Penguin Conservation

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Penguin Conservation

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Please address all correspondence to:
Cynthia Cheney, Editor
Penguin Conservation
8060 Upper Applegate Rd.
Jacksonville, Oregon 97530
USA
phone: 541/899-1114
fax: 541/899-1131
e-mail: editor@faunapub.org

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Protective laws for the Galapagos

The Ecuadorian government has approved a series of measures for the Galapagos Islands which have been hailed as the biggest milestone toward their conservation in the last half century. The Galapagos Conservation Law—signed by Ecuadorian President Fabian Alarcon despite strong opposition—establishes extensive protective measures for the islands made famous by the work of Charles Darwin.

It strengthens protection of the islands by expanding the protected waters around the archipelago from 15 miles to 40 miles; banning industrial-scale fishing within protected waters; limiting permanent resident status to Ecuadorians who have been on the islands for five years or more; approving the island’s first inspection and quarantine system to combat “invader” species such as rats and goats which threaten native species and degrade the habitat; and mandating that 50 percent of tourist dollars support island conservation. (40% to the Galapagos National Park Service continued on page 21)

Penguin photos wanted

Colour photographs of Galapagos and Humboldt Penguins are required for a forthcoming book. Would anyone who has suitable photographs please contact me by Fax: (+ 500) 21960 (Falkland Islands) or E-mail: mbingham@horizon.co.fk —Michael Bingham, Environmental Research Unit, Falkland Islands

Air Force captain honored for penguin rehab work

Public relations officer Captain Mariette Hopley, of the Ysterplaat Air Force Base in South Africa, recently became the first recipient of the Wouter van Hoven trophy, an award to honor air force members for outstanding services to environmental conservation.

Hopley was awarded the floating trophy named for Professor Wouter van Hoven of the Center for Wildlife Management at the University of Pretoria, for her management of penguin rehabilitation after the 1994 Apollo Sea and, particularly, the 1996 St Croix Island oil disasters.

Hopley undertook the St Croix project when the South African...
Introduction

Over the last five years, SeaWorld California has made significant changes to its penguin chick hand-feeding diet and hand-rearing guidelines for small penguin species. These protocols have been used successfully to raise gentoo, Adélie, chinstrap, macaroni, Magellanic, and Humboldt penguins.

We have distributed these new materials as people have requested them. We are now submitting them to Penguin Conservation to ensure a wider dissemination of the information.

The most noticeable change to the penguin chick “fish milkshake,” or formula is the absence of half and half cream. This ingredient was removed from the formula in 1993. There was some concern initially that removing such a high fat and high calorie component of the formula would result in lower weight gains in the chicks. This proved not to be the case. Weight gains have been equal to or greater than those of first generation chicks which were raised on the original formula. Chinstrap penguins have shown a marked improvement on this formula, fledging at twice the expected, a decrease in gastrointestinal problems since removing dairy products from the diet. Without the half and half cream, the formula can now be warmed to a slightly higher temperature which is more easily absorbed, especially by younger chicks.

In 1995, we began adding fish pieces to the chicks' diet when their morning weight was 100 g or more, instead of at 200 g. Adult weight as had been done previously. When chicks are healthy and vigorous, this change has worked well. In a few cases, where a chick is progressing more slowly than normal or is ill, we have had to delay the introduction of fish. After the first or second fish feeding, it should become clear—through monitoring of feces production and behavior—whether the chick is able to process the fish.

There has also been a major procedural change in feeding technique, since the last published guidelines (“Hand-rearing Guidelines for the Humboldt Penguin,” Spheniscus Penguin Newsletter, August, 1991: 2-6). We no longer tube-feed healthy chicks. After the feeding response begins, the syringe is placed in the open mouth with the tip at the back of the mouth and the formula is squirited in (see description under section III.2). Two and one-half centimeter-long catheter tube extensions are used for 6 cc and 12 cc syringes, for ease of feeding with these wider diameter syringes.

The following are procedures currently in use at SeaWorld California for hand-rearing penguins. They are intended to be used as guidelines. Depending on the physical plant, availability of products and materials, and the individual needs of chicks, modifications to these guidelines might be necessary.

I. Eggs

Adélie, chinstrap, and gentoo eggs are incubated at 96.5° F (35.8° C) dry bulb, 81-82° F (27.2-27.8°C) wet bulb (52% relative humidity). Macaroni, Magellanic and Humboldt eggs are incubated at 96.5° F (35.8° C) dry bulb, 82-83° F (27.8-28.3°C) wet bulb (55% relative humidity). This may need to be adjusted, depending on type of incubator, local humidity, altitude, number of eggs in incubator, etc.

Pip-to-hatch interval for Adélie and chinstrap eggs is approximately 24-48 hours; for gentoo eggs it is usually less than 24 hours, for macaroni eggs approximately 24-72 hours, and for Magellanic and Humboldt eggs approximately 36-60 hours.

II. Chick husbandry

1. Hatchlings and young chicks

Once hatched, chicks are allowed to dry in the hatcher. Check for yolk sac absorption and closure of the seal. If the yolk sac is not properly absorbed and/or the umbilical opening is not properly closed, be extremely careful handling the chick. Swab the umbilicus with a sterile povidone-iodine swab by rolling the swab gently over the area. Continue this at each feeding until the umbilicus is completely dry/healed.

Chicks should not be moved from the hatcher for their first water feeding until at least 12-24 hours after hatching. They are then placed in a brooder with a heat source (such as a 250-watt infrared heat lamp). Those under 7 days of age tend to wander away and get lost from heat; a rolled towel that functions as a barrier can keep them near the proper heat range.

Chicks younger than 14 days of age should be kept at approximately 80-90° F (26.7-32.2°C), depending on age, weight, and thermoregulatory needs. Chicks older than 14 days are usually kept at approximately 70-80° F (21.1-26.7°C), again depending on

the individual chick's needs, as well as the species.

Chicks are usually ready to be moved from the brooder to the bin at 400-500 g first morning weight. Do not crowd the chicks. For example, 1-3 young chicks fit comfortably in the brooder described below. A maximum of 5 young chicks should be in the brooder at one time.

The brooder used at SeaWorld is an open-topped and open-bottom, plexiglas frame measuring 16 in. (40.6 cm) wide, 33 in. (83.8 cm) long, 15 in. (38.1 cm) high, set 36 in. (91.5 cm) above the ground on a painted wooden cabinet. The plexiglas frame is removable for cleaning. Other materials, such as painted and sealed plywood, or plastic storage containers without lids, may also be used for a brooder.

It is important that the brooder be open-topped rather than an isolette-type, closed baby incubator. Penguin chicks require the lower humidity and good air circulation allowed by the open-topped brooder.

2. Brooder hygiene

The brooder is cleaned thoroughly and completely twice a day (at early morning and mid/late afternoon feedings). During cleaning, chicks are placed in a clean, dry, disinfected plastic container with a cotton/terry towel and heat source. The brooder is scrubbed clean with Betadine® surgical scrub (see Appendix C for product list), rinsed, and dried; then two layers of clean towels, without holes or frayed areas, are placed down on the bottom. Frayed towels may catch a chick's toenails. A layer of Dri-dek® (see Appendix C) may be placed under the towels to give chicks better traction.

At those feedings when a complete cleaning is not done, the sides of the brooder should be wiped clean of fecal matter and the soiled towel (top layer) removed, leaving the chicks on a clean towel.

3. Bins

When bins (see description below) are in use they too are thoroughly cleaned twice a day. Chicks are placed either in an empty, clean section of the bin or in another holding area with towels during cleaning. The bin is scrubbed clean with Betadine® surgical scrub, rinsed with a hose, sprayed with Pro-Clean 200™ disinfectant (an Iodophore, see Appendix C), and wiped dry.

Clean mats (feltlike, indoor/outdoor matting cut to size for bins) and towels are placed on top. Rockery rocks—river rocks approximately 1.5 in. (3.8 cm) in diameter—and towels are also sometimes used in the bins. Towels need to be changed at every feeding or more often if excessively soiled or wet.

When chicks start to become warm in the bins, ice or ice packs may be added to a section of the bin. Ice is not placed on mats or towels because they get wet as the ice melts. Ice packs are placed under or wrapped in towels to avoid slipping. Note: Ice is not used for Spheniscids.

The bins used at SeaWorld are wooden-sided with Ampligrip 201™ (a metal grate-like surface, see Appendix C) on the bottom. Two sheets of Ampligrip with approximately 1 in. (2.5 cm) holes are overlapped thereby making the holes in the bottom of the bin approximately 0.25 in. (0.64 cm). Bins are raised on legs approximately 6 in. (15.2 cm) above ground for drainage. They are 8 ft (2.4 m) long; 4 ft (1.2 m) wide and 2 ft (0.6 m) deep, with wooden partitions which are used to divide the bin into quarter- or half-sections as needed.

Once they are ready, chicks are moved to a larger holding area with more space to move around and pool access. Cleaning of this area follows the same basic procedure as bin cleaning. Whenever mats are placed on solid flooring, Dri-dek® should be placed beneath the mats for drainage.

4. Heat lamps

When setting up or adjusting a heat lamp, always make sure that the lamp is secured, and that wires are not touching the lamp. Heat lamps should be placed no closer than 3 ft (0.9 m) to chicks, or other surfaces, otherwise severe burns may result. The temperature in a brooder or a bin with a newly installed heat lamp should be stabilized for several hours before putting in a chick.

5. Temperature regulation

The temperature is lowered in brooders as chicks approach 500 g. They will begin to appear warm in brooders and may be moved to a bin and a much cooler environment at this time, i.e. a refrigerated/cool space at ~60°F (15.6°C).

Spheniscids may stay in a warmer environment, i.e. room temperature of ~65-70°F (18.3-21.1°C), with a fan to circulate the air.

At approximately 1000 g, the temperature is reduced further as needed. Then, as chicks approach completion of first moult, they are given access to a pool. We begin introducing chicks to the exhibit at this time, initially with keeper supervision.

Always be aware of the possibility of over/under heating in the chicks. Overheating may be indicated by any of the following: a spread out posture, with feet and flippers extended and/or very warm to the touch; panting; lethargy; dehydration (see below); and disinterest in food. If overheated, the chick may shiver, huddle against the side of the brooder directly under the heat lamp, have feet and flippers drawn in and/or cool to the touch, and be slow to respond to feeding stimulus.

Many of the above signs can also be indicators of illness in a chick. Keepers should be on the lookout for any behavior or physiological sign that deviates from normal. Be conservative and wary; problems are often much easier to solve if caught early.

continued on page 4
6. Overfeeding/underfeeding

Even though a chick is being fed according to stated guidelines, over- or underfeeding is still a potential concern. This problem is best caught by careful evaluation of the chick’s weight gains. Generally, expected weight gain could range from 10%-15% per day (individual variation will occur) until the chick reaches approximately 1000-1500 g, at which time, depending on the individual chick and species, growth rate will slow. Behavioral signs of overfeeding might be indicated by the chick refusing food, being lethargic, spitting-up repeatedly, etc.

When giving a normal, healthy feeding response, a chick should be eagerly swallowing the food and stretching up to reach it. When giving a poor feeding response, a chick will not open its bill to eat and will often move its head away from the feeder’s hand to avoid food.

7. Hydration

Hydration should be monitored carefully throughout the chick’s development and particularly as the chick begins eating fish pieces/whole small fish. The morning is a critical time to check hydration. To determine hydration, we use a four-point system:

a) skin-tent test: pinch skin up at the top of the chick’s back—the skin should immediately fall back into place. The longer the skin stays “tented” up, the more dehydrated the chick is.

b) eyes: eyes should appear bright, wide, and moist (not runny)—if they are dry or “drawn” around the edges, the chick could be dehydrated.

c) feet: the skin on the feet will have normal scaling associated with rapid growth, but it should appear soft and smooth; if skin is “shriveled” and/or appears dry, the chick could be dehydrated.

d) feces: thick or pasty feces may also indicate dehydration.

8. Feces

It is important to examine a chick’s feces routinely. A normal young chick (on formula, not fish) will have slightly runny feces that “squirt out” a good distance during defection, with an orange/brown color (orange resulting from the krill and vitamins in the formula). Reddish oil droplets in the feces are also normal if krill is in the diet. An older chick which is eating fish will have slightly thicker feces, but still quite soft in appearance.

Feces should not be pasty, dry, pellet-like, excessively green, black, or yellow, or contain blood—any of these indicate a problem.

In a young chick (first few days of life), all defections should be recorded.

It is normal for a chick to defecate at least once between every feeding—often while being fed. If any doubt exists as to whether a chick is defecating normally, it should be stimulated to defece by gently massaging the cloaca with a wet finger. If a chick is suspected of being ill, it should be isolated from other chicks; this way defections can be positively identified.

9. Safety

Chicks should not left on a high surface (i.e. counter, table, scale) unattended, even in a container.

10. Handwashing

Keepers’ hands should be washed with Betadine surgical scrub or other bactericidal/virucidal hand wash before feeding or handling any chick.

11. Recordkeeping

Complete records for each chick are of utmost importance. Record the amount fed, the quality of the feeding response, activity level and other behavioral observations at each feeding. Important information regarding the chick’s development should also be recorded in its file (e.g. record when the chick’s eyes first open, the stages of moult and the date when the bird is 100% moulted).

12. Weighing

Chicks are weighed at least once daily, before the first feeding of the day, until being moved into the exhibit permanently after moult. We recommend that young chicks be weighed with the scale in the brooder so that they do not get cool. If there are special concerns about whether a very young chick is processing food, a chick can be weighed prior to each feeding until it reaches approximately 400 g morning weight.

Once the chick is left in the exhibit full-time and is eating well it is weighed every 5 days, unless more frequent weighing is indicated. Weighing continues until the bird is judged to be acclimated to the exhibit and its weight has stabilized. Each bird is evaluated on an individual basis. If at any time there is a concern regarding the health of a bird, more frequent weighing is resumed.

III. Feeding

Penguin hand-rearing diet

The recipe for the formula, or “SeaWorld Fish Shake” is given in Appendix A.

1. Preparation and hygiene

All utensils, containers, etc., used to prepare formula are thoroughly washed in dish-soap and hot water, soaked in Pro-Clean 200™, rinsed in hot water, and air-dried before use. Unheated formula should be refrigerated until use and will remain fresh for approximately 24 hours.

The formula to be fed is heated by setting the container in hot water until the temperature reaches approximately 95° F (35° C). For very young or finicky chicks, formula may need to be heated to 98° F (36.7° C). Formula must be stirred continually during the heating process to prevent curdling. If curdling occurs, dispose of that formula. Do not boil. Do not reheat. The unused portion of heated formula should be discarded. When feeding several chicks, the formula...
container is placed in a warm water bath to maintain temperature.

The consistency of the formula is important. If it is too watery, chicks older than 3-4 days may regurgitate during or after feeding. When made properly, formula should be the consistency of a thick milkshake. For chicks from 3 days of age to 400 g AM weight, stir in 1 pinch of ground vitamin B per 100 cc of formula prepared, just prior to feeding. (See Appendix B for Vitamin Regime.)

Each chick should be fed with its own syringe. The size of the syringe used is increased as the chick grows; e.g. 1 cc, 3 cc, 6 cc, 12 cc, 60 cc with catheter tip.

Syringes need not be affixed with feeding tubes. However, it is often convenient, when using the 6 cc and 12 cc syringes to affix a section—no longer than 1 in. (2.5 cm)—of feeding tube. For this purpose, use size 12 or 14 French, (4.0-4.7 mm). Glue the feeding tube to the syringe with instant bonding glue to prevent the tube from coming off and being swallowed by the chick.

Syringes are washed, soaked in disinfectant (Wavicide-Ol ®, see Appendix C), rinsed, and air-dried between each feeding. Syringes do not need to be dipped in disinfectant between each drawing up of formula; the feeder can wipe the syringe with tissue or a towel to remove residue. Separate containers of formula are used to feed from for each “group” of chicks (chicks living in the same brooder or bin).

Chicks are fed from youngest to oldest so that the youngest chicks receive the warmest formula. The exception is in the case of an ill bird, which is fed last to avoid contaminating the feeding area.

2. Early Feeding

We give 5 feedings per day, every 3 hours. For the very first feeding it is recommended to feed water only. This allows determination of the chick’s initial vitality, and introduces the chick to feeding from the syringe.

Young chicks should be fed in a clean, warm, draft-free area. All feeding materials should be prepared before bringing a chick out to feed. It is preferable to feed chicks in the brooder or bin to minimize handling. To elicit a feeding response, the feeder should hold the syringe filled with the specified amount of formula in one hand, then extend the first and second fingers of the other hand in an inverted “V” shape over the chick’s bill and wiggle the fingers. The chick should respond with a feeding response by opening its bill and pushing into the “V”, at which time the syringe should be placed in the chick’s mouth and the formula fed.

Never force a chick to eat.

Evaluate each chick individually and then determine cause for inappetence.

The rate at which formula is fed and the amount fed at a “bout” will depend on the age of the chick and how quickly the chick is swallowing. The feeder should continually look down the chick’s throat while feeding, to ensure that formula is not being fed too quickly. As long as the chick is swallowing, the trachea is closed and formula can be fed. The chick should respond with a feeding response by opening its bill and pushing into the “V”, at which time the syringe should be placed in the chick’s mouth or throat with the syringe or tube.

General Intake Guidelines

Feeding is based on a calculated percentage of the morning weight of the chick before the first feeding, as follows (but treat chicks individually, based on information previously discussed; the range in amounts for the first 3 days is due to chicks varying in weight from 60 g - 120 g):

Day 1: 50:50 formula/water, with the total intake per feeding totalling 1-5 g (cc), but not to exceed 10% of the morning weight (AM wt).

(1 g formula = 1 cc formula.)

Note: Day 1 here is defined as the first day of feeding; this may differ from the chick’s age where day 1 equals day of hatch. In these early days, the chick may still be absorbing yolk sac. This is an important factor in judging intake for young chicks; it is all right to be conservative.

Day 2: 75:25 formula/water—not to exceed 4-8 g (cc) total intake per feeding. This will depend on the chick’s AM weight.

Day 3: Introduce straight formula—not to exceed 4-10 g total intake per feeding. If not well accepted, go back to 75:25 formula/water.

Day 4 & 5: Try 10% of AM weight total intake per feeding of straight formula—do not exceed this amount. Use 10% of AM weight as a guide for each feeding’s total intake. When the chick reaches 100 g AM weight, begin adding fish to the diet as described below.

continued on page 6
SeaWorld California penguin hand-rearing guidelines

continued from page 5

3. 100-500 g chick weight

Begin fish when the chick reaches 100 g first morning weight. We introduce fish using herring (Clupea spp.) fillets cut into 1-1.5 in. (2.5-3.8 cm) x 0.25 in. (0.6 cm) pieces, then use whole small silversides (Atherinidae) as the chick is able to swallow them whole (this may not occur until the chick is approximately 300 g). We limit silversides to less than 50% of the total fish intake, due to the belief that silversides may not contain enough iron to maintain adequate nutrition long-term in penguins. Dip the fish or fish pieces in formula or warm water just prior to feeding. This hydrates the fish, warms it a little, and makes it easier for the chick to swallow.

Gentoos usually begin fish at slightly greater than 100 g AM weight (approximately 110-115 g AM weight) due to their larger hatch weights. Nevertheless, their first day on fish should not be any earlier than their first or second day of straight formula.

The guidelines for the amount of fish fed are as follows:

100 g AM weight:
- 1st day on fish: 3 g fish given once a day (SID) for the first day, at the first AM feeding. Fish is given with formula, and the total intake (fish plus formula) per feeding is not to exceed 10% of AM weight.
- 2nd day on fish: a maximum of 3-5 g fish given twice a day (BID), with formula, at the (first) morning and mid-afternoon feedings. The total intake per feeding must not exceed 10% of AM weight.
- 3rd day on fish: 3-5 g fish maximum given at every other feeding, with formula so that the total intake per feeding equals 10% of AM weight.
- 4th day on fish: 3-5 g maximum fish given every feeding.
- 5th day on fish: 5-7 g maximum fish given every feeding.
- 6th day on fish: 7-10 g maximum fish given every feeding.

300 g AM weight: 10-15 g fish maximum every feeding with formula, not to exceed 10% of AM weight per feeding.

400 g AM weight: Fish is 50% maximum of total intake every feeding in combination with formula, the total not to exceed 10% of AM weight per feeding. Begin vitamin supplements at this time. (25 mg B1 BID)

Note: Heating formula to the full 95°F (35°C) becomes less critical as a chick is consuming a higher percentage of cold fish.

500 g chick’s first morning weight:
Decrease the number of feedings to 4 per day (QID), every 4 hours, at approximately 500 g first morning weight.

Let the chick’s appetite guide you. Although the number of feedings has been reduced to 4, the chick should still be receiving the same amount of food as it would be getting if fed 5 times per day. This is calculated by multiplying 10% of chick’s AM weight x 5 and dividing that total by 4 to get the amount to feed at each of the four feedings. This “boosted” feeding protocol will last until the chick is approximately 800 g at which time chicks don’t seem to gain extra weight even on more food. Then the chick can go to 10% of AM weight fed at each feeding QID.

Humboldts: This “boosted” feeding protocol does not apply to Humboldt penguin chicks who usually go directly, at 500 g morning weight, to 10% of AM weight fed at each feeding QID.

4. 600 g first morning weight

After the chick reaches approximately 600 g or greater and has been doing well on the 50:50 fish/formula + water regimen, then the feeding schedule may be altered to increase the percentage of fish in the diet: 30 cc formula, plus fish to equal 10% of AM wt. Water may be given as needed.

The size of fish given can usually be increased at this time, with a mixture of one-half capelin (Mallotus villosus) and one-half small or cut herring replacing silversides. Keep in mind that herring is a dense-fleshed fish, and may be difficult for younger birds to process whole. Do not feed more than 30 cc of formula per feeding.

5. 1000 g or greater chick’s first morning weight

Chicks may start to “wean themselves” from formula by refusing to feed from a syringe. This may begin to occur as the chick approaches 1500-2000 g first morning weight. Formula may be reduced to 15 cc QID.

Formula is eventually reduced to 30 cc once a day (at the first feeding of the day, when the chick is most hungry), then eventually eliminated from the diet altogether.

Once chicks are off formula, the fat intake needs to be replaced by a fish with a high fat content such as herring. At least 50% of the fish fed should be a high fat fish.

Fish fed to chicks which are not receiving formula should be dipped in water or hydrated by injecting water into the fish just prior to feeding. If this is not enough to hydrate the chicks, an electrolyte replacement solution should be used.

Although chicks may be on QID feedings, they may not eat the full amount of fish offered at each feeding, especially at the fourth feeding of the day. Feeders should be thinking in terms of “daily intake” and whether chicks are maintaining the proper weight gains.

An additional reduction of the number of feedings per day may also be indicated at around 1500 g. Chicks that are not hungry at the second feeding for several days are probably ready for three feedings per day, every 6 hours or so.

When chicks go to three times a day (TID) feedings, start with 10% of AM weight per feeding, then adjust as needed to achieve the desired weight gain. Chicks should be eager to eat at each feeding. As chicks start to moult, they may not eat the full amount offered. Once chicks have completed moult, are in the exhibit full-time, and have reached a good, stable weight,
fish may be fed on demand, or on the same schedule as the other birds in the exhibit.

As chicks progress through various feeding stages, they will respond differently. Keep in mind the aspects previously discussed. Sometimes chicks will not eat all the food items offered at all feedings. Never force a chick to eat. Evaluate each chick individually and then determine the cause for inappetence.

There are two stages at which most chicks become finicky: at 500 g for a day or two, and at 1000 g for several days. They may refuse food at one feeding or not eat full amounts at each feeding. Check for overheating. Evaluate the environment. If low appetite continues for more than a few days, it is a cause for concern, not just a phase. The chick may be ill.

In writing out these guidelines, the authors have endeavored to be clear and to provide all necessary information. These are meant to be used as guidelines only, not a strict regimen. Should there be questions, either of us can be contacted for clarification and additional information. We would also appreciate hearing from people who use these guidelines about their experience.

Acknowledgments
The authors wish to thank the Aviculture staff of the SeaWorld California Penguin Encounter for their work in raising many penguin chicks. The staff’s accurate and detailed recordkeeping on the hand-rearing of penguin chicks has provided the data upon which we monitor the success of these hand-rearing guidelines and initiate changes. We would also like to recognize the pioneering work of Frank Todd, Frank Twohy, and Scott Drieschman, whose vision for penguins and development of the earlier chick diet made our work possible.

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### Appendix A

**SeaWorld California—Penguin formula - Dec. 1997**
(see Appendix C for product list)

#### Whole Batch

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-7 in. (12.7-17.8 cm) whole herring (w/head, tail, fins &amp; skin removed)</td>
<td>440 g</td>
<td></td>
</tr>
<tr>
<td>Krill (squeeze water out after defrosting &amp; before measuring)</td>
<td>440 g</td>
<td></td>
</tr>
<tr>
<td>Bottled drinking water</td>
<td>800 ml</td>
<td></td>
</tr>
<tr>
<td>7 grain brewers yeast tablets</td>
<td>8 ea</td>
<td></td>
</tr>
<tr>
<td>Mazuri® Sea Bird vitamins (=formulation for birds eating Sibs fish per day; see Appendix C)</td>
<td>550 mg</td>
<td>B1</td>
</tr>
<tr>
<td>5 lb. Mazuri® Sea Bird vitamins (=half of a “5 lb” tablet; see Appendix C)</td>
<td>1 ea</td>
<td></td>
</tr>
<tr>
<td>10 grain calcium carbonate tablets</td>
<td>4 ea</td>
<td></td>
</tr>
<tr>
<td>Vitamin E</td>
<td>1200 i.u.</td>
<td></td>
</tr>
<tr>
<td>Children’s multi-vitamin drops</td>
<td>2 ml</td>
<td></td>
</tr>
</tbody>
</table>

Blend ingredients thoroughly. Strain through large colander. Refrigerate formula, mark with date and time; use within 24 hours. Warm formula to 95 °F (35 °C) before serving.

Note: for chicks 3 days of age to 400 g am weight: just prior to feeding formula, stir in 1 pinch of ground B1 per 100 cc formula prepared for feeding.

#### Half Batch

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-7 in. (12.7-17.8 cm) whole herring (w/head, tail, fins &amp; skin removed)</td>
<td>220 g</td>
<td></td>
</tr>
<tr>
<td>Krill (squeeze water out after defrosting &amp; before measuring)</td>
<td>220 g</td>
<td></td>
</tr>
<tr>
<td>Bottled drinking water</td>
<td>400 ml</td>
<td></td>
</tr>
<tr>
<td>Brewers yeast tablets</td>
<td>4 ea</td>
<td></td>
</tr>
<tr>
<td>Mazuri® Sea Bird vitamins (=half of a “5 lb” tablet; see Appendix C)</td>
<td>275 mg</td>
<td>B1</td>
</tr>
<tr>
<td>“2+1/2 lb” Mazuri® Sea Bird vitamins (= 2 of the “1/2 lb” tablets, plus one of the same divided in half; see Appendix C)</td>
<td>1 ea</td>
<td></td>
</tr>
<tr>
<td>10 grain calcium carbonate tablets</td>
<td>600 i.u.</td>
<td>Vitamin E</td>
</tr>
<tr>
<td>Children’s multi-vitamin drops</td>
<td>1 ml</td>
<td></td>
</tr>
</tbody>
</table>

#### Quarter Batch

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-7 in. (12.7-17.8 cm) whole herring (w/head, tail, fins &amp; skin removed)</td>
<td>110 g</td>
<td></td>
</tr>
<tr>
<td>Krill (squeeze water out after defrosting &amp; before measuring)</td>
<td>110 g</td>
<td></td>
</tr>
<tr>
<td>Bottled drinking water</td>
<td>200 ml</td>
<td></td>
</tr>
<tr>
<td>Brewers yeast tablets</td>
<td>2 ea</td>
<td></td>
</tr>
<tr>
<td>Mazuri® Sea Bird vitamins (= 2 of the “1/2 lb” tablets, plus one of the same divided in half; see Appendix C)</td>
<td>150 mg</td>
<td>B1</td>
</tr>
<tr>
<td>“1 + 1/4 lb” Mazuri® Sea Bird vitamins (plus one of the same divided in half; see Appendix C)</td>
<td>1 ea</td>
<td></td>
</tr>
<tr>
<td>10 grain calcium carbonate tablet</td>
<td>300 i.u.</td>
<td>Vitamin E</td>
</tr>
<tr>
<td>Children’s multi-vitamin drops</td>
<td>1/2 ml</td>
<td></td>
</tr>
</tbody>
</table>

Appendices continue on pp. 8-9.
Appendix B

SeaWorld California Penguin Hand-rearing
Vitamin Regime - Feb. 1997

Through 1000 g AM weight

3 days of age to 400 g AM weight:
    Just prior to feeding formula, stir in 1 pinch of ground B1 per 100 cc formula prepared.

>400 g AM weight through 1000 g AM weight:
    25 mg B1 BID

First daily weight = 1000 g - or when chick receives formula twice a day (BID)

AM:
    ½ children's multi-vitamin
    125 mg oystershell calcium
    50 mg B1

PM:
    100 i.u. Vitamin E every other day
    ½ tablet B-Complex (B-50)
    125 mg oystershell calcium

First daily weight = 2000 g - start of juvenile vitamins:

AM:
    125 mg oystershell calcium
    1 children's multi-vitamin
    50 mg B1

PM:
    25 mg oystershell calcium
    B-Complex (25 mg)
    100 i.u. Vitamin E every other day

Juvenile vitamins
(after completion of first juvenile moult until 4 months post-fledge of the youngest chick)

2 ea. ½ lb. Mazuri® Sea Bird vitamin tabs SID (macaroni, chinstrap, Adélie)
½ ea. 5 lb. Mazuri® Sea Bird vitamin tab SID (gentoo, Humboldt, Magellanic)
1 ea. 50 mg B1 SID
1 ea. 50 mg B-complex SID
100 i.u. vit E on odd days

(Vitamins may be inserted into the gills of the fish before feeding, or—if no whole fish is being given—fed to the chicks with a feeding response, followed by the fish fillets).
Appendix C

Product List (description, manufacturer or vendor)

**Ampligrip 201™**
Manufactured by:
Emtek 1-800-356-2741

**Betadine surgical scrub®**
Povidone-iodine, 7.5%
Antiseptic Bactericidal/Virucidal sudsing skin cleanser
Manufactured by:
The Purdue Frederick Company
Norwalk, CT 06850-3590

**Pro-Clean 200™**
Iodine sanitizer (1.6% iodine)
Available from: Shamrock Foods
Manufactured by:
ProClean of Arizona, Inc.
Phoenix, Arizona 85043

**Dri-dek matting®**
Interlocking PVC matting
Available from:
Lab Safety Supply, Inc.
P.O. Box 1368
Janesville, WI 53547-1368

**Wavicide-01®**
2.5% Glutaraldehyde Solution
Used as a sterilant or disinfectant
Available from: Cameron Medical
Manufactured by:
Medical Chemical Corporation
1909 Centinela Avenue
Santa Monica, CA 90404

**Children's Chewable Vitamin Tablets (various vendors and manufacturers)**
Each tablet supplies:

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vit. A, i.u.</td>
<td>2500</td>
</tr>
<tr>
<td>Vit. C, mg</td>
<td>60</td>
</tr>
<tr>
<td>Vit. D, i.u.</td>
<td>400</td>
</tr>
<tr>
<td>Vit. E, i.u.</td>
<td>15</td>
</tr>
<tr>
<td>Thiamine, mg</td>
<td>1.05</td>
</tr>
<tr>
<td>Riboflavin, mg</td>
<td>1.2</td>
</tr>
<tr>
<td>Niacin, mg</td>
<td>13.5</td>
</tr>
<tr>
<td>Vit. B-6, mg</td>
<td>1.05</td>
</tr>
<tr>
<td>Folate, mcg</td>
<td>300</td>
</tr>
<tr>
<td>Vit. B-12, mcg</td>
<td>4.5</td>
</tr>
<tr>
<td>Sodium, mg</td>
<td>5</td>
</tr>
</tbody>
</table>

**Children's Multi-Vitamin Drops (various vendors and manufacturers)**
Each 1.0 ml supplies:

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vit. A, i.u.</td>
<td>1500</td>
</tr>
<tr>
<td>Vit. C, mg</td>
<td>35</td>
</tr>
<tr>
<td>Vit. D, i.u.</td>
<td>400</td>
</tr>
<tr>
<td>Vit. E, i.u.</td>
<td>5</td>
</tr>
<tr>
<td>Thiamine, mg</td>
<td>35</td>
</tr>
<tr>
<td>Riboflavin, mg</td>
<td>8</td>
</tr>
<tr>
<td>Niacin, mg</td>
<td>400</td>
</tr>
<tr>
<td>Vit. B-6, mg</td>
<td>2</td>
</tr>
<tr>
<td>Folate, mcg</td>
<td>15</td>
</tr>
<tr>
<td>Biotin, mcg</td>
<td>50</td>
</tr>
</tbody>
</table>

**Mazuri® Sea Bird Multi-Vitamin tablets**
Tablets are formulated for animals eating 2 1/2 lb (1.13 kg) and 5 lb (2.27 kg) fish per day

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vit. A, i.u.</td>
<td>1650</td>
</tr>
<tr>
<td>Vit. E, i.u.</td>
<td>25</td>
</tr>
<tr>
<td>Vit. C, mg</td>
<td>25</td>
</tr>
<tr>
<td>Thiamin, mg</td>
<td>20</td>
</tr>
<tr>
<td>Riboflavin, mg</td>
<td>15</td>
</tr>
<tr>
<td>Pyridoxine, mg</td>
<td>15</td>
</tr>
<tr>
<td>Pantothentic Acid, mg</td>
<td>15</td>
</tr>
<tr>
<td>Folic Acid, mcg</td>
<td>50</td>
</tr>
<tr>
<td>Biotin, mcg</td>
<td>25</td>
</tr>
</tbody>
</table>

Oceans without fish

The destruction of life in the oceans has progressed farther than anyone had suspected, according to a recent report in Science magazine (Pauly 1998). The causes include overfishing and pollution, but the focus of the new report is overfishing alone. [Science is the voice of the American Association for the Advancement of Science (AAAS)].

The world's catch of ocean fish peaked in 1989 and has been declining since (Broad 1995). In the early 1990s, scientists reported that 13 of the world's 17 major fisheries were depleted or in steep decline (Egan 1994). Typical is the Grand Banks fishery off the shallow coast of Newfoundland in the north Atlantic. There, after 350 years of commercial exploitation, the haddock, cod and flounder have all but disappeared and the fishery was officially closed a few years ago.

The depletion of the world's most popular fish species has set off three trends, each of which is adding to the oceans' troubles: (1) fishermen are adopting new technologies that (2) allow them to fish in deeper waters, and (3) they are fishing lower on the food chain.

New Technologies

Commercial fishing can be very profitable if conducted on a grand scale. In 1992, Don Tyson, the Arkansas chicken magnate and supporter of Bill Clinton, bought the Arctic-Alaska Fisheries Company, and three other fishing companies. They operate a fleet of industrial super-trawlers that each cost $40 million to build and reach the length of a football field.

These trawlers pull nylon nets thousands of feet long through the water, capturing everything in their path — 400 tons of fish at a single netting. Super-trawlers like these can stay off-shore for months at a time, processing and freezing their catch as they go, giving them a major advantage over smaller land-based boats.

Approximately 40 percent of what these super-trawlers catch is considered trash and is ground up and thrown back into the ocean. They call it "bycatch" and, according to investigative reporter Jeffrey St. Clair, it can include endangered sea lions, and seals, as well as unwanted fish (St. Clair 1997). (In the northeast Atlantic alone, the bycatch in a year's time amounts to 3.7 million tons (Pauly 1998).

Trawlers are now using technology developed by the military to fish waters as deep as a mile, catching species that few would have considered edible or useful a decade ago. Now that the shallow fisheries are in serious decline, trawl nets fitted with wheels and rollers are dragged across the bottom of the deep oceans, removing everything of any size.

Squid, skate, rattails, hoki, blue ling, black scabbard, red crabs, black orees, smooth orees, deep shrimp, chimeras, slackjaw eels, blue hake, southern blue whiting, sablefish, spiny dogfish, and orange roughy are now being harvested from the deep ocean and sold in seafood stores, cooked into "fish sticks" at McDonald's, or processed into fake "crab meat" for seafood salads.

Part of the problem is consumer ignorance. For example, orange roughy began to appear in fish stores and on the menus at fancy restaurants in the U.S. just a decade ago. Yet in that short time the species may have become threatened with extinction. The orange roughy lives up to a mile deep in cold waters off New Zealand. Now scientists have learned that species living in deep, cold waters grow and reproduce very slowly. The orange roughy, for example, lives to be 150 years old and only begins to reproduce at age 30. Recently, the principal stocks of orange roughy around New Zealand collapsed. Still, today in Annapolis, Maryland, fish stores, orange roughy is available for $8.99 per pound, and there's no sign telling consumers that the species is threatened. "People wouldn't eat rhinoceros or any other land creature that they knew was threatened with extinction. But they're eating fish like orange roughy without a clue to what's happening," says Greenpeace fisheries expert Mike Hagler in Auckland, New Zealand (Broad 1995).

Radar allows ships to operate in the fog and the dark; sonar locates the fish precisely; and GPS (geographical positioning system) satellites pinpoint locations so that ships can return to productive spots. Formerly-secret military maps reveal hidden deep-sea features, such as mountains, which are associated with upwelling currents of nutrient-rich water, where fish thrive. Combined with larger nets made from new, stronger materials, modern fishing vessels guided electronically can sweep the oceans clean—and that is precisely what is happening. As a result, the ocean's fish are disappearing, and so are the family-scale fishing operations that used to dominate the industry.

Peter Montague
Environmental Research Foundation
P.O. Box 5036
Annapolis, MD 21403-7036
Fax (410) 263-8944
email: erf@rachel.clark.net

Because modern fishing equipment is immensely expensive, the stakes are high. With big money on the line, the fishing industry has curried political favor. As a result, modern fishing factories like Tyson’s are subsidized by federal and state governments. Tyson’s company has received more than $65 million in low-interest loans from the federal government, to help build 10 of these super-trawlers. According to Jeffrey St. Clair, the Seattle-based factory-trawler fleet has received $200 million in federal subsidies.

Furthermore, because so much is at stake, deep-water factory trawlers cannot afford to let up. They must keep fishing until the last fish is gone.

Fishing down the food chain

But it gets worse. The new report in Science shows that humans are now fishing not only in deeper waters, but also lower on the food chain (Pauly 1998). This has ominous implications, because as the lower levels of the food chain decline, the chances of revival at the top of the food chain are diminished even further. Scientists are now discussing the "wholesale collapse" of marine ecosystems (Stevens 1998). "It is likely that continuation of present trends will lead to widespread fisheries collapses," says Daniel Pauly, the author of the new study (Pauly 1998). "If things go unchecked, we might end up with a marine junkyard dominated by plankton," he says (Williams 1998).

Pauly’s new study examined the diets of 220 fish species, then gave each species a numerical ranking in the food web, between 1 and 5. Those assigned a 1 are plankton—tiny floating plants that photosynthesize, using the energy of sunlight to convert water and carbon dioxide into carbohydrates, thus forming the bottom of all aquatic food chains. Level 2 is zooplankton—tiny floating animals that eat plankton. Top predators, such as the snappers inhabiting the continental shelf off Yucatan, Mexico, receive a ranking of 4.6.

These data were combined with Food and Agriculture Organization (FAO) data on fish landings worldwide. The result is an estimate of the average place in the oceanic food web (the average "trophic level") where humans are harvesting fish. The new study reveals that the average trophic level has been steadily declining for 45 years, meaning that humans are progressively taking fish from lower on the food chain. The steady decline has been about 0.1 trophic levels per decade. "Present fishing policy is unsustainable," says Pauly. Of the 220 species studied, at least 60% are being overfished, or fished to the limit. (Williams 1998)

Pauly believes that the true situation is somewhat worse than his study indicated, principally because many countries under-report their fishing harvest.

Even if a fishery does not collapse completely, fishing down the food chain can have serious consequences. In the North Sea, the cod population has been so depleted that fishermen are now concentrating on a second-level species called pout, which the cod used to eat. The pout, in turn, eat tiny organisms called copepods and krill. Krill also eat copepods. As the pout are removed, the krill population expands and then the copepod population declines drastically. Because copepods are the main food of young cod, the cod population cannot recover (Stevens 1998).

Fish farming might seem like a way out of this problem, but it is not—at least not as presently practiced—because farmed fish are fed fish meal made from second-level fish (Stevens 1998).

Dr. Pauly believes that in 3 or 4 decades, many oceanic fisheries will "collapse in on themselves." The result will be a loss of high-quality protein for humans, even before the fisheries collapse completely.

Humans eat somewhere between trophic levels 2.5 and 4. Lower than that, there isn’t much that people eat. "There is a lower limit for what can be caught and marketed, and zooplankton [at trophic level 2] is not going to be reaching our dinner plates in the foreseeable future," Dr. Pauly wrote in Science.

Preserving and restoring ocean fisheries

Solutions? Government could limit the kinds of fishing technology that are allowed but this would put "the public interest" up against the likes of Don Tyson. In today’s political climate, with private money dominating our elections, Don Tyson would win because he’s wealthy and he supports all the right politicians.

Dr. Pauly believes there is an urgent need to create protected areas where fishing is simply not allowed. He sees no-fishing zones as easier to implement and enforce than fishing quotas, limiting fishing time at sea, restrictions on allowable fishing gear, and controls on pollution—though these steps, too, are needed, he believes. No-fishing zones can be created quickly and can be enforced.

In Britain, the fishing industry has begun to accept no-fishing zones as a way to save the industry in the face of declining fish stocks [Williams 1998].

continued on page 12
The most important idea, proposed in the same issue of *Science* magazine, would be to shift the burden of proof onto the fishing industry (Dayton 1998). Those who profit from public resources such as the oceans should have to demonstrate, before they can begin fishing, that their activities will not harm the public resource. For example, owners of super-trawlers should have to show that their yield will be sustainable before their ships can put to sea.

At present, it is assumed that fishing will not damage life in the oceans, and the burden is on the general public to prove otherwise. But there is abundant evidence indicating damage, and it is definitely time to shift the burden of proof onto the fishing industry.

References


[This article originally appeared as issue #587 of Rachel's Environment and Health Weekly (an electronic publication), 26 February 1998. It has been slightly abridged and is reprinted with permission. To subscribe to this free publication, E-mail the words SUBSCRIBE RACHEL-WEEKLY YOUR NAME to: listserv@rachel.org]
Crucial fisheries treaty goes unsigned

As of February 1998, only four of the top twenty fishing nations in the world have ratified a landmark United Nations treaty on fisheries, and no country has acted to put the agreement into effect, according to the World Wildlife Fund Endangered Seas Campaign.

The 1995 United Nations Convention on Straddling Fish Stocks and Highly Migratory Fish Stocks is, says WWF, "the most far-reaching treaty ever negotiated to promote the conservation of marine fishes." Among its requirements are that countries must: adopt the "precautionary approach" to fisheries management; adopt new measures to promote the use of selective or "clean" fishing gear to reduce fisheries bycatch; and that fisheries management bodies must open their deliberations to public scrutiny by admitting observers.

However, says WWF, of the top twenty fishing nations, only the United States, Russia, Norway and Iceland have ratified the agreement. By contrast, eight developing nations which account for 27 percent of world fishing have not signed the agreement: Chile, Peru, India, North Korea, Thailand, Mexico, Malaysia and Vietnam.

Environmental groups also look to the UN General Assembly to push for World Trade Organisation (WTO) action to prod nations to reduce government subsidies that favour commercial fishing. Those subsidies amount to tens of billions of dollars a year, and are linked to the 'over-capacity' of the fishing industry, said Michael Sutton, director of World Wide Fund for Nature (WWF) Endangered Seas Campaign.

"The European Union alone spends two-thirds of its fisheries budget subsidising commercial fleets" which in turn are linked to over-fishing in the waters off the developing world, he contended.

The UN Food and Agriculture Organisation (FAO) estimates that some 70 percent of the world's main fisheries either have been exploited to their maximum capacity, or over-exploited. Meanwhile, the largest-scale fishing fleets, which account for most of the over-fishing, receive an immense amount of government subsidies - amounting to 54 billion dollars in 1989 alone, according to FAO.

Some groups are challenging the use of large-scale trawlers directly. [See article at right. — Ed.]

Earlier this month, the U.S. Congress passed legislation which prevents the re-entry of factory trawlers and other large fishing vessels into the waters off New England, and also imposed a one-year moratorium on any U.S. activity by foreign-based large-scale fishing vessels.

Fishing as a whole has increased dramatically in recent years, with the fleet of middle- and large-scale vessels doubling from 385,000 in 1970 to 1.2 million in 1990, according to the FAO.

The Fish Stocks Agreement intends to reduce the harm from over-fishing by urging countries to adopt a 'precautionary approach' in which vessels must err on the side of conservation rather than of increasing the volume of fishing.

The treaty also pushes governments to cooperate in managing fisheries and promotes the use of non-destructive fishing gear. Greenpeace estimates that some 27 million tonnes of unwanted fish are caught, killed and dumped back into the sea each year, simply because some large-scale fishing technologies—like drift net fishing—pick up a heavy volume of undesirable fish.

"While governments have procrastinated," says WWF, "fish populations have continued to decline. Until 30 countries join the ... Agreement and it enters into force, the world's fishing fleets will continue to plunder the high seas virtually unchecked. Unless governments act quickly to implement the treaty, the future of world fisheries will remain in jeopardy." [from World Wildlife Fund documents]

Excluded by Chile, supertrawler moves on

The American Monarch—called the world's most efficient factory supertrawler—is headed for Russian fishing grounds, after being barred from fishing in Chilean waters.

Nearly 100 meters (328 ft) long, the American Monarch has state-of-the-art fish finding technology, and is capable of fishing and processing up to about one million pounds (454 metric tons) of fish per day—more than any other fishing vessel in the world.

At a time when the UN's Food and Agriculture Organization is calling for a reduction of the world's fishing fleets because 70 per cent of fish stocks worldwide are either fully exploited, over exploited or depleted, this vessel is only the first of 25 huge new fishing vessels to be built by Resources Group International (RGI) shipyards in Norway. All of them, according to Greenpeace International, are being subsidized by the Norwegian Government in the amount of $56 million.

In November, 1997, the Chilean High Court of Justice refused to allow the supertrawler to operate in the waters of southern Chile, which are already heavily fished, ruling that the ship could cause "irreparable damage" to Chile's marine life.

Now owned by American Seafoods of Seattle, a subsidiary of RGI, the American Monarch spent most of 1997 docked in Seattle. Plans announced early this year called for it to fish for pollack in the Bering Sea, on the Russian side of the North Pacific. (US rules exclude the ship from the two billion dollar a year fishing industry in American territorial waters off of Alaska, because it was foreign-built.)

No such rules govern Russian waters, and, in addition, fishery regulations there allow 40% of the pollack stocks to be caught each year, while the US limit is 18%.

Several North Pacific pollack stocks are already showing signs of stress. The Central Bering Sea has been closed to fishing since 1992, due to overfishing by factory trawlers.

[compiled from various news sources]
Preservation of Antarctic marine ecosystems: excerpts from the 1997 report

Six years of hard work came to fruition this year with the entry into force of the Antarctic Environmental Protocol. On Wednesday, January 14, 1998 the entire continent of Antarctica was declared off-limits to all exploitation of oil, gas and other minerals. In the process, comprehensive environmental protection was afforded to one-tenth of the planet's surface.

Protecting Antarctic marine life

The protection of the biodiversity of Antarctica's waters continues to be a priority. As the environmental representative on the U.S. delegation to meetings of the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), our Director ensures that the environmental viewpoint is represented when adopting conservation measures to regulate fishing. ASOC representatives also serve on the Australian, New Zealand and UK delegations, and ASOC attends as an observer to the meetings.

The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) was established to sustainably manage Southern Ocean fisheries. It is unique in its "ecosystem" approach to the management of fisheries because its aim is not only to conserve the targeted species, but to take into account the impact of fishing on those animals (seals, whales, penguins and other seabirds) that depend on the targeted species. During the past years, it seemed that precautionary principles have gradually become embedded in some of CCAMLR's management mechanisms. But now, conservation appears to be taking a back seat to economic priorities as CCAMLR is faced with an illegal fishing situation that renders largely meaningless all of these fine principles. Unless this is reversed, CCAMLR will have lost its ability to sustainably manage Southern Ocean fisheries.

Increase in both legal and illegal fishing

This change in emphasis has come about due to a resurgence of interest in Antarctic fisheries, primarily in the highly valued Patagonian toothfish (Dissostichus eleginoides, often sold as "Chilean sea bass"). Ironically this interest has come from nations which have traditionally been concerned with conservation. In addition to an increase in the number of legal fisheries, illegal and unregulated fisheries on Patagonian toothfish have exploded. The illegal and unregulated fishing has destroyed the effectiveness of conservation measures, and threatens to destroy the sustainability of regulated fisheries unless halted quickly. It is believed that the illegal fisheries have taken a minimum of 100,000 tonnes [1 tonne or metric ton =1.1 traditional ton -Ed.] compared to legal fishing of around 30,000 tonnes.

At the last CCAMLR meeting eleven proposals for new or exploratory Patagonian toothfish fisheries were approved—at commercial rather than precautionary levels—in various areas covering most of the remainder of the Southern Ocean (in addition to established commercial fisheries in three other areas). ASOC had called for complete closure of the toothfish fisheries, since the illegal fisheries are taking considerably more fish than CCAMLR considers precautionary. Although Members spent considerable time discussing these contentious issues, without a mechanism to enforce compliance with conservation measures, it will not be possible to stem the illegal and unregulated fisheries.

Regrettably, agreement could still not be reached on the mandatory placement of vessel monitoring systems (VMS) on all fishing boats, despite their proven effectiveness as a means to monitor the position of vessels. (Instead, a voluntary Resolution was agreed which calls on nations to endeavor to establish VMS on its fishing vessels within the year.)

Incidental seabird mortality is one consequence of these longline fisheries. The level of seabird by-catch in the illegal fisheries has been estimated to range from 5,000 to 145,000 seabirds depending on assumptions of the level of by-catch. These include several IUCN-listed threatened species of albatross and petrels and are unsustainable for the species involved. This problem is exacerbated by the low level of compliance with the conservation measure for avoiding incidental mortality of seabirds.

An expanded campaign to counter the growing inability of CCAMLR to regulate itself and to protect Antarctica's marine ecosystems will focus on building support for the implementation of strict international measures to prevent over-fishing in the Southern Ocean. This campaign includes working in closer collaboration with organizations which are active on fisheries issues in other regions, with fishers, and with governments. In particular, we will be working to gain agreement on trade measures and port controls to prevent fish from non-licensed boats entering trade.

Kril fishery

The increased interest in Southern Ocean fisheries is not focussed solely on Patagonian toothfish. There are also alarming signs of a substantial expansion in the krill fishery. At this past meeting, four nations indicated their intention to enter or expand their krill fisheries in the 1997/98 season. Chinese interest was also rumored. This fishery has been at a fairly low level for the past four years, primarily because krill is not palatable to humans. However, during the past

Beth Clark, Director
The Antarctic and Southern Ocean Coalition
P.O. Box 76920
Washington, DC 20013 USA
e-mail: antarctica@igc.org

of the Antarctic and Southern Ocean Coalition (ASOC)

year, there have been significant developments in krill-based pharmaceutical and biotechnology uses which could change the nature of the fishery and lead to an increase in krill catches over the next 5 years; there is also a growing market for krill for aquaculture (primarily for salmon). CCAMLR was originally negotiated in response to the concern that a rapid escalation of the krill fishery could precipitate the demise of the Southern Ocean food chain (of which krill forms the base). Unfortunately, the reality that a greatly expanded krill fishery could negatively impact dependent species was barely discussed at this meeting.

Positive measures taken at CCAMLR meeting

In spite of these obstacles, we achieved a number of successes at this year's CCAMLR meeting:

- The proposal for a year-round season for toothfish fisheries was blocked; a shortened season is the only way at present to protect fish stocks and minimize incidental seabird mortality.
- Agreement was reached to prohibit the import of any fish caught by a Non-Member unless an inspection has determined that fishing was in compliance with CCAMLR's measures.
- Nations agreed to collect information on the international trade "flow" of toothfish. This is needed to determine if imports of toothfish are caught in compliance with CCAMLR's measures, and could ultimately reduce the benefits of reflagging.
- Fishing for toothfish was prohibited in the last three areas not yet opened for fishing.
- Members were encouraged to extend the application of permits to areas adjacent to CCAMLR. This would be consistent with the Straddling Stocks agreement which called on Members to ensure the harmonization of measures in adjacent areas.
- Nations agreed to prohibit fishing by their flag vessels in the Convention Area except pursuant to a license or permit that the Party has issued.
- Kept alive the discussion on the need for a new conservation measure which defines the way in which fisheries are resumed.

In order for CCAMLR to sustainably manage the marine ecosystem, nations need to continue funding research programs that generate the data to support conservation measures. Agreement can only be reached on strong conservation measures if nations are provided with scientific proof of a fishery's status. In the US, this crucial data has been provided by the National Oceanic and Atmospheric Administration's (NOAA) Antarctic Marine Living Resources Program (AMLR). Its work has been essential in laying the scientific foundation for protecting the Antarctic marine ecosystem.

Recovery reported in marine reserves

There is growing evidence that protected areas can be highly effective in restoring and maintaining marine ecosystems. Such areas on the Georges Bank off Massachusetts were created only in 1994, but researchers are already finding an increase in the size and spawning population of key fish species, as well as a rapid increase in the bottom-dwelling scallop population, says a spokesperson for the National Marine Fisheries Service in Woods Hole, Massachusetts.

Even tiny protected areas can be very effective in some regions. Callum Roberts of the University of York in the United Kingdom says reserves of just a few hectares on tropical coral reefs have boosted fish stocks and helped maintain long-lived large predators. [excerpted from: Williams, Nigel. 1998. Overfishing disrupts entire ecosystem. Science (6 February 1998): 279:809.]

Air Force captain honored for penguin rehab work

National Foundation for the Conservation of Coastal Birds (SANCCOB) rehabilitation center in Table View was struck by Newcastle disease.

Using an old aircraft X-ray hangar at the air base, Hopley ran an operation that—without volunteers' time, and the donations of equipment and food—would have cost the air force more than R188,000. In a three-month project about 7,000 penguins were saved and returned to the sea.

At the presentation ceremony yesterday Major-General P. R. Miller, the Chief of Staff (Logistics) of the air force, said it was "the first time we have seen an effort that was so well-managed."

A beaming Hopley said the award was "for me the greatest privilege that anyone could receive; I live and love nature."

However, she pointed out that the project would not have worked had it not been for the efforts of SANCCOB, the public, and the air base. "I just managed the thing," she said.

The runner-up was Flight Sergeant Francois Coetzee of the Ellisras radar post, who was honored for fixing a black eagle nest to a mountainside after it had been knocked off its perch several times. [article by Willem Steenkamp, © Independent Newspapers]
Little blue penguins (Eudyptula minor) at the Adelaide Zoo

Mary Johnson
Supervisor of Birds
Adelaide Zoo
Frome Road
Adelaide SA 5000
Australia

Introduction
and Brief Colony History

Since its founding in May 1878, Adelaide Zoo has kept several species of penguin. They are:

1950: King penguins (Aptenodytes patagonicus): kept for less than one year
1941 or 42: Jackass penguins (Spheniscus demersus): bred a few times and remained in the collection until 1962
1936: Little penguins (Eudyptula minor): not bred successfully until the 1980's
various: Fiordland penguins (Eudyptes pachyrhynchus) These birds are occasionally washed up on our shores in poor condition. They are nursed back to health if possible, and sent to Taronga Zoo.

At present, the only species on show at Adelaide Zoo is the Little penguin (Eudyptula minor). Our small colony consists of a dozen adults and two chicks.

Exhibit Description

The present penguin enclosure is a smallish yard featuring beach sandhills, eight burrows, rocks, logs, sedges and grasses, all fronted by a pond which runs almost the entire front length of the exhibit. This exhibit was completed in September 1982.

The pond is approximately 3 feet (1 m) deep, cement lined, and is cleaned twice a week. Bore water is used to fill it and we do not salinate the water. Algae is kept to a minimum by regularly chlorinating the walls whilst the pond is empty for cleaning. There is no reticulation or filtration of the water.

Our pond was originally designed with only one narrow exit point and we found this insufficient. We even had a case of a recently-fledged bird swimming around unable to find the exit and eventually drowning. Since that incident, we have cemented in some rocks at either end of the pond, a few inches below water-level. This way the birds can swim onto the rocks, stand up and clamber out onto the land.

Little penguins in the wild usually come out of the sea onto a gently sloping beach and seem to be incapable of the giant leaps from the water that are seen in some other species. The pool edge should not be sharply sloped (Figure 1) or the birds may not be able to exit the water. A ramp is probably the best option.

The original nestboxes in our exhibit were wooden boxes with a small entrance tunnel and removable lid but they weathered quickly, were difficult to access and hard to camouflage from the public.

The burrows we currently use are illustrated in Figure 2. Design 1 is the pattern of the half dozen burrows spread along the rear of the exhibit. These were built first (in the early 90's) and have been very successful, with up to four of them used for breeding in one year. The burrows which are furthest apart are favored for nesting so I would recommend at least three feet (1 m) between burrow entrances. If space doesn't permit this, logs, rocks, vegetation, etc. should be used as visual screens between the burrows.

Design 2 is much shorter and more recent (late 90's) but already a new pair of birds is sitting on an egg in one of them and the other burrow is favored as an “escape/hiding den’ or sleeping area.

Nesting burrows can build up such a stink of ammonia from droppings that it burns your eyes and nose when you open the back door for nest inspections. This smell, however, seems to have no ill effect on the birds and we don’t clean burrows at all (except to prize out leaves and branches and droppings which build up against the door). If there are two chicks being raised, both parents will sleep with them at first (and they’ll both incubate and feed the chicks too) but as the chicks grow, the male will often be booted out to another burrow at night and the cramped quarters shared by the female and both chicks.

Adelaide’s climate: Average winter temperatures are in the mid- to high teens Celsius (59-66° F) and average summer temperatures are in the high 20’s-low 30’s C (95-105° F). Rainfall of about 23 inches (580mm) occurs mainly in the winter; we get no snow, and frost is rare. Summers can occasionally get very hot, high 30’s to low 40’s C (95-105° F), but with our coastal location cool changes usually blow in after a few days of heat.

Husbandry

Feeding

Average feed per bird is 5 pilchards (Sardinops neopilchardus; totalling about 250 gm) per day. Our colony is routinely fed, with accompanying keeper talk, at 2:45 pm each day. The morning feed is around 8 am, before

![Fig. 1. Sharply sloping pool sides like this make it difficult for Little blue penguins to get out of the water.](image-url)
the public has access to the Zoo and while seagulls are absent.

The local seagulls (silver gulls, *Larus novaehollandiae*) can be a decided nuisance during public feeds as they squawk and squabble amongst themselves vying for fish and scraps. Even one or two gulls can upset most of our birds enough to put them off their food and head for the water.

The gulls will take fish out of a penguin's mouth if he is slow in swallowing, and they will chase penguins on land to do this. Keepers often throw sand at the gulls to scare them off, but a small flock can be very difficult to budge. Even though the gull problem varies constantly, it can get so bad at times that we have seriously considered netting in the enclosure to ensure some peace for our birds. Usually after the feeding is completed, the gulls hang around for a bit and then head off to annoy something, or someone else.

The pilchards we feed are caught and frozen in Western Australian waters and shipped to us in bulk. Our birds can be quite finicky about their fish. If the pilchard guts are mushy or the girth too large, the birds may attempt to eat them but if the fish only gets halfway down and gets stuck it will be regurgitated. If a 'bad batch' of pilchards comes our way we have contacts with local fishermen to supply very small tommy ruffs (*Arripis georgiana*, also known as Australian herring) and the penguins usually take to these quite well.

We hand-feed our penguins for a number of reasons.

1) it helps us keep an eye on the appetite of individual birds
2) it helps keep the birds fairly tame and approachable
3) we can regulate the fish to individual birds, i.e. both the big bossy one and the shy little one will get their fill
4) we haven't seriously tried or succeeded in teaching little penguins to eat dead fish by themselves; they barely look at the live fish in the water, let alone dead ones!
5) hand feeding helps stop silver gulls stealing the pilchards meant for penguins.

Feed times are a small frenzy of eager birds with their heads on or near the bucket, and the odd bird hanging around in the background waiting for the others to finish. Some birds can get so 'grabby' and 'snatchy' toward the fish that their food ends up a pulpy mass on the sand, but this is generally only if we've missed the morning feed and the birds are very hungry.

Frozen pilchards are removed from the freezer about 3 pm daily in preparation for the next day. We used to soak the fish in water sometimes to assist thawing but this is not done any more as the leaching of vitamins, especially *B* vitamins, was contributing to young chick mortality. For supplementation, we are presently using "Keylomin Organic", 1/8 tablet per bird once a week (see Table 1).

**Personalities**

**Our penguins are quite shy of people and don't like being handled. Among themselves they can be contentious, and during breeding season there are occasionally fights in which two birds, locked together beak to beak, roll down the sand into the pool and continue fighting in the water. Ailing penguins are often pecked and ostracized by other birds in the colony.

They show a keen interest in flying insects, such as flies, bees, or cabbage moths, that come within range, and I was present on one occasion when a moth fluttered over the sand dunes and all the penguins chased after it, following one another in a line.

**Individual ID and weighing**

Our birds are leg-banded with spiral bands. Each bird is also micro-chipped as the leg bands can snap off, and we have removed the odd wing band in the past which has become too tight during the molt. Microchips are placed at the back of the neck.

All our birds are weighed monthly, except for incubating or breeding pairs, and it is best to use gloves when handling as they can give a nasty bite. As birds are weighed we put them in a small temporary pen at the rear of the exhibit until they are all done, then we lift the gate and they march themselves back into the exhibit. Once the equipment is put away, we return to the exhibit and feed the birds to help them 'forget' their handling. Average weights for the adults in our colony range from 950-1750 gms.

**Breeding**

Of the dozen adult birds we have currently, three pairs are known and the others are being watched for sexual behaviors to enable sexing. Surgical sexing has been tried in the past but was unsuccessful. On average, males tend to be larger in the body than females and have a longer bill, but this is not 100% accurate.

Breeding can occur as early as two years of age. Our birds are predominantly monogamous. Usually one pair will choose a burrow and stick to that burrow exclusively for breeding. They will use their burrow for sleeping and hiding, as well, and defend it year-round from other birds. Breeding birds will collect sticks and grasses to line their burrows. We cut Melaleuca branches into pieces a few inches long and spread them around the exhibit for the birds to collect. Some birds have also been observed eating small sticks.

Incubation of (normally) two eggs, laid two days apart, is a month long and it takes about 60 days for the chicks to be able to fend for themselves. Our colony has no set breeding season.

Hand-rearing chicks has not been attempted at Adelaide Zoo for over 10 years and was never successful. We believe it is much better to let the parent birds do it: just keep supplying the fish to them and they'll do the rest. Young parents, however, as with many species, may need a practice run or two to perfect their techniques...
and chick mortality is possible at this stage.

At the height of breeding season we may feed three or four times a day and we check burrows every 7-10 days. Older and more experienced parents tolerate nest inspection better than young inexperienced pairs. We don't handle chicks if we can possibly help it but if we have to, the chick must be shielded by a gloved hand when it is replaced or the parent may inadvertently strike and injure or kill the chick.

Once the chicks are fledged, we catch them in the exhibit, by the bucket at each feeding time, and give them each 2 or 3 fish. It can take anything from a few days to a few weeks for the youngsters to feed themselves properly, and we keep a close eye on their weight at this time. We used to pull all youngsters and get them 'on the bucket' in an off-exhibit area, but it seems to work better, though it is a little more effort, to do the food training on exhibit.

Molting

Our birds have two molt periods, in about March and October, with most of the colony molting in March (early autumn here). The remaining individuals molt in October. Sometimes birds molting in October go through only a partial molt and occasionally individuals molt twice in one year. The birds will gorge themselves for a week or two to more than double their weight (average weight is 800-1700 g, in non-molting condition) and will then wander around in or near the burrows for a couple of weeks while losing the old feathers.

Wild birds don't feed during the molt, as they don't swim, but all our birds do take about a fish a day even at the height of the molt.

One of our females molted whilst still feeding her chick and another continued feeding her chick for 6 months, instead of the normal 2 months or so. We also have the odd bird, mainly young, which does not molt properly: it does not put on enough weight and the feathers don't drop off as they should. The end result is a very pale-looking bird that has a rather scruffy appearance. We are not sure why this happens and we have a young unpaired bird in the colony at present that we have photographed and are monitoring because of this condition.

About half of the individuals in our colony are wild birds which were found ill or injured and brought to the zoo. Aspergillosis is a common killer of stressed birds and many of the injured birds we receive have either aspergillosis or worms, or both. Quite a few of our adult mortalities show no observable cause of death.

Offspring of our colony have never been released to the wild as it is against our Wildlife Authority policies at present. Little blues are so common in the wild that there is no need at the moment and I believe it would be a rather difficult thing to achieve in practice. Some private individuals have raised rescued penguins for a time and attempted to release the birds back where they found them, only to have the bird wandering around on the beach aimlessly for days looking very lost. I think if the need ever arose, an in situ scenario for breeding and release would be the best option.

There is no studbook on little blues in the Australasian region but a number of zoos and wildlife parks keep this smallest species of penguin.

Thanks to Fiona Camilleri (our present penguin keeper) for her insights into the birds, Richard Smith for the penguin burrow illustrations upon which Figure 2 is based, and Mark Craig (General Curator) for perusing this article.

Testing a new vitamin supplement paste on penguins

Susan Maher

Ellen Dierenfeld

Introduction
Piscivorous species fed frozen fish in captivity require dietary supplementation with vitamin E (Engelhardt and Geraci, 1978) and thiamin (Geraci, 1974). Whole raw fish that have been properly stored and prepared have been shown to contain high levels of vitamin A (Dierenfeld et al., 1991), and the need for supplemental dietary vitamin A appears unwarranted in animals fed whole fish. Furthermore, high levels of supplemental vitamin A have been reported to reduce vitamin E status in seals (Mazzaro et al., 1995), chicks (Frigg and Broz, 1984), and swine (Ching and Mahan, 1995).

This study was designed to test the effects of two supplementation protocols on circulating plasma levels of vitamin A and E in a short-term (6 month) trial with captive penguins. One was a liquid vitamin supplement containing Rovomix vitamin E - 50% SD, Hoffman LaRoche Inc., Nutley NJ, and thiamin mononitrate. The other supplement, ThiaminE, manufactured by Stuart Products, Inc., Bedford, TX, is guaranteed to provide 1 IU d-alpha-tocopherol acetate (natural source of vitamin E) and 50 mg thiamin per ml, in a paste formulation. Neither vitamin supplement contains vitamin A.

Animals and Methods
Eight adult rockhopper penguins (Eudyptes chrysocome) at Lincoln Park Zoo were used in this trial. These birds had been on a regime of daily liquid vitamin supplementation for several years. All birds consumed an average daily diet comprising 265 g capelin (Mallotus villosus, 6 to 10 fish; mean weight 33 g), 100 g herring (Clupea harengus, 2 to 4 fish, mean weight 33 g), 45 g trout (Salmo spp., 1 to 3 fish; mean weight 23 g), 130 g surf smelt (Osmerus spp., 2 to 4 fish, mean weight 43 g), and 65 g whitebait (Allosmerus elongatus, 1 to 3 fish, mean weight 32 g), for a total of 605 g of fish.

Half of the birds were maintained on the liquid vitamin supplementation, which consisted of injecting 1.25 ml of a solution containing vitamin E and thiamin mononitrate into one fish (unless fish were exceptionally small, when two vitamin-supplemented fish were fed). The other penguins were dosed with 1 ml ThiaminE paste per kg fish fed. Liquid-supplemented penguins were dosed daily, while the paste supplement was offered three days per week providing calculated daily doses of 25 or 43 IU of vitamin E, and 15 or 22 mg thiamin for liquid and paste, respectively.

All species of fish were also analyzed for vitamin A and E content at the beginning and end of the study, following the methodology described in Dierenfeld et al., 1991.

Blood samples were obtained from each bird at 0, and approximately 30, 90, and 180 days following the supplementation change, separated, and the plasma frozen for analysis of retinol and tocopherols by methods that have been previously described for birds (Dierenfeld et al., 1993). Several birds came into molt during the study, and the 90-day bleeding was delayed 3 to 4 weeks for five birds to minimize handling (two birds each on the paste and liquid supplements completely molted, 1 on the paste supplement partially molted).

Data were analyzed by analysis of variance, blocked by treatment (supplementation) and season.

Results
Plasma retinol and tocopherol values, as measures of vitamin A and E activity, respectively, are found in Table 1. No significant differences were detected due to supplementation, but seasonal effects on vitamin E concentration were apparent. Circulating levels of tocopherol decreased between winter and spring, then remained stable. Retinol concentrations did not vary throughout the study.

Discussion
Captive animals that consume frozen or raw unprocessed fish have unique vitamin requirements compared to animals that consume live fish. Due to the nature of the diet, the two vitamins of most critical importance for captive piscivores are vitamin E and thiamin. Vitamin E is recognized as an essential nutrient for all species of animals, due primarily to its role as a fat-soluble, non-enzymatic antioxidant. Deficiency symptoms are many and differ among species (Dierenfeld 1994). One primary factor that increases vitamin E requirements is dietary levels of polyunsaturated fatty acids (PUFAs) (NRC 1985). The levels of PUFAs found in unsaturated fish oils can dramatically increase the need for supplemental vitamin E, especially those fish oils that have undergone rancidity or those in the process of oxidative rancidity prior to being consumed. Oils from raw fish
Testing a new vitamin supplement paste on penguins

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are likely to exhibit some degree of rancidity prior to being consumed. In most pet foods, for every gram of PUFA, vitamin E supplementation is increased by 1 IU (McDowell, 1989).

ThiaminE paste is formulated to provide 100 IU vitamin E per kg fresh raw fish (approximately 400 IU per kg dry matter) which should be adequate for piscivorous species (Engelhardt and Geraci, 1978). Plasma concentrations of this nutrient (an indicator of dietary availability) did not differ between the two supplementation treatments, and levels were within ranges reported as normal for free-ranging rockhopper penguins (21.7 to 50.8 µg/ml; Williams et al., 1989). Circulating tocopherol levels in apparently healthy penguins (n=428 samples from 7 spp., both free-ranging and zoo animals) average about 24 µg/ml (Wildlife Conservation Society, unpublished data), similar to the level reported here.

Retinol levels were somewhat lower in these birds than reported in 12 free-ranging rockhopper penguins (0.99 to 1.57 µg/ml, Ghebremeskel and Williams, 1989), but were considered normal by comparison with other penguin species monitored extensively in this laboratory (unpublished data), and no health problems associated with low vitamin A status have been detected in these penguins. Furthermore, the fish eaten by these birds contained from 12,200 (trout) to 468,600 (surf smelt) IU vitamin A per kg DM, and likely provide adequate levels of this nutrient without the need for additional supplementation of vitamin A (Dierenfeld et al., 1991).

Thiamin deficiencies can also occur in animals consuming unprocessed raw or frozen fish due to high thiaminase activity (Halver, 1989). Deficiency symptoms include neurological disorders, edema, and anorexia. Although thiamin status was not measured by laboratory assay, no clinical signs associated with deficiency have been noted in these penguins. The paste supplement is formulated to provide 50 mg thiamin per kilogram of whole fish, which should be adequate based on estimates from determinations of thiamin requirements in seals (Geraci, 1974). The liquid injectable vitamin provided a similar concentration of thiamin. No other watersoluble vitamins were administered during this trial.

Through observations and use, keeper reaction to the use of the vitamin paste was mixed. Several felt that since the paste only had to be given three times a week, as opposed to the liquid which was administered daily, the product saved time. They also felt that there was less wastage with the paste product, since the liquid would seep out of the fish. Less seepage resulted in more confidence in actual dosing quantity with the paste. Others felt the paste was more time consuming than the liquid, since it had to be administered into the gills, mouth, or a cut in the fish, while the liquid is a rapid injection into the body of the fish. Twice, it was noted, the penguins squeezed the paste out of the fish when eating, and then seemed to dislike the taste or texture of the paste, rapidly shaking their heads back and forth. Feed refusal, when paste was on the exterior of the fish, and/or actual rejection of partially-eaten paste-supped fish was reported occasionally. This could be a result of having been on the liquid supplement for a more extended period of time.

Keepers also expressed interest and suggested obtaining a product for use with other species, such as seabirds which consume much smaller fish than penguins do. Again, feeding behavioral questions were raised as to the palatability of the paste, particularly if smeared on the outside of fish. The possibility to alter concentration of vitamins and other supplements fed to piscivorous species, in a paste matrix, allows known dosages to be administered rapidly for future experimental studies. These preliminary data suggest ThiaminE is a suitable product for vitamin supplementation to rockhopper penguins.

Table 1. Plasma vitamin E (a-tocopherol) and vitamin A (retinol) concentrations (mean ± s.d.) in Rockhopper penguins (Eudyptes chrysocome) fed either a liquid or paste vitamin supplement (n=4 per treatment). Seasonal, but not treatment, effects were significant (P<0.05).

<table>
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<th>Date</th>
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<th>Vitamin E µg/ml</th>
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a,b,c: different superscripts are significantly different (p<0.05)
References


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