird medicine is primarily used for the diagnosis of fractures and the detection of foreign bodies, particularly fish hooks and sinkers. It can also be used for the diagnosis of disease in other organ systems, particularly the respiratory tract. However lesions, particularly those associated with aspergillosis can be particularly difficult to detect even if advanced. Unless a diagnosis is clear **all seabirds presented should be radiographed** to detect the presence of foreign bodies, particularly those showing non-specific signs of illness. The radiographic technique and interpretation for seabirds is no different to that for other bird species (Vogelnest 1994). Adequate restraint for radiography is critical to obtain high quality radiographs. Physical restraint of a wild bird is very stressful and difficult. There is a risk of fracturing limbs, worsening the bird's condition and increased radiation exposure of staff. Chemical restraint must be used (see 5.2). Correct positioning is important to obtain diagnostic radiographs. The aim is to prevent superimposition of the limb bones over one another and over the body and to get a symmetrical image. The limbs must be extended to allow proper evaluation of the chest and abdomen. Keel and vertebrae should be superimposed in a satisfactorily positioned ventrodorsal radiograph and right and left acetabullae should be superimposed in a symmetrical lateral radiograph. In most cases a single ventrodorsal projection of the whole body provides adequate diagnostic information. A lateral projection will however be necessary if fractures, organ changes or the position of foreign bodies need to be further evaluated.

3.5 Endoscopy

Endoscopy is a widely used diagnostic tool in avian medicine. Small 1.7-2.7mm rigid arthroscopes are most commonly used. It is primarily used as a means to surgically sex monomorphic species of birds, but is also used for diagnostic purposes (Vogelnest 1994). In seabirds the primary indications would be for the examination of body orifices and the trachea, oesophagus, proventriculus and ventriculus. Laparoscopy is useful for the examination of internal organs and the air sacs. It is rare that a wild seabird would require sexing (many are monomorphic, however gender determination usually has no relevance to the treatment, rehabilitation and release of most wild seabirds). Avian anatomy lends itself to laparoscopy as air-filled air sacs precludes the need for insufflation of the body cavity. Internal examination of the gastrointestinal tract however does usually require some degree of insufflation.

Aspergillosis is readily diagnosed using endoscopic techniques, either by direct visualisation of typical lesions or by facilitating sample collection (see 3.2 and 8.6). Retrieving foreign bodies, biopsies, minor surgery and the collection of swabs and aspirates is facilitated by the use of endoscopic techniques.

The entry site for most laparoscopies is a point on either flank halfway between the acetabulum and stifle, either between the last 2 ribs or behind the last rib. The feathers are plucked from the area and the site prepared with povidone iodine or alcohol. A small 3mm incision is made in the skin using fine iris scissors and fine forceps. Blunt dissection in a ventrodorsal direction, parallel to the ribs, through muscle and peritoneum is then used to enter the body cavity. The hole is held open with the forceps while the endoscope is inserted. With this approach one usually enters the caudal thoracic air sac, but occasionally the abdominal air sac. If clear, organs can usually be visualised through the air sac membranes, however if clearer visualisation is required, the membrane can be punctured with the end of the scope without adverse effect. A small amount of antiseptic/antibiotic powder or spray is put on the wound that is left open.

4. Emergency Care

4.1 Warmth and a stress-free environment

There is a common misconception that seabirds naturally found in cold climates (and sometimes those from warmer areas - I once had a live little penguin presented in and esky on ice) do best in cold conditions. When healthy and well fed in the wild, such conditions are tolerated, however most seabirds presented will need to be kept at room temperature or warmer. If being released back in to a cold climate birds will need to be acclimatised prior to release. Birds that are bright and alert can be kept at room temperature. If the bird is fluffed up (ie. trying to conserve heat), depressed and in poor condition it is important to provide warmth. A temperature of 25-30˚C is adequate in most cases. Overheating must be avoided as this will stress the bird and worsen its condition. The dense plumage of some species makes them more prone to hyperthermia. Birds may pant and attempt to get away from the heat source. Heat can be provided using a purpose-built heated hospital cage, infra-red lamps, hot water bottles wrapped in cloth, electric heaters (not blower types), low watt light globes or heating pads. It is important that a heat gradient is created so that the bird can move away or get closer to the heat source if it wishes. Humidity should be maintained at about 50-70%.

Keeping stress to a minimum is critical when treating and rehabilitating seabirds, as this is the most significant factor that predisposes them to aspergillosis and other infections. Stress reduction involves minimising unusual inputs to the bird’s senses (eg. sights, sounds, smells) and maximising any simulation of the bird’s natural environment. All seabirds presented should be placed in a quiet area of the hospital where they will not be exposed to noise and other animals, particularly dogs and cats. During the initial period of treatment most seabirds will tolerate a hospital cage of an appropriate size for the species. However as soon as the bird is strong enough it must be placed in an environment that more suits its needs. Many species will be stressed in a confined environment without access to water. Most seabirds have very specific requirements. These are discussed elsewhere in these proceedings. It is preferable to house them in larger, outdoor enclosures with a pool. Few if any seabirds will be able to fly in a captive situation as the size of the enclosure would be prohibitive and suitable conditions to allow them to take off are rarely available. Access to water to wade and swim in is important. Pools must be deep enough for a bird to submerge if that is part of that specie’s normal behavior. Not all species however will voluntarily use the water (particularly pelagic species) and seem to prefer to stay on land when in captivity. These birds should however be placed in water from time to time as it encourages preening and provides some exercise. Appropriate furniture for the species, such as rocks, logs and perches must be provided. Fresh water can be used in the short term for most seabirds. However after variable periods in captivity, their salt glands will atrophy (the salt glands of truly pelagic birds probably atrophy within a few days). Salt water also appears to help prevent the development of pododermatitis (see 8.7). Sea salt can be added to pools or salt tablets can be added to the bird’s food (see 4.3 and 8.4).

Gregarious species such as penguins, gannets and shearwaters should be housed in contact or at least in sight of conspecifics if possible. Overcrowding however must be avoided (at least $1m^2$ per bird). Solitary species must be housed individually and natural predators or competitors must not be housed in close proximity of each other.

Few seabirds will eat on their own in captivity and will require force or hand feeding. Appropriate feeding and nutrition of seabirds is discussed elsewhere in these proceedings.

Providing a suitable substrate is critically important for the prevention of pododermatitis (see 8.7). Most seabirds spend much of their lives in water or flying. Their feet are not adapted for constant weight bearing. Very few floor coverings are ideal and it is rare for a seabird not to develop pododermatitis in captivity. Non-abrasive, soft substrates that can be kept clean should be used. Concrete and artificial turf must be avoided. Straw, hay and shredded paper must not be used as these may harbour aspergillus spores. Soft rubber matting, clean dry sand and grass (lawn) are usually suitable. Other forms of padding and netting can also be used. Netting provides the additional benefit of keeping faeces and urates off feathers, thus preventing feather damage (see 8.3).

4.2 Fluids

It is difficult to assess the degree of dehydration in birds. The signs of dehydration seen in mammals are not easily detected in birds. The eyes may be sunken and dry, and the skin wrinkled and dry. However the best indications for fluids are how depressed and sick the bird looks, diarrhoea, blood loss and if the bird readily accepts food.

A number of routes can be used for fluid administration in seabirds:

4.2.1 Oral (PO)

Fluid absorption from the gastrointestinal tract is rapid and is a suitable route of administration in birds that are not critically ill. The fluid may be given with a syringe or dropper by placing the end in the side of the bill or at the tip of the bill and dribbling the fluid in slowly. Fluid can also be placed directly into the proventriculus by gavage. This is preferable in most seabirds. This is done using a feeding tube or crop needle. Soft pliable tubes with a rounded end are suitable for most seabirds. Care must be taken in birds with powerful, sharp edged bills as they may bite the tube and swallow it. In these cases a crop needle or a gag must be used to keep the bill open. Birds are very easy to tube as the glottis is easily visualised. An assistant should hold the bird with its neck slightly extended and the bill held open. The tube can then be passed over the glottis into the oesophagus. A tube of a suitable length that will reach the proventriculus must be used (measure from the commisures of the bill to the caudal edge of the keel). The tube should be lubricated. The volume of fluids that can be given at one time will depend on the species and size of the bird. The proventriculus and ventriculus of seabirds are large. An average guide is 15-30ml/kg for most seabirds. The fluid may well up in the pharynx before this volume is reached. A useful technique is to gently clamp ones fingers around the oesophagus and tube creating a seal and preventing the fluid from coming up. Care must be taken not to give to large a volume if this technique is used. A more accurate calculation of fluid requirement can be made. This should be based on the daily fluid maintenance requirement of 50ml/kg. If the bird is dehydrated, the bird's present weight must be adjusted to estimate its normal weight. For example if a bird weighs 1.2kg, and is 10% dehydrated, its estimated normal weight will be 1.32kg. Its daily fluid requirement is therefore 50ml x 1.32 = 66ml. This should be divided in to 3-4 doses over 24hrs. Oral rehydration solutions such as Lectade®, Vy-trate® or Spark Electrovet® can be used. Equal parts of lactated Ringer's (Hartmann's) solution and 2.5% dextrose in 0.45% NaCl or 5% dextrose is also suitable for oral administration. All fluids should be warmed to 39-40°C. Fluids alone can be provide for the first 24hrs however beyond this (and preferably before if the bird is well enough) caloric and other nutrient requirements will need to be met (see 4.3). Once the bird is eating well there is usually no need to continue fluids unless there is continued loss. Fish must have been appropriately stored and thawed to ensure that it contains enough fluid. Appropriate preparation, storage and thawing of fish are discussed elsewhere in these proceedings.

4.2.2 Subcutaneous (SC)

The SC route is rarely used in seabirds. Absorption is usually slow and many seabirds have subcutaneous air spaces. If this route must be used the inguinal, pectoral or interscapular areas can be used.

4.2.3 Intramuscular (IM)

This route is not commonly used as significant muscle damage can occur when large volumes of fluid are injected.

4.2.4 Intravenous (IV)

This is a good route of administration in critically ill birds. The right jugular vein can be used although access can be difficult in seabirds. The cutaneous ulna vein can also be used, however the medial metatarsal vein is preferable in most seabirds. Indwelling IV catheters are difficult to maintain in most birds. They can be used in larger species such as pelicans. The cutaneous ulna or medial metatarsal vein is usually used. The veins are very fragile and birds tend to chew at the catheter and tubing and also move around a lot. IV fluids are usually given as a bolus. This may be repeated 2-3 times depending on availability of veins. The total dose of fluids is calculated as for oral fluids, however each bolus volume should not exceed 1ml/100g and must be given slowly. Hartmann's solution or a 50:50 mix of Hartmann's and 2.5% dextrose in 0.45% NaCl can be used.

4.2.5 Intraosseous (IO)

The IO route is very useful, particularly in larger species. Standard hypodermic or spinal needles are used. The gauge and length will depend on the size of the bird. Sites of insertion include the ulna and tibiotarsus. Needles in the ulna are usually tolerated better. For placement in the tibiotarsus, the proximal cranial tibiotarsus is surgically prepped. The tibiotarsus is grasped in one hand, and the stifle flexed. The needle is introduced into the cnemial crest (tibial crest) through the patellar tendon parallel to the tibiotarsus. Once the needle has been introduced into the medullary cavity to the level of the hub a syringe or drip line is attached. A butterfly tape is placed on the hub of the needle and sutured to the skin. The needle and tubing should be secured with a bandage. For placement in the ulna the medial distal carpal area is surgically prepped. The ulna is supported with one hand, and the needle introduced in the medial distal ulna parallel to the diaphysis. Once the needle has been introduced into the medullary cavity to the level of the hub a syringe or drip line is attached. A butterfly tape is placed on the hub of the needle and sutured to the skin, and the wing is immobilised with a figure-of eight bandage. A wooden tongue depressor incorporated into the bandage and protruding beyond the needle hub helps support the needle. When an intaosseous catheter is placed correctly, negative pressure will cause a small amount of blood to come into the hub of the needle and syringe. Resistance after entering the medullary cavity can indicate contact with cortical bone. If this happens repositioning of the needle is required. Birds will need to be kept confined during fluid administration so as to prevent twisting of the tube (Rupely 1997). Spring-loaded fluid administration systems can be useful for medium to small birds. Boluses of fluids can also be given and the hub blocked with a bung between doses. A flow rate should be set that will provide the required fluids over a 24hr period.

4.3 Hyperalimentation and feeding

Few seabirds eat on their own in captivity. Most have to be force- or assist-fed. Some will learn to pick up dead fish from in water and occasionally from land however most seabirds will not associate food or water with being on land or with food bowls. Weak, hypothermic and debilitated birds should not be given whole fish until their condition has improved. These birds are not able to digest the fish properly and will either regurgitate them or become impacted. In these cases gavage with an easily absorbed, calorie-rich puree is preferable. The tube is passed as described in 4.2.1, however a larger gauge tube should be used to more easily facilitate the passage of a thick puree. A variety of mixes can be used. All provide water, utilisable energy and electrolytes. A useful mix is a 50:50 combination of Hills® a/d diet and an oral rehydration solution such as Spark Electrovet®, Lectade® or Vy-trate®. Mixes of blended fish and squid with water or electrolyte solutions can also be used. If frozen fish is used this should be supplemented with appropriate vitamins (discussed elsewhere in these proceedings). Liquid diets should be warmed to near body temperature before feeding. Tubing mixes must be made up fresh daily and refrigerated. If the bird requires oral rehydration solutions initially, nutrients can gradually be added to the fluids, and tube feeding repeated every 4-6hrs until the bird is strong enough to be fed whole fish.

Once the bird is strong enough, force- or assist feeding with a variety of fish of appropriate size (pilchards, white bait, yellowtail or red-spot whiting or squid) can commence. A variety of fish species should be offered, however some birds will show a strong preference for a specific species of fish and refuse others. Not all seabirds eat fish exclusively and knowledge of their natural diets is important. Many seabirds eat crustaceans, squid and other invertebrates. Knowledge of their feeding strategies is also important (dipping, skimming, pattering, hydroplaning, surface filtering, scavenging, aerial pursuit, aerial piracy, surface plunging, deep plunging, pursuit plunging, pursuit diving with wings, pursuit diving with feet, bottom diving, surface seizing) when encouraging birds to eat (Pokras 1996). It is preferable to feed fresh whole fish however it is generally difficult to obtain a regular supply of fresh fish and frozen fish is often used. Whole fish rather than fillets or cleaned, gutted fish should be fed. These can be used in emergencies or when first starting a bird on solid food. The calcium provided by the skull and bones, vitamin A in the liver, and fats present in the gonads are all essential in providing a balanced diet. The appropriate storage and thawing of frozen fish is important to maintain nutrient content and quality (Geraci 1986, Geraci and StAubin 1980). Frozen fish must be stored in airtight packaging at -18ºC, for no longer than 6 months for non-fatty fish and 3 months for fatty fish. The ideal thawing conditions to maintain hydration and nutrients are either in air at 4-8ºC in a sealed container or in 25% seawater. Other methods result in dehydration of fish or leaching of NaCl and water-soluble vitamins. Fish contain thiaminases that destroy thiamine. Fat-soluble vitamins are also rapidly lost with inappropriate storage, particularly after thawing. Seabird diets must be supplemented with vitamins. A number of commercial products are available (Sea Bird Tablets® [Vetafarm], BVR Marine Tablets® [Biochemical Veterinary Research]). Alternatively, thiamine at 25-30mg/kg and vitamin E at 100IU/kg of fish fed can be used. Pelagic seabirds require supplementation with salt if kept in fresh water for more than 10 days (see 8.4). Salt tablets at 100mg/kg body weight per day should be added to the fish of these birds. An assistant holds the bird as described for tube feeding and the moistened fish inserted headfirst in to the pharynx. Most birds will then swallow the fish without the need to push it further. Seabirds should be fed 2-3 times per day. The bird's weight must be monitored regularly and the feeding strategy adjusted accordingly.

4.4 Other treatments

The use of steroids in seabirds should be avoided as they suppress the immune response and thus increase susceptibility to opportunistic infections particularly aspergillosis. Other non-steroidal anti-inflammatory and analgesic drugs can be used if indicated (see Appendix C). The use of antibacterial drugs should also be avoided if possible as these also increase susceptibility to aspergillosis. Birds are generally more resistant to bacterial infections than mammals. Antibiotics should only be used if the presence of bacterial infection has been confirmed. If antibiotics are used antifungal drugs to prevent aspergillosis should be used at the same time. Due to the high susceptibility of seabirds to aspergillosis, prophylactic use of antifungals should be considered in most cases anyway. This should commence as soon after presentation as possible (see 8.6 and Appendix C)

5. Restraint

Appropriate restraint of seabirds is essential to minimise stress and the risk of injury to the bird and ensure the safety of the handler and other personnel. The general principals of capture, transport, physical and chemical restraint of birds has been well described (Vogelnest 1994, Vogelnest 1999). The capture and handling of most seabirds requires considerable skill, confidence and knowledge of how the bird defends itself and its agility and speed. Seabirds may need to be captured on open water or land, from within an aviary, cage or other container. The capture can be extremely stressful and traumatic, and speed and precision during the capture operation is essential. Prolonged pursuits should be avoided. Equipment such as nets, towels and cloth bags can be very useful for the capture and handling of seabirds. The use of gloves is rarely indicated. Bare hands can be used for handling of most seabirds. The seabirds are a diverse group of birds and their size varies from hundred grams to over 10 kilograms. Their strength and techniques used for defense are also variable. Extreme care must be taken to avoid traumatising small fragile species, while other are relatively resistant to physical trauma. Capture, transport and restraint techniques appropriate to the species must be used.

5.1 Physical restraint

Many simple procedures such as a brief physical examination, venipuncture, injections, minor treatments, banding and gavage can be carried out safely on some seabirds using physical restraint alone. It is generally preferable, however particularly if the procedure is prolonged and potentially stressful that chemical restraint is used. When restraining seabirds the following general points should be considered:

The bills of many seabirds can be extremely dangerous. The tip and occlusal margins can be very sharp. Care must always be taken to protect ones eyes and hands. In these species the bill must always be immobilised first.
The claws of most seabirds are sharp and the legs of larger species powerful. Immobilisation of the legs in these species is essential.
The wings of larger species can be very powerful.
Gannets, cormorants and frigate birds lack external nares. These birds breathe through openings near the commissures of the bill. The external nares of pelicans are present but significantly reduced. When handling these species it is essential that the bill is not held shut as they will not be able to breathe (Figure 2).

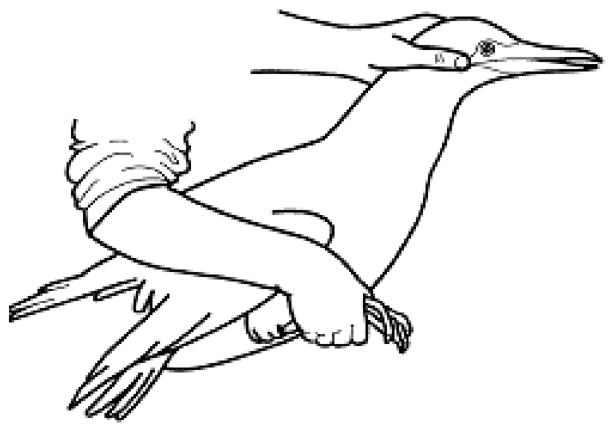

Figure 2. Correct physical restraint of a seabird, with the head pointing in a safe direction and the bill not held closed. (taken with permission from *Rescue and Rehabilitation of Oiled Birds,* Walraven E., Taronga Zoo, 1992)

Larger species such as pelicans, gannets and albatross should have their heads supported and bills immobilised with one hand, while the bird's body is tucked under the other arm and held against the handlers body (Figure 3). The feet can also be tucked up and held against the bird's body, if necessary. Two or more people may be required to handle these birds. A towel can be wrapped around the bird's body to aid restraint. The head should be held by grasping the back of the skull in the palm of the hand, with the thumb placed on one side and the fingers on the other. The bird's bill can now be pointed in a safe direction (Figure 2 and 3).

Figure 3. **Correct physical restraint for a large seabird.** (taken with permission from *Rescue and Rehabilitation of Oiled Birds*, Walraven E., Taronga Zoo, 1992)

Smaller species can be held cupped between both hands or tucked under an arm with the head gently restrained if attempting to bite. Wrapping the bird in a small towel or cloth is useful.
Little penguins are best grasped firmly by the back of the head with one hand and the body supported with the other. Healthy penguins will rarely settle while being handled and often flap, move around a lot and make frequent attempts to bite. Wrapping the bird in a cloth or towel is useful.

Seabirds will commonly defecate or regurgitate when being handled, expelling the material considerable distance. Seabirds should preferably not be fed prior to handling.

5.2 Chemical restraint

The availability of suitable chemical restraint drugs has dramatically improved the safety and cost-effectiveness of avian anaesthesia. Procedures performed under anaesthesia are less stressful for the bird (and personnel), can be carried out faster and more efficiently, and total handling time is reduced considerably. Any procedure that requires considerable restraint (radiology, placing an intraosseous catheter), causes pain or stress should be performed using chemical restraint. Most birds are physically restrained for the administration of chemical restraint agents. Providing some special precautions are taken anaesthesia in birds is now as safe as in mammals. Some important pre-anaesthetic considerations for seabirds include:

Pre-anaesthetic fasting – 8-12hrs is recommended for piscivorous birds as regurgitation is common.

Critically ill birds must be stabilised before anaesthesia by providing fluids and warmth. Stressed birds (after capture or transport) should be allowed to rest before anaesthesia.

Anaesthetic time must be kept to a minimum. No bird should be kept anaesthetised for longer than 30min. The risk of complications increases dramatically beyond this time primarily due to hypothermia. If a procedure is anticipated to take longer than 10-15min or involves a sick bird warmth should be provided. If the ambient temperature is less than 20^{o}C warmth should be provided in all cases.

Prior preparation and planning of the procedure is essential. All equipment must be prepared and ready beforehand. Drugs, including emergency drugs must be readily available.

5.2.1 Anaesthetic monitoring

Monitoring the rate and depth of respiration is the most reliable method for assessing depth of anaesthesia in birds. Palpebral and withdrawal reflexes and degree of muscle relaxation can also be used. Electrocardiograms have been used in larger species of seabirds, however vital signs monitors such as pulse oximeters, doppler blood flow monitors and blood pressure monitors are of little use in birds. The normal body temperature of most seabirds is between 40 and 42^{o}C. The cloacal temperature should be taken regularly if a procedure under anaesthesia lasts for more than 15min.

5.2.2 Sedation/ tranquillisation

There are few suitable sedatives or tranquillisers that are routinely used in birds. Diazepam at 0.5-2mg/kg IV or IM, and midazolam at 1-2mg/kg IM have been used however they are not as effective as sedatives in birds as they are in mammals. Butorphanol is a useful analgesic and mild sedative in birds. Doses of 0.3-4.0mg/kg IM have been used. A dose of 1mg/kg gives good analgesia with minimal sedation in most birds. With higher doses birds will become sedated. Butorphanol has a short duration of action, and frequent redosing at 2-4hr intervals is needed to maintain analgesia (see Appendix C for information on other analgesics and anti-inflammatory drugs).

5.2.3 Anaesthesia

Injectable anaesthetics. A range of injectable anaesthetic agents has been used in birds, however few provide consistent, smooth induction, anaesthesia and recovery. Analgesia is variable. Injectable agents are usually used for induction of anaesthesia prior to intubation and maintenance with inhalation agents. Rarely are birds maintained on injectable agents only. Biologists and veterinarians working on wild birds in the field may need to anaesthetise birds using limited equipment and at low cost. When working on free-ranging wild birds rapid recovery from anaesthesia is also important to minimise stress, prevent pair bond disruption, and reduce detrimental effects of egg cooling while birds are not incubating. In these situations agents that are eliminated rapidly or can be reversed are most useful.

By far the majority of seabird anaesthetics are carried out using inhalation agents. However induction of anaesthesia with inhalation agents via a facemask in some seabird species (pelicans, albatross, gannets) is however difficult. It is difficult to fit a mask over their bills and induction is frequently associated with much struggling in these species. Some also breath-hold prolonging induction. The size and strength of these birds can also make restraint during induction difficult posing a risk to the bird and personnel. Once anaesthetised after mask induction maintenance of suitable levels of anaesthesia can also be difficult to achieve, as apnoea is common. A useful protocol in these birds is to induce anaesthesia using an injectable agent. All drugs should be administered IV as this results in a more rapid and smooth induction. With the bird restrained appropriately the medial metatarsal vein is the most accessible vein in these species.

Ketamine at 15-20mg/kg IM can be used for short procedures. Recovery may be prolonged and the bird must be observed and kept warm. Ketamine at 10-20mg/kg IM or 2.5-5mg/kg IV plus xylazine at 1-4mg/kg IM or 0.25-0.5mg/kg IV provides better muscle relaxation, analgesia and smoother, although more prolonged recovery than ketamine alone. Some individuals may require higher doses for adequate anaesthesia. It is important that the bird is placed in a quiet, warm and dark area for induction and not disturbed for 3-5min. Ketamine at 1.5-3.0mg/kg IV or 3-8mg/kg IM plus medetomidine at 25-75mg/kg IV or 50-100mg/kg IM reversed with atipamezole IV at 3 times the medetomidine dose has proven useful in some bird species, however its use in seabirds has yet to be evaluated. Ketamine at 40mg/kg plus midazolam at 1-2mg/kg IV produces anaesthesia with poor analgesia and recovery in 20min in waterfowl. Ketamine at 10mg/kg, plus midazolam at 2mg/kg, plus medetomidine at 50mg/kg IV produces adequate anaesthesia and analgesia of 30min duration in waterfowl. Reversal with atipamezole at 0.25mg/kg IV and flumazenil at 0.05mg/kg IV gives a rapid and smooth recovery (Machin and Caulkett 1998).

Zoletil® or Telazol® (tiletamine/zolazepam) at 4-10mg/kg IM or 1-3mg/kg IV can be used. Induction and recovery after IM injection can be slow and rough. Induction after IV injection is generally smooth however recovery in seabirds is usually rough and prolonged. Topping up should be avoided.

Propofol (Diprivan®) is the IV anaesthetic agent of choice in seabirds. Doses of 8-10mg/kg IV for induction prior to intubation and maintenance with inhalation agents provides rapid, smooth induction and recovery and anaesthesia with good muscle relaxation. About half to two thirds of the dose of propofol is given as a bolus and the rest to effect. Once induced anaesthesia is maintained with an inhalation agent via an endotracheal tube. Maintenance with boluses of 1-4mg of propofol is also useful if inhalation anaesthesia is not available. Most birds recover fully within 20min of the last bolus administered. Propofol does produce dose-dependent respiratory depression so adequate monitoring and ventilation may be required. Respiratory depression may occur. Recovery is usually longer than when an inhalation agent, particularly isoflurane is used as the sole agent. Birds may need support and warmth during recovery. Respiratory depression appears to be more profound and recovery more prolonged (up to 1hr) in albatrosses.

Inhalation anaesthetics

New volatile anaesthetic agents have revolutionised avian anaesthesia. They are easy to administer, induction and recovery is smooth and rapid, muscle relaxation and analgesia are excellent, and the depth of anaesthesia can be changed with ease. Inhalation agents are usually administered via a facemask and T-piece. In most cases the facemask can be used for maintenance, however, for prolonged procedures or if one needs to work on the head or gain access to the mouth it is useful to intubate the bird. Small standard endotracheal tubes or for smaller species catheters can be used. Uncuffed tubes are preferable. If a cuffed tube is used the cuff should not be inflated as birds have complete tracheal rings and the trachea will not expand around the cuff, resulting in pressure necrosis of the mucosa.

Inhalation agents are administered with oxygen. Nitrous oxide should never be used in birds due to the second gas effect and the presence of air spaces in bird's bodies.

Halothane and isoflurane are the most commonly used inhalation agents in veterinary practice. Sevoflurane is now available but its use has not been fully evaluated in seabirds.

Halothane (Halothane M&B® [Merial], VCA Halothane® [Veterinary Companies of Australia], Fluothane® [ICI Australia]) is a halogenated hydrocarbon and is widely used in veterinary practice, but is gradually being replaced by isoflurane. It gives a rapid induction. There is however a close interval between respiratory and cardiac arrest so it is essential that birds are closely monitored during anaesthesia. Recovery takes 3-15 min. Birds may remain depressed for several hours after halothane anaesthesia. Anaesthesia is usually induced with 2.5-5% (never go higher than 3% in birds) and maintained with 1-1.5% halothane and 1-2l/min oxygen.

Isoflurane **(**Aerrane® [ICI Australia], Forthane® , Isoflo® [Abbott], Isoflurane Inhalation Anaesthetic® [Faulding Pharmaceuticals]**)** is now the inhalation agent of choice in birds. Analgesia and muscle relaxation are excellent. Induction and recovery are very rapid and smooth as it is poorly bound in blood. Although blood pressure is reduced, cardiac output and stroke volume do not fall, cardiac arrhythmias are much less common and the myocardium is not sensitised to adrenaline. Respiratory depression occurs but the time between respiratory and cardiac arrest is much greater than with halothane. Isoflurane is expelled virtually unchanged from the lungs. It is not hepatotoxic or carcinogenic and is therefore safe for patient and personnel. Induction is usually with 3-4% and maintenance with 1-2% isoflurane and 1-1.5l/min oxygen. Depth of anaesthesia can be altered rapidly without adverse effects. Rapid recovery allows birds to be released to their enclosures or the wild immediately with little supportive care.

6. Surgery

The primary indications for surgery in seabirds are orthopaedics, removal of gastrointestinal foreign bodies and wound debridement and suturing. All the basic principals of avian surgery are applicable to seabirds. The primary difference is that in many cases the bird will need access to water at some time after surgery. Techniques must be used that can readily be managed in this environment and are not adversely affected by water.

Sterility is not as critical in birds as it is in mammals. It is more important to keep the anaesthetic and surgery time to a minimum. A small area of feathers from around the incision site should be plucked. Drapes can be used, however a sheet of cling-film is just as effective and allows visualisation of the whole patient. Alcohol should be avoided for surgical site preparation in small birds as it results in significant cooling. Povidone iodine alone is adequate. Standard surgical techniques and instruments can be used however radio surgery (Ellman Surgitron®) is particularly useful in birds. Prior to any surgery birds should be stabilised. Hydration and body temperature must be restored to normal.

6.1 Orthopaedics

Fractures in seabirds are not as common as in other bird species. Incidents such as being hit by cars, caught by dogs or cats and flying into windows that result in fractures in most birds do not usually occur in seabirds. Birds that are hit by boats often sustain fractures. If a fracture is suspected in a seabird it must be fully evaluated radiographically. This is critical to establish a prognosis for release after repair, to determine the most appropriate method of repair and to ensure there are no other fractures or injuries. The primary aim of rescue and treatment of wild seabirds should be to rehabilitate and release them. An early assessment of prognosis and suitability for release must be made. Generally fractures that are associated with significant soft tissue trauma, those close to or involving joints, severe pectoral girdle fractures, wing fractures particularly those distal to the mid radius and ulna, compound fractures where the bone ends are exposed and dry, beak fractures and any fracture that would result in a functional or physical deficit have a poor prognosis and repair should not be attempted. Amputations and application of beak prostheses must not be attempted unless the bird is to be maintained in captivity. Most seabirds are poor candidates for long-term captivity and as most avian fractures require at least 2 weeks to heal this should also be taken into account when making a decision to repair a fracture. External fixation methods on legs can be difficult to maintain as they get wet and dirty. The legs and feet off seabirds are poorly adapted to constant weight bearing. If one leg is immobilised and not functional the extra pressure on the other leg and foot is likely to result in severe pododermatitis. Fractures in little penguins are usually difficult to repair, as the bones are short and have small medullary cavities. Their bones are also very strong and any trauma that results in a fracture is usually significant – causing soft tissue damage and multiple bone fragments.

If a decision is made to repair a fracture this should be done early. If bone ends are exposed (common in birds) they will dry out and become necrotic. The longer a fracture is left the greater the chance of further soft tissue damage. Both internal and external fixation can be used and are usually tolerated well by most seabirds. Most of the orthopaedic techniques used in mammals and other bird species can be used in seabirds (Cannon 1994). Kirschner-Ehmer (KE) apparatus is useful in larger birds. The bars can be stabilised using small cable ties and an epoxy putty (Selleys Knead-IT®, CRC Minute Mend®). The following general rules of thumb apply:

Shoulder dislocations – rare as this is an injury that usually results from flying into objects. Immobilisation with a figure-of-eight bandage and body strap for 2-3 weeks is required.
Elbow dislocations – these can be reduced by applying pressure over the proximal radius with the elbow extended. Immobilisation with a figure-of-eight bandage and body strap for 2-3 weeks is required.
Fractures of the bones of the pectoral girdle (coracoid, furcula and scapula) – these injuries tend to result from flying into objects. Only minor non-displaced fractures should be treated as the prognosis for return to flight is poor. Treatment is as for shoulder dislocations. Surgical techniques have been described.
Fractures of the humerus – intramedullary pins (IMP) or Kirschner-Ehmer (KE) apparatus should be used. The wing should also be strapped with a figure-of-eight and body strap for at least 1-2 weeks.
Fractures of the radius and ulna – if only one of these two bones is fractured external fixation is generally adequate (figure-of-eight and body strap). In small birds if both are fractured and there is minimal displacement external fixation may be adequate. However in large birds and if there is displacement internal fixation will be required. An IMP or KE apparatus in the ulna should be used. Pins should exit at the elbow and the radius should never be pinned. A figure-of-eight and body strap should also be applied for 1-2 weeks.
Fractures of the carpus and phalanges – the prognosis is usually poor and repair not attempted.
Dislocations of the leg joints – the prognosis is usually poor and repair not attempted. Hip dislocations can be reduced however the acetabulum is shallow and rarely remains reduced. Internal reduction and stabilisation may be required.
Fractures of the femur – an IMP or KE apparatus should be used. Confinement for 2-3 weeks for larger species may be necessary.
Fractures of the tibiotarsus and tarsometatarsus – external fixation using a splint is adequate in most cases however an IMP or KE apparatus may be useful. Difficulties may be encountered with birds that require access to water.
Fractures of the toes – splints or ball bandages can be used.
Fractures of the bill – only minor fractures where there is no displacement or deficit should be repaired. No prosthesis will remain on the bird for the duration of its natural life. Any displacement that cannot be corrected will result in malocclusion and the potential to interfere with the bird's ability to forage and eat. Cerclage wires and KE apparatus can be used. Surgical glues and cement can be used to strengthen the repair. The repair of pelican bills with intramedullary pins and figure-of-eight wiring to compress the fracture site has been used. A form-fitted splint attached with epoxy must be used for additional stability. The bones in these cases rarely heal and the birds should not be released (Williams 1998).

6.2 Laparotomy, proventriculotomy and ventriculotomy

The primary indications for laparotomy, proventriculotomy and ventriculotomy are the removal of foreign bodies such as fish hooks, sinkers and fishing line. Occasionally plastic bags, balloons, netting and other material may be found. Most foreign bodies occur in the oesophagus, proventriculus and ventriculus. Occasionally objects in the oesophagus and proventriculus can be retrieved using endoscopic techniques. These procedures are easy to perform and are well tolerated by most seabirds. Providing there is no significant internal damage from the foreign material the prognosis is good. The bird must be fasted for 6-8hrs prior to surgery to ensure that the proventriculus and ventriculus are empty.

A number of surgical approaches have been described (Harrison 1986), however access to the proventriculus and ventriculus of seabirds is usually straight forward and a ventral midline abdominal incision is adequate. An area about 0.5-2cm (depending on the size of the bird) on either side of the incision site should be plucked and surgically prepared. The skin incision is made along the ventral midline from the tip of the xiphoid extending caudally. The length of the incision will depend on the degree of exposure required. The linea alba is then picked up with forceps and a small stab incision made with a scalpel. The incision is then extended using scissors. The skin and abdominal wall is very thin on the midline and care must be taken not to go too deep, inadvertently incising underlying organs. Significant amounts of subcutaneous and abdominal fat may be present in some birds. The proventriculus or ventriculus should now be visible just under the incision. If care is taken the abdominal air sacs should still be intact. The size of the air sac spaces will depend on the species of bird. Incising or rupturing air sacs does not seem to have any adverse effect. Anaesthetic depth may be affected as inhalation agent escapes from the incision. If greater exposure is required a horizontal incision extending laterally from the cranial end of the midline incision can be made. Flap incisions offer a greater degree of exposure for visualisation and manipulation.

In seabirds there is no clear distinction between the proventriculus and ventriculus from the outside. Both together form a large goblet-shaped organ that fills most of the abdominal cavity. They should be palpated to locate the position of the foreign body. Fishhooks frequently puncture the proventricular or ventricular wall and may be visible. Access to the cranial end is greater than in most bird species however blunt dissection and elevation may be required. Care must be taken not to rupture large vessels in this area. Once the foreign body has been located the organ should be elevated into the laparotomy incision. Gauze swabs should be packed around the organ to prevent spillage into the body cavity. The proventriculus or ventriculus can be secured in position using stay sutures or Allis tissue forceps. An incision is then made in the ventral surface of the proventriculus or ventriculus avoiding blood vessels. Liquid contents can be removed using suction or gaze swabs. All other contents should be removed to avoid leaving any foreign material behind. In most cases fishhooks will have partially or fully penetrated the organs wall and will need to be cut to facilitate extraction. The proventricular or ventricular wall is closed with a double inverting Connell/ Cushing suture pattern using 4/0-2/0 absorbable suture material. Flushing the body cavity should be avoided as fluid may enter the respiratory system via the air sacs. The abdominal wall and skin are sutured using absorbable suture material in a simple continuous pattern. Skin wounds tend to heal quickly and most birds can be returned to an enclosure with a pond within 24-48hrs. Inta- and post-operative fluids can be given if indicated. In most cases, providing there is no significant contamination or obvious infection a short course of oral or parenteral antibiotics should be given (see Appendix C). If there is contamination or infection a longer course may be required. Antifungal prophylaxis should also be considered in these cases. No food should be given for 12hrs post-operatively. A liquid diet (see 4.3) should then be given by gavage for 24hrs. Beyond this normal feeding can resume if the bird is accepting solid food or tube feeding continued.

6.3 Wounds

Wounds should be cleaned and debrided. Small wounds can be left open to heal. Feathers and dirt should be gently removed from the wound. A warm 1% povidone iodine solution can be used to clean the wound. If wounds require suturing 4/0-2/0 absorbable suture material using a continuous pattern is suitable. In most cases only the skin requires suturing. The patagium (see 2) is prone to injury particularly from fishing line entanglement. Adequate repair of the patagium is essential to allow the bird to fly and soar properly. The normal locking mechanism of the propatagialis complex must be restored. It is difficult to suture the propatagial ligament and the skin should be carefully repaired forming the canal surrounding the ligament. The wing should be placed in a figure-of-eight bandage for 1-2 weeks. Providing the tissues are viable and fresh the ligament will recanalise and reattach. Physiotherapy will be required to strengthen the ligament and return it to normal function (Cannon 1999).

Large lacerations of the gular pouch of pelicans and other species may require suturing. The integrity of the gular pouch in pelicans is essential for the survival of the bird. When the gular pouch is seriously damaged, the pelican cannot effectively catch fish and may die of starvation. Simple apposition of the wound edges and suturing using standard suture patterns in these cases is ineffective. The gular pouch epidermis consists of stratified squamous epithelium lining both the internal and external surface. The epithelium is between 5 and 10 cells thick. Both epithelia are lined externally by a thin compact stratum corneum. The dermis consists of melanin, blood vessels, nerves, collagen and muscle. A layer of collagen bundles lines the deep surface of both epithelia. A layer of skeletal muscle is sandwiched between the inner and outer epithelia. Blood vessels occur throughout the collagen and muscle bundles. Effective repair of gular pouch lacerations relies on debriding the edges of the wound and separating the internal and external epithelial surfaces by about 2mm. The internal and external layers are then sutured separately by careful apposition of the debrided surfaces. It is important that the central skeletal muscle is included in the suturing. A simple interrupted pattern using 4/0 monofilament absorbable or non-absorbable suture material, with sutures placed every 3mm should be used. Magnification may be required to facilitate precise approximation of tissues. Sutures can be removed 14 days later. Other repair techniques compress the muscle layer and blood vessels resulting in necrosis and wound dehiscence (Williams 1998).

7. Presenting Problems

When presented with any wild animal, a detailed history must be taken from the rescuer and an accurate identification of the species made. This is essential, as it is likely to be relevant to the reason for presentation, and will have an important bearing on the rehabilitation and release of the animal. A thorough clinical examination and assessment should then be carried out (Vogelnest 1994). The specialised requirements for the handling and housing of seabirds must be kept in mind at all times and if these cannot be catered for the bird should be referred to a facility that can.

7.1 Trauma

Trauma as a reason for seabirds requiring veterinary attention is not as common as in other groups of birds. They are rarely hit by cars or fly in to windows, and are only occasionally predated on by dogs, cats or foxes. Gunshot wounds, injuries from fishing equipment and being hit by boats is however more common. The treatment of wounds and fractures has been discussed (see 6.3).

Tragically, the fishing industry sees many seabirds as competition and unscrupulous fisherman will occasionally shoot these birds from their boats. Some marine fisheries are attempting to use methods that are less likely to catch seabirds however these are slow to be adopted as most are less efficient an more costly. Long-line fishing is one of the most significant threatening processes to endangered seabird species such as the wandering albatross. New techniques where the line and hooks are cast deeper in the water are being used and the seabird by-catch has been reduced. In many cases birds that have been shot or caught on fishhooks do not survive however occasionally they will be alive and require veterinary attention. These birds should be radiographed and the injuries dealt with appropriately. Injuries from fishing line and hooks are common. Fishhooks may be found lodged in and around the mouth or any other part of the body. Line may be entangled and wrapped around wings, legs, the base of the tongue or other parts of the body. Seabirds may also become entangled in other material such as netting, plastic bags and plastic six-pack rings. In most cases the treatment is relatively straight foreword, however occasionally damage may be so severe that euthanasia is indicated. In most cases anaesthesia will be required to adequately treat these injuries. Unfortunately fishing line, nets and plastics last almost forever in the environment and are deadly to marine animals. Pelicans and sometimes other species are presented with lacerations to the gular pouch. Fishhooks or other sharp objects may cause these. Small lacerations usually do not require treatment, however large ones will (see 6.3).

Injuries caused by boats, particularly lacerations and fractures from the propeller are common. The incidence of these injuries is relatively high in little penguins that are often found in areas where there is considerable recreational boating activity. These injuries may be fatal or associated with major soft tissue and/or bone damage and euthanasia is indicated. Less severe injuries however are readily treated. Occasionally lacerations, amputations or other injuries caused by predatory fish and sharks may be seen. Little penguins that come ashore in areas where there are predators such as foxes, dogs and cats may be attacked. This, loss of suitable habitat due to housing and other “developments” and human interference has been a significant factor in the decline of little penguins on mainland Australia.

7.2 Foreign bodies

Seabirds frequently ingest foreign material. These include fishhooks, fishing line, sinkers, netting, floating plastic spherules (a by-product of the plastics industry), balloons, plastic bags and other plastic objects, and kebab sticks. Most seabirds presented should be evaluated radiographically to rule out the presence of foreign bodies, particularly hooks and sinkers. The clinical presentation of seabirds with foreign bodies may vary form an apparently healthy bird, poor condition, weakness, lethargy, anorexia, dehydration, anaemia, regurgitation, diarrhoea, constipation, bleeding from the mouth or blood in the faeces. If a bird has fishing line hanging out of its bill it is likely that a hook or sinker has been swallowed. Contrast studies may be required to identify the presence of radiolucent foreign bodies. Other exploratory procedures such as endoscopy (see 3.5) or exploratory laparotomy (see 6.2) may be required to make a diagnosis. It is important to note that some radiodense objects such as squid beaks, fish ossicles and stones or gravel may normally be found in the gastrointestinal tracts of seabirds.

Foreign bodies should be removed with the bird anaesthetised. These may be removed using endoscopic techniques or via a laparotomy and ventriculotomy or proventriculotomy. Fishhooks can be difficult to remove, particularly treble hooks or those with barbed shafts. If sinkers are present lead poisoning may occur (see 7.6).

7.3 Oil pollution

Seabirds are one of the most common groups of birds affected by oil pollution. The effects of oil on wildlife and the treatment and washing of oiled birds is discussed elsewhere in these proceedings.

7.4 Shearwater "wrecks"

Wedge-tailed (*Puffinus pacificus*) and short-tailed shearwaters (*Puffinus tenuirostris*) are two of the most numerous bird species on earth (also called mutton birds). Wedge-tailed shearwaters nest from November to May on islands off the west coast from Sable Island in the Forrestier Group to Carnac Island and on the east coast between Raine and Montague Islands. They are common off the east and west coasts but rare on the south coast. Short-tailed shearwaters nest from November to early May on islands in Bass Strait and off the south-east coast. Both species migrate north along the coast to the northern Pacific after breeding and return from October to December. It is during this southward migration that hundreds of exhausted, starved and dead birds ("wrecks") may be found on east coast beaches. Variation in the density of plankton with fluctuations in hydrographic conditions affects the number of pelagic fish available as a food source for the migrating birds and they are unable to take in enough energy to support their migration (Cannon 1999). Adverse weather conditions such as storms and high winds often make the situation worse as the birds battle against the conditions and are often blown toward land. During periods of bad weather at sea other species such as petrels and gannets may also be found suffering exhaustion and starvation. Birds are presented in various stages of exhaustion and dehydration, and are often emaciated and moribund.

Careful consideration must be given to the decision to treat and rehabilitate these birds – they are the most numerous bird species on earth and treatment of an individual is purely for welfare reasons and has no conservation benefit. These "wrecks' are natural phenomena. The disease risks to the population associated with the release of these birds back into the wild must also be considered. The specialised requirements for the maintenance of these birds in captivity are also an important consideration. If these cannot be met it is preferable to euthanase the bird/s or refer them. Triage is important and only those birds with the best chances of survival should be treated ie. those in relatively good condition, normal or near normal body temperature, only mildly dehydrated, bright and alert, and have no fractures or other injuries. Even in these cases treatment can be intense. The most common pathological finding in birds that die or are euthanased is dehydration, emaciation, acute tubular necrosis and visceral gout. The longer the birds remain in captivity the poorer the prognosis for release as they will start to develop problems associated with the captive environment.

Treatment involves the provision of a suitable environment, fluids and careful force-feeding (see 4). An understanding of the special requirements of these species is essential to ensure a successful outcome. Currumbin Sanctuary receives over 100 shearwaters each year and their staff have considerable experience in treating and rehabilitating these birds. Their treatment and rehabilitation protocol is included in Appendix D.

7.5 Moulting and emaciated Little Penguins (*Eudyptula minor*)

All penguin species have a distinct annual cycle of breeding and moulting. The little penguin is the only species found on or around mainland Australia. Its range is in southern waters from south of Queensland, around the coast of Tasmania to Fremantle in Western Australia. Occasional vagrants of other species such as the Fiordland crested penguin (*Eudyptes pachyrhynchus*) may be found on mainland Australia or nearby islands. The little penguin nests in burrows on islands and on the mainland. Most birds return to their natal colony each year to breed and moult. After fledging young birds leave the colony without their parents. During their first year of life these birds travel extensively (500-100km from their natal colony). Young birds are rarely seen on land during their first year. About half of the young birds breed for the first time at the end of their second year and some return to their natal colony to moult. Most penguins have commenced breeding by the time they are three years old. After breeding penguins stay at sea for several weeks at a time, presumably to gain condition for moulting. The average life expectancy of a wild breeding penguin is 6.5 years. The annual cycle for little penguins is variable around Australia. Nest building occurs from August to January. Egg laying and the raising of chicks occur from August to March. The moult occurs from February to May (Little penguin Research Project, Taronga Zoo 1993).

It is during breeding and moulting that penguins come ashore. During the moult penguins are unable to return to see and are most vulnerable. Breeding adults share nesting responsibilities. They return to sea during the day to feed both during incubation and while rearing the chick/s. One parent usually remains with the egg/s and then the chick/s until they are 10-12 days old when both parents will leave to feed and return at night. The chicks prior to fledging are vulnerable to attack by predators. Chicks fledge at 8 weeks.

Normal moulting penguins may be found on beaches or rocky coastal areas frequented by people and their dogs. These birds may be presented because they are thought to be ill or are removed from the area to protect them from people, predators or other anthropogenic activities. Moulting penguins may also be presented because they have been injured. Occasionally moulting penguins may be found emaciated and either not yet started moulting with tatty, old feathers or incompletely moulted. In these cases the birds may not have gained enough weight and thus fat prior to moult to sustain them during the moult. The shedding and production of a new set of feathers is a considerable drain on the bird's energy reserves.

First year birds may be presented within a few months of fledging. Due to a combination of inexperience and depleted food supplies in some areas these birds starve. They are presented emaciated, weak and dehydrated. Body weights may be from 400-700g (normal is 900-1600g). The prognosis for birds less than 600g is often poor. In the past few years' adult birds have also been found emaciated or dead and some populations along the east coast have declined. Pilchards are one of the primary food sources for little penguins. Massive pilchard mortality from pilchard herpes virus and increased fishing is thought to be a cause for this decline. Mass mortalities due to starvation due to depleted food supplies have also been reported in Victorian populations since the mid 1980's. The causes of morbidity and mortality of little penguins has been reported in detail by Harrigan 1988.

Disease is rarely a reason for presentation. Ectoparasites such as ticks (*Ixodes kohlsi*), fleas (*Parapsyllus australiacus*) and lice (*Austrogoniodes watersoni*) may be found but are rarely significant. Endoparasites occur but are rarely in large enough numbers to be of concern. *Contracaecum spiculigerum* are common nematodes that parasitise the oesophagus and proventriculus of little penguins. There have been reports of penguins found along the Victorian coast having heavy burdens of this parasite associated with proventricular ulceration and haemorrhage. Intestinal cestode infections (*Tetrabothrius* spp) are common. Heavy parasitism is rarely reported in birds found along the New South Wales coast. *Mawsonotrema eudyptulae* is a trematode that lives in the bile duct of little penguins. Infection is usually incidental but can be associated with pathology. Renal coccidiosis is a common incidental finding in little penguins. A babesia-like piroplasm is occasionally seen in the erythrocytes of little penguins. The organism is most likely transmitted by ticks, and is associated with regenerative anaemia (Rose 1999). Aspergillosis and bumblefoot (see 8.6, 8.7) may occur in birds kept in captivity for treatment and rehabilitation. Penguins are also frequently presented with wounds, foreign bodies or entanglement.

Little penguins are robust and are easier to treat than most seabirds, providing a suitable environment and appropriate food is provided. Supportive care in the form of a stress free environment, warmth (if needed), fluids, force feeding and appropriate treatment for injuries, foreign bodies etc. is all that is needed in most cases. Anthelmintics must be given if parasitism is suspected (see Appendix C). Despite this, however their needs are more specialised than most other birds, and penguins should be cared for in appropriate facilities by people with experience.

7.6 Toxicities

A wide range of toxic compounds both natural and anthropogenic (pollutants) may be found in marine environments. These may affect seabirds by either contact or ingestion. Long-term exposure to pollutants may have serious consequences for seabird populations, and over time, a gradual decline in numbers may go unnoticed. Pollutant toxins include metals and metalloids (lead, cadmium, copper, nickel zinc, mercury, selenium, arsenic), pesticides (organophosphates, carbamates, organochlorines), industrial chemicals (polychlorinated biphenyls [PCBs], polybrominated biphenyls[PBBs], dioxins, dibenzofurans) and petroleum products (aromatic hydrocarbons) (Fairbrother 1996, Fairbrother 1999a,b,c). Natural toxins include those produced by the red tide organism, *Gonyaulax tamaensis*, and botulinum toxin.

The investigation and diagnosis of toxicities in wildlife is difficult and expensive. Single cases of mortality or morbidity in a wild animal suspected of being associated with a toxin are rarely confirmed. Even in situations where a number of animals are affected a definitive diagnosis may not be made. Toxicities in seabirds in Australia are rarely reported or diagnosed (other than those associated with oil spills). This may be because the incidence is in fact very low or morbidity and mortality caused by toxins is not being recognised. Toxic problems should be suspected when birds of several taxa from the same area are presented showing similar signs. Three toxicities may be seen more commonly in Australian seabirds. These are botulism, lead poisoning and toxicity associated with oil pollution (discussed elsewhere in these proceedings).

7.6.1 Botulism.

Avian botulism is a specific intoxication that results from the ingestion of a toxin produced by the bacteria *Clostridium botulinum*. Type C toxin is most commonly associated with avian botulism. It is not a significant problem in seabirds in Australia, however, sporadic outbreaks do occur, particularly in species that are found in fresh water (pelicans, cormorants). Botulism is not usually associated with salt water environments and usually affects species that utilise the margins of waterways. Birds of several taxa may be affected in the same area. Outbreaks depend on the presence of the bacteria in the environment, the presence of susceptible birds and favourable environmental conditions, such as high temperatures, decomposing vertebrate and invertebrate carcasses, rotting vegetation, and stagnant and shallow water. The ingestion of maggots has been associated with botulism, due to their ability to bioconcentrate the toxin. Ingestion of as few as two maggots can kill a bird. Fish may also eat the maggots, which in turn are eaten by seabirds causing toxicity.

Typical signs are a flaccid paralysis of wings, legs and neck. In early stages birds stand with their head drooping. Some birds drown, as they are unable to hold their heads out of water. Birds usually become comatose and die. Mild cases will recover with intensive supportive care.

Diagnosis is based on history, clinical signs and identification of *C.botulinum*, type C toxin in serum and culture filtrates of intestinal contents. An ELISA test is now available for types C and D toxin. There are no gross or histopathological lesions. Examination of the area where affected birds are found may alert one to the diagnosis of botulism particularly if rotting carcases, vegetation and maggots are present and appropriate environmental conditions exist. Outbreaks tend to occur repeatedly in the same areas as bacterial spores remain in the environment and sporulate when conditions are suitable.

Treatment is primarily supportive. This includes fluids, warmth and a stress-free environment. Botulism antitoxin is not commercially available. Antibiotics may be indicated if secondary infection is suspected. Aspergillus prophylaxis should also be considered. The prognosis is usually good in mildly affected birds. Severely affected birds particularly if there are large numbers may need to be euthanased.

7.6.2 Lead poisoning

Lead poisoning occurs in seabirds as a result of the ingestion of lead sinkers. Lead shot lodged in the tissues of birds does not cause poisoning - it has to be ingested.

The usual clinical signs include depression, weakness, wing droop, head tremors, blindness, ataxia, convulsions, weight loss, regurgitation, vomiting and diarrhoea.

Diagnosis is based on species, history, clinical signs, radiographic evidence of radiodense particles in the gastrointestinal tract and blood lead levels. Treatment involves removing the lead from the gastrointestinal tract using cathartic or bulking agents (metamucil, mineral oil, magnesium sulphate, sodium sulfate – see Appendix C) or physically removing the sinker endoscopically or surgically. Chelating agents such as calcium EDTA (see Appendix C) are used to bind lead within the blood and aid in its elimination.

7.7 Infectious diseases

It is rare that seabirds are presented because they are suffering from a primary infectious disease. In most cases infectious diseases occur once a bird is compromised as a result of starvation, exhaustion or stress. These organisms are usually carried in low numbers as part of a bird's normal flora and multiply when the bird's immune system is suppressed. Various surveys have been carried out to determine the normal microbial flora of wild seabirds. It is apparent that some wild populations have become infected with pathogens associated with human activities such as the discharge of effluent into the ocean, expeditions and tourism into remote areas such as Antarctica and birds feeding off human waste (Gardner, Kerry and Riddle 1997).

7.7.1 Viral diseases

Only a few viral diseases have been reported in Australian seabirds. In most cases these have been identified based on serological evidence only. Several serological studies have been conducted to determine the importance of seabirds as viral reservoirs. The majority have been in the Northern Hemisphere (Pokras 1996, Stoskopf and Kennedy-Stoskopf 1986) however there have been a few conducted on Australian species and most of these have been in penguins. These have been reviewed by Harrigan 1988 and Clarke and Kerry 1993. Antibodies to, and viruses that have been detected include infectious bursal disease in Antarctic penguins (Gardner, Kerry and Riddle 1997), various strains of avian paramyxovirus in little and other penguins, Newcastle disease virus, avian influenza virus and flavivirus in penguins (Morgan, Wesrbury and Campbell 1985). The significance of these antibodies is uncertain, however it is known that penguins are susceptible to pathogenic strains as disease has occurred in the wild and captivity (Clarke and Kerry 1993).

7.7.2 Bacterial and fungal diseases

It is rare that primary bacterial and fungal diseases are diagnosed in wild seabirds. These are far more common in captive, particularly recently captive seabirds. Bacterial infections that have been reported in seabirds include *Salmonella typhimurium* and other *Salmonella* species, *Klebsiella* spp, *Escherichia coli, Pasteurella* spp, *Pseudomonas aeruginosa, Clostridium perfringens, Campylobacter fetus, Yersinia pseudotuberculosis, Streptococcus* spp, *Staphylococcus* spp, *Erysipelothrix rhusiopathiae, Mycobacterium avium* and *Mycoplasma* spp. The highest incidence of *M. avium* infection is in scavengers (Pokras 1996). Most of these are diagnosed at necropsy and the lesions are no different to those seen in other avian species (Stoskopf and Kennedy Stoskopf 1986). A number of surveys of intestinal flora of wild seabirds, particularly penguins have been conducted and have identified the presence of various apparently non-pathogenic bacteria in healthy birds. The species of bacteria found varied with species of bird, diet and stage of breeding cycle. Antibodies to *Chlamydia* have been found in a number of penguin species (Clarke and Kerry 1993).

By far the most common fungal disease diagnosed in seabirds is aspergillosis caused by *Aspergillus fumigatus.* It is rare for a wild bird, although it does occur to be presented with aspergillosis. In these cases the bird is often compromised for some other reason such as starvation or exhaustion. Aspergillosis is invariably a disease associated with captivity and is discussed in detail in 8.6. *A. flavus, Mucor* spp, *Geotrichium cadidum, Candida albicans* and blastomycosis have occasionally been isolated from seabirds.

7.7.3 Parasitic diseases

The parasitic flora of seabirds is vast and all species of seabird are natural hosts to a variety of both endo- and ectoparasites. In most cases these parasites are of no consequence to the bird, however at times of nutritional and other stress, concurrent disease or exposure to pollutants, parasite numbers increase and may become pathogenic. Massive parasitic infestations are often encountered in wild, apparently healthy birds as well as sick birds. It is rare to find a seabird without parasites. If debilitated one must not assume that parasites are the reason for the bird's debility. Diagnosis of parasitic infections are based on a thorough external examination of body surfaces and orifices, a blood smear, faecal wet preparation, faecal flotation and sedimentation tests. Although one should not aim to eliminate all parasites if a bird is to be released, their numbers should be controlled so that they do not increase while the bird is in captivity and cause further debility. Large numbers of lice and occasionally ticks are seen on seabirds and these should be treated using carbaryl dusting powders or permethrin preparations. Gastrointestinal nematodes are common and these can be detected on faecal flotation. However it is best to assume that most seabirds presented have a nematode burden and it is good practice to treat all seabirds with an appropriate anthelmintic (see Appendix C) once stabilised. This should be repeated within 10-14 days.

Although to list all parasites of Australian seabirds is beyond the scope of these notes some are worthy of mention. Harrigan 1978 gives a detailed review of avian parasites. Clarke and Kerry 1993 provide a detailed list of the parasites of penguins. The following parasites of seabirds are worthy of note:

Ectoparasites

A large number of species of biting lice infest seabirds (sucking lice do not infect birds). These lice feed on the feathers and skin debris. Lice are host specific and are not readily transmitted between different bird species. Lice live permanently on the bird.

Ticks are common on seabirds particularly penguins. *Ixodes uriae* is common on subantarctic and Antarctic penguins. Chicks are most commonly infected and ticks are found around the eyes, bill, webs of the feet and around the cloaca. Ticks of the genus *Ornithodorus* have been found on little penguins (Clarke and Kerry 1993). *Ixodes kohlsi* is common on little penguins.

Fleas (*Parapsyllus* spp) are found on many penguin species other than Antarctic species as the stages of the life cycle that are off the host do not survive (Clarke and Kerry 1993).

Endoparasites

Renicola spp trematodes have been found in the kidneys of little penguins and cormorants in Tasmania and South Australia (Harrigan1978). Light infections are of no consequence however heavy infections may result in debilitation and death due to inflammation of the ureters and retention of urates. Diagnosis is at necropsy although trematode eggs may be found in excreted urates.

A hepatic trematode, *Mawsonotrema eudyptulae* has been reported in little penguins in Victoria. This parasite lives in the bile ducts and may be associated with hepatomegaly and necrosis, however most infections are incidental.

Heavy trematode infestations have been found in severely debilitated juvenile pelicans in Western Victoria. The small intestinal mucosa of these birds was congested but no ulceration was present (Harrigan 1978).

Contracaecum spp is a common nematode in the oesophagus and proventriculus of piscivorous birds. They have been found in cormorants, shearwaters, pelicans and penguins in Australia. They are a moderately large nematode requiring an intermediate host which may include small aquatic invertebrates or fish. Heavy infections are associated with ulceration and haemorrhage of the mucosa. Heavy infestations with mature and larval worms (*C. spiculigerum*) have been reported in little penguins in Victoria. These are rarely reported in little penguins found further north on the east coast of Australia. Young pelicans in Victoria often have large numbers of these parasites in the gular sac and/or in the oesophagus and proventriculus. The mucosa is often inflamed and infected birds are emaciated and weak. These birds are often also infected with other parasites (*Synhimantus* spp, *Cosmocephalus* spp and trematodes) and the contribution of the *Contracaecum* spp is not clear (Harrigan 1978).

Heavy infestations with cestodes are common in seabirds, however they are rarely pathogenic.
Renal coccidiosis (Limey disease) caused by *Eimeria serventyi* occurs in short-tailed shearwaters (*Puffinus tenuirostris*). The disease occurs in flightless chicks in the nest. It is also occasionally seen in exhausted, emaciated adults but is probably an incidental finding in these birds. Signs include caking of the vent with white pasty droppings and weight loss. At necropsy adipose tissue is yellow rather than white, kidneys are enlarged and the ureters, rectum and cloaca distended with urates. Interstitial nephritis centered around the intrarenal ureters and collecting ducts, and the presence of coccidia (*Eimeria* spp), are the characteristic histological findings. Renal coccidiosis is also a common incidental finding in little penguins and Australsian gannets.

Avian malaria (*Plasmodium relictum, cathemerium* and *elongatum*) is commonly reported in captive penguins in the Northern hemisphere, however it has not been found in wild Antarctic or subantarctic penguins in the Australasian region or little penguins (Clarke and Kerry 1993). *Plasmodium* spp have been found in the Southern (great or giant) skua (*Stercorarius skua*) (Vogelnest 1991).

Leucocytozoon tawaki has been found in Fiordland crested penguins (*Eudyptes pachyrhynchus*) and a little penguin housed with a Fiordland crested penguin. The vector is a simuliid fly *Austrosimulium ungulatum*. This parasite is non-pathogenic.

The trypanosome *T. eudyptula* has been found in low numbers in the blood of little penguins (Clarke and Kerry 1993).

A babesia-like piroplasmid organism has been found in the blood of little penguins and may be associated with regenerative anaemia. These birds are also usually infected with the tick *Ixodes kohlsi*.

8. Diseases Associated with Captivity

8.1 Plumage damage

Intact plumage is critical for flight, waterproofing, buoyancy and thermoregulation. The housing of seabirds in confined spaces and regular handling often damages the feathers. The inability of many seabirds to lift their bodies off the ground often results in damage to the ventral plumage and tail feathers. Weak, debilitated birds will also not preen regularly. Some species will only preen when in water. All enclosures should be large enough so the bird can stretch its wings out and move around without contacting the sides. Substrates and enclosure furniture appropriate for the species must also be used to prevent plumage damage (discussed elsewhere in these proceedings).

8.2 Cloacal impaction

Some seabird species that have difficulty elevating their bodies off the ground either due to weakness or anatomical conformation are prone to cloacal impaction. This is usually an external impaction and results from the bird's inability to lift itself when passing faeces and urates. The vent area quickly becomes encrusted with urates and faeces and impaction follows. The cloaca may then become impacted with excreta due to the external impaction. It the cloaca is significantly stretched it may become temporarily atonic which exacerbates the problem. The vent areas of these birds should be cleaned regularly using warm water and gentle massaging. Placing the birds in water several times a day helps prevent impaction (Pokras 1996).

8.3 Decubital and tarsometatarsal ulcers

Due to anatomical conformation or weakness many seabirds are not able to hold their bodies off the ground when out of water. Much of their weight is born on the tarsometatarsi or keel bone. If the substrate is hard and abrasive decubital and tarsometatarsal ulcers occur. These ulcers are then prone to secondary infection and can be very difficult to treat and often lead to death or the necessity to euthanase the animal. Prevention is essential and particular attention must be given to suitable substrates. These ulcers may still occur if soft substrates such as rubber or toweling are used particularly in heavy birds. Netting, where birds are suspended off the ground has been used with some success (Pokras 1996). This reduces the area of pressure on the keel and tarsometatarsi and feather soiling. A three-dimensional matting (T.E.C. MAT, Total Erosion and Pollution Control, 35 Parraweena Rd, Caringbah, 2229, Australia, tepc@ol.com.au) is being used at Taronga Zoo, however its effectiveness in preventing ulcers and pododermatitis is yet to be fully evaluated. Similar matting has been used in the United States of America (Pokras 1996). Treatment is difficult but involves improving the substrate, suspending the bird, cleaning and flushing with antiseptics (1% iovone) or astringents (Lotagen®) and the application of dressings. Wound dressings such as Duoderm®, Cutinova®, Gelocast® and Fixomull® can be useful to assist healing.

8.4 Salt balance

Pelagic seabirds can drink salt water. They must therefore have some mechanism for excreting excess salt. Although the kidney can secrete some sodium and chloride, the excessive load in these seabirds is excreted by the paired salt glands (see 2). In response to an osmotic load these glands produce a hyperosmotic secretion containing mostly sodium chloride. Some drugs (cholinergic blockers, sympathomimetics), general anaesthesia, pollutants (some petroleum fractions, pesticides) and botulinum toxin have been shown to inhibit or eliminate normal glandular response to salt loading (Pokras 1996). Shearwaters have an obligate requirement for saline drinking water, however in captivity any procellariform bird should be supplemented. In these species hyponatraemia will occur if kept in fresh water without a supplement. The salt glands of seabirds will also atrophy if kept in fresh water without salt supplementation while in captivity. When procellariform birds are kept in freshwater or not supplemented for 7-10 days, the salt glands must be reactivated by gradually increasing salt in the diet before the bird is released back in to a marine environment. This can be done by providing salt-water pools using seawater or adding sea salt to make a 3% solution. This is not as important for species such as pelicans, cormorants and penguins. Salt can also be added to the diet until nasal secretions are seen. This can be done by gavaging with a 1% salt solution that is increased to 3% just prior to release or giving salt tablets at 100mg/kg body weight per day. Birds released in to a marine environment without functional salt glands will suffer salt toxicity. Over supplementation in captivity may also result in toxicity. Signs include inappetance, tremors, lethargy and convulsions. Birds should be gavaged with fresh water of given sterile water intravenously (Pokras 1996).

8.5 Nutritional disorders

Failure to successfully treat and rehabilitate seabirds is frequently related to improper feeding and nutrition. The feeding and nutrition of seabirds and other piscivorous animals and disorders associated with inappropriate feeding is discussed elsewhere in these proceedings. It is essential that the natural diet of the species being treated and rehabilitated is known so that the same or similar food items can be offered (Cannon 1999). Not all seabirds eat fish exclusively. If inappropriate food items are offered this may result in refusal to eat, regurgitation, gastrointestinal disturbances or nutritional deficiencies. Deficiencies and nutritional stress may also predispose birds to other infectious or noninfectious diseases. The key to adequate nutrition of seabirds is freshness, variety and appropriate storage, thawing, handling and supplementation of fish. If these are inappropriate toxicities, deficiencies or infections may occur. Diets using several different species of food items with different nutritional compositions are more likely to provide a good balance of protein, fat, calories and trace nutrients. Seabirds kept in captivity for some time often develop strong preferences for a single species of fish if it is fed exclusively for a period of time. This may result in nutritional disorders and could be catastrophic if the fish species becomes unavailable.

Vitamin supplementation is essential when feeding seabirds (see 4.4). Many vitamins are depleted or destroyed when fish is stored. Vitamin E deficiency may result in steatitis or muscle necrosis. Vitamin B deficiency due to the presence of thiaminases in fish is well recognised in piscivorous animals and results in ataxia, abnormal posture, dyspnoea, seizures, coma and death. Scombroid poisoning, associated with feeding poorly preserved dark flesh oily fish (mackerel,tuna) has been suspected but not confirmed in seabirds. (Geraci and StAubin 1980, Stoskopf and Kennedy-Stoskopf 1986, Geraci 1996, Pokras 1996).

8.6 Aspergillosis

Aspergillosis is a common fungal infection of birds. It is caused by various aspergillus species but *Aspergillus fumigatus* is most common. It is rarely a primary disease, and stress and other immunosuppressive factors, such as viral or bacterial infections, malnutrition, trauma and exposure to environmental contaminants such as oil, all predispose to the development of aspergillosis. Aspergillus fungi are ubiquitous in the environment and birds are usually infected by inhaling spores in contaminated food, bedding, nesting material or other material.

Seabirds are particularly susceptible to aspergillosis. This is probably due to stress-induced immunosuppression in recently captive wild birds and seabirds lack of previous exposure to these fungal pathogens (Pokras 1996). The disease is occasionally seen in wild seabirds brought in sick or dead however this is rare. These birds have probably been under stress in the wild. It is more commonly seen as a secondary infection in birds presented for other reasons.

The clinical signs of aspergillosis are subtle, non-specific and often insidious in onset. The disease primarily affects the respiratory tract, but can become systemic. Initial signs may include changes in behaviour, weakness, slow weight loss and changes in voice. Knowledge of the high susceptibility of certain species and the presence of concurrent disease or stresses may alert one to the possibility of an aspergillus infection at this stage. In advanced cases depression, weight loss, emaciation, weakness, ocular and nasal discharges, facial swellings, sneezing, respiratory noises and dyspnoea may be seen.

Antemortem diagnosis can be difficult but should be suspected on the basis of clinical signs, species of bird and the use of ancillary tests such as haematology, microbiology, endoscopy, radiology and serology. Typical haematological changes include leucocytosis due to heterophilia. Monocytosis and toxic heterophils are seen in later stages. Hyperproteinaemia with hyperglobulinaemia is often seen. Protein electrophoresis may also be useful. A drop in albumin is seen while beta and gamma globulins increase. Albumin levels below 1.8g/dl indicates a very poor prognosis (Reidarson and McBain 1995). Deep tracheal swabs, swabs of air sacs and necropsy samples can be examined using saline or KOH wet-mounts, or stained using lactophenol cotton blue or Gram stain (see 3.2). Aspergillus is readily cultured. A positive culture however must be interpreted in the light of other findings as due to the ubiquitous nature of the organism, culturing it may be incidental. Endoscopic examination of the trachea and/or air sacs often provide an immediate diagnosis.

Radiology can be used as an adjunct to diagnosis, however a definitive diagnosis can rarely be made using radiology alone and failure to detect lesions radiographically does not preclude a diagnosis of aspergillosis. Radiographically visible lesions imply a poor prognosis.

Serological testing for aspergillosis in birds is not readily available in Australia. A double diffusion test for precipitation is available through Veterinary Pathology Services in Sydney and Brisbane. This test is only genus specific. Overseas, an ELISA test is available. False negative results may occur with overwhelming infections (Reidarson and McBain 1995)

Necropsy diagnosis is frequently straightforward. Focal lesions in the sinuses, trachea or syrinx may be seen, however lesions are more commonly seen within the pulmonary parenchyma and air sacs. Typical white/yellow nodules or plaques may be seen. Lesions may have a typical green mould appearance due to the presence of conidiophores or fruiting bodies. Microbiology and histopathology usually confirm the diagnosis (Rose 1999).

Treatment is difficult unless started early in the disease process. Once clinical signs are evident, lesions are extensive and the prognosis is poor. Occasionally an aspergillus plug will form at the tracheal bifurcation or in the syrinx, which can be removed via the trachea (Redig 1993).

Many different drugs have been used to treat aspergillosis. The current drug of choice is itraconazole (Sporanox®, Janssen Cilag). Other drugs that have successfully been used are amphotericin-B, 5-fluorocytosine, ketoconazole, fluconazole and enilconazole (see Appendix C). Treatment may need to be continued for 2-3 months to ensure the organism has been eliminated.

Prevention involves maintaining a clean environment, the use of clean, dry bedding (avoid straw or hay), provision of fresh food and minimising stress by providing an appropriate environment for the species with minimal noise and plenty of cover. Adequate ventilation is also important. Systemic antibiotics and steroids should be avoided if possible as these increase susceptibility to fungal infections by eliminating competitive bacteria and suppressing immunity. Susceptible species can be put on a prophylactic course of itraconazole for 1 –2 weeks, nebulised with amphotericin-B for one week, or given 5-fluorocytosine at 50-60 mg/kg bid for two weeks (see Appendix C).

8.7 Pododermatitis (bumblefoot)

Pododermatitis is a common problem in seabirds kept in captivity for any length of time. It usually results from inappropriate and unhygienic substrates and perches. In seabirds, an important factor is that their feet are not well adapted to constant weight-bearing. In the wild these birds spend most of their time in the air or on water. Once in captivity, most of their time is spent on solid surfaces. Consequently, they develop calluses and nodules of hyperplastic tissue usually on the balls of their feet and along the plantar surfaces of the digits. The lesions along the digits usually correspond with the joints as there is more direct contact and pressure at these points. Lesions may start to develop within a few weeks of being in captivity and if left untreated may become very large. Lesions may become ulcerated and extend into deeper tissue or joints. Infection does not usually occur with superficial lesions however deeper lesions may become infected. Chronic ulceration and secondary bacterial infection may then lead to infectious tenosynovitis (Rose 1999).

There is probably no ideal surface to keep seabirds on, however, rough and abrasive surfaces (eg. concrete and artificial turf) should be avoided. Relatively smooth, but not slippery rubber matting, which is easily cleaned, is probably the best. Netting materials have been used with some success (see 8.3).

Treatment can be difficult and usually involves improved hygiene and substrates. Regular cleaning and flushing with antiseptics (1% iovone) or astringents (Lotagen®) and bandaging may be useful. Wound dressings such as Duoderm®, Cutinova® and Gelocast® can be useful to accelerate healing. Topical or systemic antibiotics may be indicated. Surgical debridement of necrotic tissue may be of use however excision of lesions should only be used as a last resort. Intra-lesional cortisone (if not infected) or long-acting tetracycline may slow the progress of lesions.

REFERENCES

Cannon M. (1999) Medicine and surgery of aquatic birds. *In: Wildlife in Australia, Proceedings 327*, University of Sydney Post Graduate Foundation in Veterinary Science, pp 527-568.

Cannon M. (1994) Avian orthopaedics. *In: Wildlife, Proceedings 233*, University of Sydney Post Graduate Foundation in Veterinary Science, pp 373-393.

Clarke JR, Kerry KR. (1993) Diseases and parasites of penguins. *Korean Journal of Polar Research*, 4 (2): 79-96

Fairbrother A, Locke LN, Hoff GL. (1996) *Noninfectious Diseases of Wildlife,* Iowa State University Press, Ames, Iowa.

Fairbrother A. (1999a) Wildlife immunotoxicology. *In: Wildlife in Australia, Proceedings 327*, University of Sydney Post Graduate Foundation in Veterinary Science, pp 235-240.

Fairbrother A. (1999b) Wildlife Toxicology. *In: Wildlife in Australia*, *Proceedings 327,* University of Sydney Post Graduate Foundation in Veterinary Science, pp 249-255.

Fairbrother A. (1999c) Environmental assessment. *In: Wildlife in Australia, Proceedings 327*, University of Sydney Post Graduate Foundation in Veterinary Science, pp 259-264.

Fudge AM. (1996a) Avian clinical biochemistry. *In:* Roskopf WJ and Woerpel RW (editors), *Diseases of Cage and Aviary Birds*, Williams and Wilkins, Baltimore, pp 773-782.

Fudge AM. (1996b) Avian microbiology. *In:* Roskopf WJ and Woerpel RW (editors), *Diseases of Cage and Aviary Birds*, Williams and Wilkins, Baltimore, pp 795-805.

Gardner H, Kerry KR, Riddle M. (1997) Poultry virus infection in Antarctic penguins. *Nature*, 386: 245

Geraci JR, St.Aubin DJ. (1980) Nutritional disorders of captive fish eating animals. *In:* Montali RJ and Migaki G (editors), *The Comparative Pathology of Zoo Animals,* Smithsonian Institution Press, Washington D.C., pp 41-49.

Geraci JR. (1986) Marine mammals: nutrition and nutritional disorders. *In:* Fowler ME (editor), *Zoo and Wild Animal Medicine,* Saunders, Philadelphia, pp 760-764.

Harrigan KE. (1978) Parasitic diseases of birds. *In: Fauna, Proceedings 36*, University of Sydney Post Graduate Foundation in Veterinary Science, pp 489-536.

Harrigan KE. (1988) Causes of mortality of little penguins. *In: Australian Wildlife, Proceedings 104*, University of Sydney Post Graduate Foundation in Veterinary Science, pp 705-716.

Harrison GJ. (1996) Selected surgical procedures. *In:* Harrison GJ and Harrison LR (editors), *Clinical Avian Medicine and Surgery*, Saunders, Philadelphia, pp 577-595.

Kasper A. (1997) Life on the ocean wave: Anatomical adaptations of seabirds to their environment. *Journal of Wildlife Rehabilitation*. 20 (3): 3-6, 12, 14-19

King AS, McLelland J. (1984) *Birds Their Structure and Function*, Bailliere Tindal, London.

Kirkwood JK and Sainsbury AW. (1995) Diseases and other considerations with wildlife translocations and releases. *In: Proceedings of a Symposium on Veterinary Involvement with Wildlife Reintroduction and Rehabilitation*, World Association of Wildlife Veterinarians, pp 12-16.

Lane RA. (1996a) Avian hematology. *In:* Roskopf WJ and Woerpel RW (editors), *Diseases of Cage and Aviary Birds*, Williams and Wilkins, Baltimore, pp 739-772.

Lane RA. (1996b) Avian urinalysis. *In:* Roskopf WJ and Woerpel RW (editors), *Diseases of Cage and Aviary Birds*, Williams and Wilkins, Baltimore, pp 783-794.

Lindsey TR. (1986) *The Seabirds of Australia*, Angus and Robinson, Sydney.

Lofgren L. (1984) *Ocean Birds, their breeding, biology and behaviour*, Croom Helm, London.

Machin KL, Caulkett NA (1998) Investigation of injectable anesthetic agents in mallard ducks (*Anas platyrhynchos*): a descriptive study. *Journal of Avian Medicine and Surgery*, 12: 255-263

McCracken H. (1993) Avian and reptilian haematology and biochemistry. *In: Clinical Pathology, Proceedings 207*, University of Sydney Post Graduate Foundation in Veterinary Science, pp 239-312.

Morgan IR, Westbury IW, Campbell J. (1985) Viral infections of little blue penguins (*Eudiptula minor*) along the southern coast of Australia. *Journal of Wildlife Diseases*, 21: 193-198

Pokras MA. (1996) Clinical management and biomedicine of sea birds. *In:* Roskopf WJ and Woerpel RW (editors), *Diseases of Cage and Aviary Birds*, Williams and Wilkins, Baltimore, pp 981-1001.

Redig PT. (1993) Avian aspergillosis. *In:* Fowler ME (editor), *Zoo and Wild Animal Medicine: Current Therapy 3,* Saunders, Philadelphia, pp 178-181.

Reiderson TH, McBain J. (1995) Serum electrophoresis and aspergillus antibody titers as an aid to diagnosis of aspergillosis in penguins. *In: Association of Avian Veterinarians, Main conference Proceedings*, pp 61-64.

Rose K. (1999) Common diseases of urban wildlife. *In: Wildlife in Australia, Proceedings 327*, University of Sydney Post Graduate Foundation in Veterinary Science, pp 365-427.

Rupely (1997). *Manual of Avian Practice*, Saunders, Philadelphia.

Sikarskie JG. (1992) The role of veterinary medicine in wildlife rehabilitation. *Journal of Zoo and Wildlife Medicine,* 23: 397-400.

Smith LE. (1998) *Seabirds – Care, Rehabilitation and Identification.* Southern Oceans Seabird Study Association, Unanderra, NSW, Australia.

Stoskopf MK, Kennedy-Stoskopf S. (1986) Aquatic birds. *In:* Fowler ME (editor), *Zoo and Wild Animal Medicine,* Saunders, Philadelphia, pp 294-313.

Viggers KL, Lindenmayer DB and Spratt DM. (1993) The importance of disease in reintroduction programs. *Wildlife Research*, 20: 687-698.

Vogelnest L, Cunningham M. (1991) Avian clinical pathology, Part II; microbiology and urinalysis. *In: Avian Medicine, Proceedings 178*, University of Sydney Post Graduate Foundation in Veterinary Science, pp 319-340.

Vogelnest L. (1991) Avian clinical pathology, Part I; haematology and biochemistry. *In: Avian Medicine*, *Proceedings 178*, University of Sydney Post Graduate Foundation in Veterinary Science, pp 243-316.

Vogelnest L. (1994) Veterinary care of wild Australian native birds. *In: Wildlife, Proceedings 233*, University of Sydney Post Graduate Foundation in Veterinary Science, pp 117-186.

Vogelnest L. (1999) Chemical restraint of Australian native fauna. *In: Wildlife in Australia, Proceedings 327*, University of Sydney Post Graduate Foundation in Veterinary Science, pp 149-187.

Walraven E. (1994) Rehabilitation and reintroduction of native fauna. *In: Wildlife, Proceedings 233*, University of Sydney Post Graduate Foundation in Veterinary Science, pp 193-205.

Williams TD, Gawlowski PQ, Strickland DM, et al. (1988) Surgical repair of the gular sac of the brown pelican (*Pelecanus occidentalis*). *Journal of Zoo Animal Medicine*, 19: 122-125

Woodforde MH. (1993) International disease implications for wildlife translocations. *J. Zoo. Wild. Med.* 24: 265-270.

APPENDIX A

SEABIRDS OF AUSTRALIA AND THEIR NORMAL BODY WEIGHT RANGES

Species	Approximate normal weight (g)	Source
PENGUINS		
Emperor penguin (Aptenodytes forsteri)		
King penguin (Aptenodytes patagonicus)		
Gentoo penguin (Pygoscelis papua)	5700	Lindsey, 1986
Chinstrap penguin (Pygoscelis antarctica)	3800	Lindsey, 1986
Adelie penguin (Pygoscelis adeliae)		
Rockhopper penguin (Eudyptes chrysocome)	2700	Lindsey, 1986
Fiordland penguin (Eudyptes pachyrhynus)	3000 – 4500	Lindsey, 1986
Snares penguin Eudyptes robustus)	3300	Lindsey, 1986
Erect-crested penguin (Eudyptes sclateri)		
Macaroni penguin (Eudyptes chrysolophus)	3000 – 4500	Lindsey, 1986
Magellan penguin (Spheniscus magellanicus)		
Little penguin (Eudyptula minor)	850 –1200	Smith, 1998
ALBATROSSES		
Wandering albatross (Diomedea exulans)	6500(f) – 8200(m)	Smith, 1998
Royal albatross (Diomedea epomophora)	7600(f) – 8650 (m)	Smith, 1998
Black-browed albatross (Diomedea melanophrys)	2850 – 3600	Smith, 1998
Buller's albatross (Diomedea bulleri)	2000 – 2500	Smith, 1998
Grey-headed albatross (Diomedea chrysostoma)	3700	Lindsey, 1986
Yellow-nosed albatross (Diomedea chlororhynchos)	1800 – 2500	Smith, 1998
Shy albatross (Diomedea cauta)	3300(f) – 3700(m)	Smith, 1998
Sooty albatross (Phoebetria fusca)	2050 – 2500	Smith, 1998
Light-mantled albatross (Phoebetria palpebrata)	2500 – 3400	Smith, 1998
STORM-PETRELS		
Wilson's storm-petrel (Oceanites oceanicus)	28 – 48	Smith, 1998
Grey-backed storm-petrel (Oceanites nereis)	31 – 44	Smith, 1998
White-faced storm-petrel (Pelagodroma marina)	40 – 60	Smith, 1998
Black-bellied storm-petrel (Fregetta tropica)	46 – 61	Smith, 1998
White-bellied storm-petrel (Fregetta grallaria)		
Leach's storm-petrel (Oceanodroma leucorhoa)	45	Lindsey, 1986
Matsudaira's storm-petrel (Oceanodroma matsudairae)		
DIVING-PETRELS		
Common diving-petrel (Pelecanoides urinatrix)		
Georgian diving-petrel (Pelecanoides georgicus)	100	Lindsey, 1986

SEABIRDS OF AUSTRALIA AND THEIR NORMAL BODY WEIGHT RANGES cont.

Species	Approximate normal weight (g)	Source
PETRELS AND SHEARWATERS		
Southern giant petrel (Macronectes giganteus)	2500 – 3400	Smith, 1998
Northern giant petrel (Macronectes halli)	2500 – 3400	Smith, 1998
Southern fulmar (Fulmarus glacialoides)	600 – 900	Smith, 1998
Antarctic petrel (Thalassoica antarctica)	325 - 460	Smith, 1998
Cape petrel (Daption capense)	340 - 480	Lindsey, 1986
Snow petrel (Pagodroma nivea)	450	Lindsey, 1986
Great-winged petrel (Pterodroma macroptera)	480 – 680	Smith, 1998
White-headed petrel (Pterodroma lessonii)	580 – 810	Smith, 1998
Providence petrel (Pterodroma solandri)	550	Smith, 1998
Kermadec petrel (Pterodroma neglecta)		
Herald petrel (Pterodroma arminjoniana)		
Tahiti petrel (Pterodroma rostrata)		
Kerguelen petrel (Pterodroma brevirostris)	340	Lindsey, 1986
Soft-plumaged petrel (Pterodroma mollis)	280 – 370	Lindsey, 1986
Mottled petrel (Pterodroma inexpectata)	300	Smith, 1998
White-necked petrel (Pterodroma externa)		
Gould's petrel (Pterodroma leucoptera)	170 – 200	Lindsey, 1986
Black-winged petrel (Pterodroma nigripennis)	140 – 170	Lindsey, 1986
Cook's petrel (Pterodroma cookii)		
Blue petrel (Halobaena caerulea)	165 – 220	Smith, 1998
Broad-billed prion (Pachyptila vittata)		
Salvin's prion (Pachyptila salvini)		
Antarctic prion (Pachyptila desolata)	115 – 183	Smith, 1998
Slender-billed prion (Pachyptila belcheri)		
Fulmar prion (Pachyptila crassirostris)		
Fairy prion (Pachyptila turtur)	99 – 128	Lindsey, 1986
Grey petrel (Procellaria cinerea)	870 – 1520	Smith, 1998
Black petrel (Procellaria parkinsoni)		
Westland petrel (Procellaria westlandica)	770	Smith, 1998
White-chinned petrel (Procellaria aequinoctialis)	970 – 1200	Smith, 1998
Streaked shearwater (Calonectris leucomelas)		
Flesh-footed shearwater (Puffinus carneipes)	570 – 700	Smith, 1998
Wedge-tailed shearwater (Puffinus pacificus)	280 - 420	Lindsey, 1986
Buller's shearwater (Puffinus bulleri)	470	Smith, 1998
Sooty shearwater (Puffinus griseus)	550 – 920	Smith, 1998
Short-tailed shearwater (Puffinus tenuirostris)	405 – 600	Smith, 1998
Manx shearwater (Puffinus puffinus)	400 – 450	Lindsey, 1986
Fluttering shearwater (Puffinus gavia)	225 - 425	Lindsey, 1986
Hutton's shearwater (Puffinus huttoni)	364	Lindsey, 1986
Little shearwater (Puffinus assimilis)		
Audubon's shearwater (Puffinus lherminieri)		
PELICANS		
Australian pelican (Pelecanus conspicillatus)	3390 – 7350	Smith, 1998
GANNETS & BOOBIES		
Australian gannet (Morus serrator)	2160 – 2400	Smith, 1998
Cape gannet (Morus capensis)	2600	Lindsey, 1986
Red-footed booby (Sula sula)	860 – 1000	Lindsey, 1986
Masked booby (Sula dactylatra)	1890 – 2250	Smith, 1998
Brown booby (Sula leucogaster)	800 – 1100	Lindsey, 1986
Abbott's booby (Sula abbotti)	1400	Lindsey, 1986

SEABIRDS OF AUSTRALIA AND THEIR NORMAL BODY WEIGHT RANGES cont.

Species	Approximate normal weight (g)	Source
DARTERS		
Darter (Anhinga melanogaster)	600 - 1100	Taronga Zoo
CORMORANTS		
Imperial shag (Leucocarbo atriceps)		
Black-faced cormorant (Phalacrocorax fuscescens)	1400	Lindsey, 1986
Great cormorant (Phalacrocorax carbo)	2500	Lindsey, 1986
Pied cormorant (Phalacrocorax varius)	2250	Lindsey, 1986
Little black cormorant (Phalacrocorax sulcirostris)	800 – 1100	Lindsey, 1986
Little pied cormorant (Phalacrocorax melanoleucos)	550 – 670	Taronga Zoo
FRIGATEBIRDS		
Christmas frigatebird (Fregata andrewsi)	1400	Lindsey, 1986
Great frigatebird (Fregata minor)	865(m) – 1500(f)	Smith, 1998
Least frigatebird (Fregata ariel)	650(m) – 860(f)	Smith, 1998
TROPICBIRDS		
Red-tailed tropicbird (Phaethon rubricauda)	700(m) – 810(f)	Smith, 1998
White-tailed tropicbird (Phaethon lepturus)	820	Lindsey, 1986

m = male
f = female

APPENDIX B

HAEMATOLOGY AND BIOCHEMISTRY REFERENCE RANGES FOR SELECTED SEABIRD SPECIES

Test	Units	Little penguin[+]	Wandering albatross[†]	Australian pelican[†]	Australasian gannet[†]
WBC	**$x10^9/l$**	12.62±10.64	17.86±3.55	21.17±12.22	25.57±14.47
RBC	**$x10^{12}/l$**	1.97±0.43	1.94±0.45	2.62±0.56	2.024±0.52
Haemoglobin	**g/l**	191±37		227±21.1	136(n=1)
PCV	**%**	43.2±6.0	35.8±3.35	45.1±5.74	35.56±7.7
MCH	**pg/cell**	99.7±33.6		89.29±13.34	87.18(n=1)
MCHC	**g/l**	463±79		538±26.4	453(n=1)
MCV	**fl**	227±50.7	189.9±30.19	176.1±26.09	180.2±35.19
Heterophils	**$x10^9/l$**	6.37±7.06	12.11±3.46	23.0±21.14	16.85±7.85
Lymphocytes	**$x10^9/l$**	4.52±2.13	3.86±1.59	5.58±4.92	4.19±4.0
Monocytes	**$x10^9/l$**	0.60±0.74	1.3±1.08	1.47±1.24	3.02±4.21
Eosinophils	**$x10^9/l$**	0.38±0.63	0.45±0.51	0.65±0.43	0.47±0.41
Basophils	**$x10^9/l$**	0.4±0.4	0.32±0.12	0.66±0.49	0.32(n=1)
Thrombocytes	**$x10^9/l$**		18.54±8.18	26.0±18.7	18.4±9.05
Glucose	**mmol/l**	9.71±4.16	12.6±2.17	6.52±5.51	14.5±6.13
Creatinine	**μmol/l**	398±371	375±208	58.2±15.2	47.4(n=1)
Uric acid	**mmol/l**	1.19±0.71	1.17±0.62	0.81±0.70	1.09±0.42
Calcium	**mmol/l**	2.45(n=1)			
Phosphorus	**mmol/l**	2.97(n=1)			
Sodium	**mmol/l**	5(n=2)			
Potassium	**mmol/l**	4.5±0.6		3.25±1.15	4.09±0.52
Cholesterol	**mmol/l**	3.02(n=1)			5.59(n=1)
Total protein	**g/l**	46.3-53.3*	48.8±11.5	46.3±10.1	29.6±17.1
Albumin	**g/l**	28(n=1)			
Globulin	**g/l**	50(n=1)			
AST	**U/l**	414±134	4656±4981	533.3±1069	1410±1541
ALT	**U/l**	16(n=1)		41(n=1)	
ALP	**U/l**	338±155			
LDH	**U/l**	1032(n=1)			
CPK	**U/l**	290±200		1928±3685	

[+] International Species Information System
[†] Taronga Zoo
* range

APPENDIX C

MEDICATIONS USED IN BIRDS

Name	Dose/Route	Comments
ANTIBIOTICS		
Amoxycillin injectable Amoxycillin palatable drops Clavulinic acid and Amoxycillin	100-150 mg/kg q 24 hours SC 100-150 mg/kg q 12 hours PO 125-150 mg/kg q 12 hours PO or q 24 hours IM	Good broad-spectrum antibiotics for wounds and systemic infections.
Amikacin injectable	20 mg/kg q 12 hours IM	Can be diluted to 25 mg/ml with sterile water. Effective against gram negative organisms.
Piperacillin injectable	100-200 mg/kg q 12 hours IM	Broad-spectrum synthetic penicillin. Can be used in combination with aminoglycosides. Reconstituted drug must be kept frozen.
Oxytetracycline injectable 50 mg/ml Oxytetracyclin injectable 200 mg/ml (long acting)	100 mg/kg q 24 hours SC 50 mg/kg q 3-5 days SC	Can cause muscle necrosis. Good for respiratory infections, especially if chlamydiosis is suspected.
Tylosin injectable	10 mg/kg q 12 hours IM for 5 days	Used for mycoplasma infections.
Enrofloxacin	15 mg/kg q 12 hours IM 30 mg/kg q 12 hours PO	Use with care in young growing birds.
Doxycycline powder Doxycycline injectable	25-50 mg/kg q 24 hours 10 g/l in water medication 75-100 mg/kg q 7 days IM	A broad-spectrum antibiotic. Good for respiratory infections, especially if chlamydiosis is suspected. Treat for 45 days with chlamydiosis.
Trimethoprim 40 mg, Sulphamethoxazole 200 mg/5 ml oral suspension	6-9 ml/kg q 12 hours	
Lincomycin/spectimonycin	50 mg/kg q 24 hours IM for 5 days	
Cefotaxime	100 mg/kg q 8-12 hours IM or IV	
Cephalexin oral drops	35-50 mg/kg q 6 hours PO	

MEDICATIONS USED IN BIRDS cont.

Name	Dose/Route	Comments
ANTIFUNGALS		
Nystatin suspension 100,000 IU/ml	300,000 IU/kg q 8-12 hours PO	Treatment for candidiasis. Works by direct contact with lesions. Therefore, put directly on mouth lesions and give on an empty crop. Not absorbed.
Amphotericin B injectable 5 mg/ml	1.5 mg/kg q 24 hours IV or SC 1 mg/kg q 24 hours intra-tracheally (IT). To nebulise, take 0.5 ml Fungizone (5mg/ml), and make up to 3ml with sterile water. Nebulise for 20 minutes q 12 hours.	Treatment for aspergillosis. Can use in combination with fluorocytosine. Potentially nephrotoxic, therefore fluids may be required. Can be used for 7-10 days. For IT route, dilute 50:50 with sterile water to increase volume for maximum distribution in lungs and air sacs.
Amphotericin Oral suspension 100mg/ml	100-200mg/kg q 6-8 hours PO	Treatment for GIT candidiasis. Empirical dose. Not absorbed, therefore no nephrotoxic effects. Best given between feeds as requires direct contact with lesions.
5-Fluorocytosine 250 mg tablets	100 mg/kg q 8 hours PO	Adjunct therapy for aspergillosis.
Ketoconazole	25 mg/kg q 12 hours PO	For aspergillosis and for candidiasis not responding to Nystatin. **Note**: Do not use in combination with Amphotericin-B.
Fluconazole syrup (5 mg/ml)	8 mg/kg q 12 hours PO	Transient vomiting may occur.
Itraconazole 100mg capsules	20mg/kg q 12 hours PO (therapeutic dose) 20mg/kg q 24 hours PO (prophylactic dose)	For treatment and prophylaxis of aspergillosis. See procedure for compounding oral liquid.
Chlorhexidine 5% solution	1 ml/l drinking water for 5-10 days	For treatment and prevention of candidiasis.

MEDICATIONS USED IN BIRDS cont.

Name	Dose/Route	Comments
ANTHELMINTICS		
Fenbendazole 25 mg/ml	50 mg/kg q 24 hours for 3 days or 100 mg/kg single dose or in food	For ascarids - repeat treatment in 2 weeks. For capillaria - may need 5 days treatment, not always effective. Do not use during moult as can stunt feather growth.
Ivermectin	0.2-1 mg/kg IM, PO or on skin	Effective against intestinal nematodes (except capillaria), Cnemidokoptes, and air sac mites.
Levamisole (Nilverm Pig & Poultry wormer)	50 ml/l drinking water or 40 mg/kg single dose (use undiluted)	Useful in Columbiforme and Galliforme birds. Other brands of levamisole, eg Avitrol tablets can be used at 40mg/kg.
Praziquantel	10 mg/kg PO 0.08 ml/500 g IM	Most effective treatment for tapeworms. Injectable can be used orally at 10 mg/kg.
Albendazole 113 mg/ml	50 mg/kg q 24 hours for 3 days or 100 mg/kg q 24 hours single dose	Has been effective against capillaria.
Netobimin 35 mg/g (Hapavet)	4 g/400 ml drinking water for 5 days	To be given as the **only** source of drinking water.
ANTIPROTOZOALS		
Amprolium & Ethopabate	3 ml/l for 1 week then 2 ml/l for 1 week, then 1 ml/l for 1 week in drinking water	For the treatment of coccidosis.
Toltrazuril (Baycox Solution 2.5%)	0.1ml/100 g single dose, or 1 ml/l in drinking water for 2 days.	For the treatment of coccidiosis.
Metronidazole 5 mg/ml	10 mg/kg q 24 hours PO for 7 days	For the treatment of Trichomoniasis, Giardiasis and Hexamitiasis.
Dimetridazole	Make up 3% solution (3g powder/l) and give 0.5 ml/ 50g q 24 hours for 5 days	Narrow safety margin.
Carnidazole	1 tablet/300 g single dose	For trichomoniasis. Remove all food and water overnight. Dose the following morning. No water to be provided for next 2-3 hours.

MEDICATIONS USED IN BIRDS cont.

Name	Dose/Route	Comments
ANALGESICS AND ANTI-INFLAMMATORIES		
Flunixin - meglumide (injectable 50 mg/ml)	1.0-10mg/kg IM q 24 hour	May cause renal ischaemia in some species at higher doses
Ibuprofen	5–10mg/kg PO	
Ketoprofen	2mg/kg IM	
Carprofen	1–2 mg/kg PO or IM q 12 hour	
Meclofenamic acid	2.2mg/kg PO q 24 hour	
Acetylsalicylic acid	5mg/kg PO q 6-8 hour	
Dexamethasone	1-2mg/kg IM	
Betamethasone	0.1mg/kg IM	
Methylprednisolone acetate	0.5-1mg/kg IM or intra-articularly	
Prednisolone (5 mg tablets)	0.2 mg/30 g or 1 tablet in 2.5 ml water and give 2 drops q 12 hour PO	Anti-inflammatory, use decreasing dosage schedule in long-term therapy.
MISCELLANEOUS DRUGS		
Dexamethasone 2 mg/ml	2-4 mg/kg q 8 or q 12 or q 24 hours IV or IM	For shock and trauma, particularly if the bird is showing neurological signs.
Calcium EDTA (Calsenate)	30-60 mg/kg q 12 or q 24 hours IM	For treatment of lead and zinc toxicity. Treat until bird is asymptomatic.
Calcium glubionate/ lactobionate (Calcium Sandoz Syrup)	0.1 ml/100 g q 24 hours PO	For treatment and prevention of calcium deficiencies and egg binding.
Vitamin B Complex	Dose by thiamine content 10-30 mg/kg IM or SC once a week	For debilitation, anaemia, stimulate appetite, neurological disorders.
Bromhexine hydrochloride (injectable 3 mg/ml)	0.05 ml/100 g q 12 hours or q 24 hours IM	Liquefy respiratory mucus.
Diazepam (injectable 5 mg/ml)	0.6 mg/kg IM or IV as needed	Anticonvulsant.
Metamucil	½ teaspoon in 60ml strained baby food	Assists in removal of lead particles from gastrointestinal tract.
Mineral oil (liquid paraffin)	3-5ml/500g	Assists in removal of lead particles from gastrointestinal tract.
Magnesium sulphate (epsom salts)	0.5 – 1g/kg or 5% solution in drinking water	Precipitates lead and acts as a cathartic.
Sodium sulphate	1mg/kg PO	Cathartic

PROCEDURE FOR COMPOUNDING ITRACONAZOLE ORAL LIQUID

Ingredients

1. 1 x Sporanox 100mg capsule
2. 0.1ml x 0.1 Normal hydrochloric acid. To prepare 0.1 NHCl add 1ml NHCl (32%) to 100ml de-ionised water.
3. 0.9ml water

*Note: to make a useful amount, times all by 10
ie. 10 capsules
1ml 0.1 NHCl
9ml water

Method

1. Empty contents of capsule into a suitable mixing container
2. Add NHCl and mix
3. Leave to stand for at least 1 hour
4. Mix to a paste, gradually adding water. This makes a thick liquid of 100mg/ml concentration. To make an easier consistency dilute with a further 10ml of water making a 50mg/ml concentration.
5. Label container with drug name, date made up and concentration.
6. Keep refrigerated

APPENDIX D

CAPTIVE CARE AND REHABILITATION OF SHEARWATERS AT CURRUMBIN SANCTUARY

Susanne Whyte, Senior Veterinary Nurse, Currumbin Sanctuary, Queensland

Currumbin Sanctuary's Wildlife Hospital receives on average 27 (between 8 and 50) Wedge-tailed Shearwaters *(Puffinus pacificus*) and 48 (between 5 and 100) Short-tailed Shearwaters (*Puffinus tenuirostris*) every year, admitted for exhaustion, illness or injury. Their care and husbandry has proven to be slightly different to that of other seabird species which are admitted by Currumbin Sanctuary for rehabilitation. The key factors involved in successful shearwater rehabilitation are strict hygiene, regular fluid administration, careful force-feeding and stress minimisation. Understanding the special requirements of these species has increased the success rate in preparing them for release.

Natural History

The Wedge-tailed Shearwater is a medium sized dark brown to blackish petrel occurring along the east and west coasts of Australia, and throughout both Indian and Pacific Oceans. It is a pelagic species that breeds in colonies between late spring to mid summer on islands off the coastline of Australia. Each nest consists of an unlined burrow with the entrance often concealed by vegetation. The dispersal away from the breeding grounds is unknown, however, a few banded birds have been found in the central western Pacific region.

The Short-tailed Shearwater is a medium sized dark grey to blackish petrel that occurs in southern and southeastern Australia. Also a pelagic species, it breeds in colonies between late spring to late summer, mostly on islands in the southern and southeastern regions of Australia. They have a defined migration away from the breeding grounds through the Pacific Ocean to the Berring Sea in enormous flocks, often numbering millions of birds.

The adults of both shearwater species abandon the nestlings two weeks prior to fledging, after load feeding the young. The fasted fledgling upon leaving the burrow must feed. Fledgling mortality is high during this period with many birds unable to feed due to bad weather, poor food stocks or waterlogging because of the down remaining on the bird. Some individuals are simply poorly adapted.

Presentation

Shearwaters admitted to Currumbin Sanctuary for care is a seasonal occurrence. The peak season is late April and May, with a less concentrated season during January. Occasionally birds are presented at other times of the year. They are found by the general public on the beach wet and exhausted. Debilitated birds unable to fly come to shore with the tide. An unknown number of these debilitated birds are eaten at sea or are washed ashore dead.

Assessment

When a shearwater is admitted it is best to allow the bird to stabilise in a warm dark environment for about an hour prior to assessment. After that hour the shearwater should be weighed, body condition assessed and clinically examined. The veterinary examination most often reveals immature, weak, dehydrated, emaciated birds with plumage problems (such as remaining down). The occasional fractures and anthropogenic problems such as fishhooks are also seen. The treatment is then instigated and a rehabilitation plan developed; the shearwater is euthanased if the prognosis is assessed as poor.

Although faecal wet preparations and flotations are usually negative parasites are usually present. About 2/3 of shearwaters necropsied have trematodes in their kidneys. Cestodes are often present in the small intestine. Renal coccidiosis is also a frequent finding. Pneumonia is also seen in some birds, possibly secondary.

Reduction of stress, fluid administration and force-feeding is the major part of the shearwaters rehabilitation. Stress is an important factor to consider during rehabilitation and should be minimised as much as possible by handling only when necessary, keeping the birds in a quiet environment, and keeping a regular routine with feeding and giving fluids. The rehabilitation plan should be developed outlining the treatment, feeding and fluid administration, increases in daily food intake, an estimate for when the bird should be moved to a larger outdoor cage for swimming exercise and a target release date.

Hospital Husbandry and Housing

Initially, each bird should be housed individually in a warm (approximately 28˚C), dark cage with visual security (cover the cage to avoid the bird seeing people unnecessarily). The cages used at Currumbin Sanctuary for this purpose are moulded fibreglass cages (each a 50cm cube) with stainless steel doors. The cage substrate is an absorbent towel changed once or twice a day, to reduce the chance of pododermatitis, feather damage and other infections.

Handling

Shearwaters should be handled deftly, firmly but for as short a time as possible to reduce stress on the bird and injury to the handler. They do bite, and when large numbers are in care it can become rather trying to be bitten too often. The first finger and the middle finger should be positioned on either side of the head to restrain any neck and head movement without restricting the bird's breathing. The other hand is used to control the wings and legs while supporting the body at the same time. A different method for restraint is used if the handler is feeding or giving fluids to the bird. The bird is wrapped in a towel to prevent the wings flapping and then the bird is tucked firmly between the handler's knees, thus leaving both hands free. Any procedure should be done as quickly as possible and the bird placed back in the cage to minimise stress and prevent regurgitation.

Oral Fluid Administration

Currumbin Sanctuary has had most success with using Spark-Electrovet (Vetafarm®), an oral carbohydrate and electrolyte supplement. It is dissolved in water at the recommended dose rate and administered via a long crop needle at the rate of 10-15% of the bodyweight per day, divided into three doses. This product is isotonic and of very high energy value and is one of the easiest ways to rehydrate the bird quickly.

Feeding

Shearwaters often will not self-feed in captivity, however a plate of fish should be left in the cage to find out which ones do. In the majority of cases fore feeding three times a day is required to ensure adequate nutrition and recovery.

The two main fish types fed to the shearwaters are quick frozen white pilchards (whitebait) and small school whiting. The fish are thawed in a refrigerator before use and discarded if not used within 24 hours. Thawing frozen fish in water leeches nutrients from the fish with warm water increasing this effect, so this method of thawing is avoided.

Each fish should be lubricated with a 3% salt solution and then introduced into the bird's mouth head first, and pushed down past the pharynx with a finger. The bird's beak is then held closed and the bird given time to swallow the fish. Sometimes it is necessary to gently massage the fish further down by rubbing the throat area in a downward motion.

Oral fluids are given a couple of hours prior to force feeding to enable it to be absorbed. The feeding regime varies depending on the bird, but as a guide three fish are given three times a day for the first day. This amount of fish then increases by three to six fish each day up to a total of 30 fish a day (or 10 fish per feed).

Each bird is given Multivet Caplets (Vetafarm®) at a rate of ½ a tablet per kilogram bodyweight. These tablets can be directly given per os or hidden in the force feed fish. The addition of this multivitamin is essential to the shearwater's recovery as many nutrients are lost or destroyed in the freezing and thawing process.

It is also vital to the shearwater's health to maintain salt ingestion. Shearwaters, like other tube-nosed seabirds have a nasal salt gland, located under the skin on the head of the bird. This gland is used to excrete salt enabling seabirds to drink seawater. If the seabird stops ingesting salt for prolonged periods of time, this gland with atrophy through disuse and not function properly. A bird without a properly functioning salt gland will invariably die after release from excess body salt. Shearwaters are supplied with salt water either in their fish or via a crop needle and the water offered in the cage is 3% salt solution.

Disease prevention

The shearwaters are regularly examined and monitored through their hospitalisation. Their body weight is taken daily and any sign of ill health such as fluffed appearance, foot problems, excessive regurgitation etc are quickly brought to the veterinarians' attention. Hygiene is vital with the cages cleaned and disinfected daily with the soft absorbent floor covering changed more regularly. Between each bird the handler's hands are washed and the utensils disinfected. A faecal examination is carried out on each bird and treatment given where required.

Larger seabirds are routinely given itraconazole (Sporanox®) to prevent aspergillosis. This is not a routine with the shearwaters, and to date there have been no signs of this disease on post mortem.

The Rehabilitation Process

When the shearwaters are stabilised (gaining weight and accepting fish without regurgitation) they are ready to be moved from the hospital to an outdoor enclosure with a pond. The shearwaters are grouped together so each bird is made identifiable by spraying stockmark colour spray on their body or leg banding with removable bands. This ensures continued monitoring of their body weight and their individual progress.

The enclosure used for rehabilitating shearwaters (and indeed other seabirds) is a large outdoor aviary 8m long x 2m wide x 2.5m high, enclosed with 10mm x 20mm mesh. The external enclosure has a substrate of river sand and contains a fibreglass pond 2.9m long x 1.8m wide x 0.4m deep. There is a secure cubicle (2m x 2m x 2.5m high) at one end of the aviary that has a concrete floor sloping towards a drain. The doors of this cubicle can be closed or left open depending on the shearwaters and the weather. The ambient temperature within the cubicle is usually between 22-25 ˚C and maintained by a 175 Watt heat lamp at one end. Shearwaters do not seem to cope with the extremities of temperature in captivity. The concrete floor is covered with rubber matting and then absorbent towels to lift the birds off the cold floor and for ease of cleaning.

The pond is sloped and has rubber matting placed on the slope to allow the birds to move freely in and out of the water. The water is a 3% salt solution and the birds will often drink during their swim. The pond water is changed daily or every second day when there is only a small number of birds in the enclosure.

During the day the shearwaters are allowed access to the pond as well as to the security of the cubicle. The cubicle door is locked at night, in cold weather or very wet weather, or if the group has only just been introduced to the enclosure.

Once accustomed to their new enclosure, the shearwaters are subjected to a regular routine of feeding and fluids three times a day. After the morning and noon feeds, the birds are placed into the pond for a bathe and drink. Access to the water to preen and exercise is an important part of the rehabilitation process, as the birds need clean and well oiled feathers. The shearwaters' progress is monitored by weighing the birds every second day.

Pre-release assessment and Release

Another thorough veterinary examination should be carried out prior to release. Unfortunately, it is difficult to assess flight ability, as the shearwaters need a large area and often a good wind to take flight. The birds should have clean, strong waterproof plumage and they should have a good pectoral mass over the keel. The bodyweight should be around 350g (between 280g and 420g). Any previous injuries must be healed and there should be no abnormalities in the limbs, feet, eyes or mouth. The bird's demeanour should be bright and active, waddling away or emitting a defensive nasal braying sound when approached.

Time of release

To give shearwaters the best possible chance, it is preferable to choose a windy, sunny morning for release. It is important to be well prepared and have the release carefully planned. Weather forecasts should be checked in case of impending storms, as heavy rain could disorientate the birds bring them back to shore or cause their inability to feed.

Release site

Currumbin Sanctuary releases shearwaters at the mouth of a nearby estuary. A small motor boat takes the birds almost to the mouth of the river where there are reasonable gusts of wind. A few birds at a time are placed gently into the water near the boat and observed. Initially most of the shearwaters swim a short distance then bathe and drink. Some individuals will then fly off straightaway and others may take up to two hours to leave. It becomes evident that the occasional shearwater was unsuitable for release, often with insufficient water proofing, as they appear wet and unable to fly. These birds must be caught again, reassessed, and possibly released in a few more days. Recapture of floating shearwaters can prove to be very difficult and requires much patience, as they will dive. The boat must be carefully manoeuvred close to the bird where a handler can grab it. Sometimes a fishing net can be useful (a conventional bird net travels too slowly through the water). At no time is a bird that has not taken a successful flight left to take its chances in the estuary.

Success

It is unfortunate that Currumbin Sanctuary (at present) has no program, such as banding, to monitor the success of the released shearwaters. In the meantime we can only assess and improve the numbers of shearwaters rehabilitated and released. This success is directly related to strict hygiene, regular fluid administration, careful force-feeding and stress minimisation.