# EAZA NEWS

## ZOO NUTRITION

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**COLOPHON**

EAZA News is the quarterly magazine of the European Association of Zoos and Aquaria (EAZA)

**Managing Editor** Jeannette van Benthem (jeannette.van.benthem@eaza.net)
**Editorial staff for EAZA News Zoo Nutrition Issue 4** Joeke Nijboer, Andrea Fidgett, Catherine King
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## FOREWORD

Although nourishing zoo animals properly and according to their species' needs is a most basic requirement to maintain sustainable populations in captivity, zoo and aquarium nutrition has been a somewhat underestimated science for a long time. However, thanks to the continued efforts of a small group of colleagues trying to raise the interest in this important aspect of our work, the EAZA Nutrition Group has become an established and active group during the past few years.

Their actions are of utmost importance, as we are facing an increasing number of nutritional challenges. EEPs and TAGS are growing in numbers and developing continuously, and most if not all of them are in urgent need of sound nutritional advice in order to produce adequate husbandry guidelines. Behavioural enrichment is receiving an increasing amount of attention, and food presentation – and thus nutrition – plays a major role. Calorie intake and energy balance of animals living under zoo conditions requires a scientific approach to ensure optimal health and reproduction. Last but not least, sustainable use of resources – a field of interest in which zoos and aquariums as educational institutions should set outstanding examples – has a considerable bearing on our ways of acquiring and preparing animal foods.

This special issue of EAZA News uniquely demonstrates that the EAZA Nutrition Group identifies these and other relevant issues, and approaches and tackles them soundly. EAZA can be proud of such a group.

Leobert E.M. de Boer
*Chairman EAZA*

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PHOTO PAIGNTON ZOO

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PHOTO STOCK

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COVER Feeding the rhinoceros
PHOTO CHESTER ZOO

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GERT JANSSEN

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# Dear member

Dr. Andrea Fidgett, Nutritionist Chester Zoo, United Kingdom, Chair EAZA Nutrition Group,
Member of the Organising and Scientific Committee for the 5th European Zoo Nutrition Conference

Organized by the EAZA Nutrition Group, the 5th European Zoo Nutrition Conference took place earlier this year from 24 to 27 January. Held at Chester's Queen Hotel, the gathering brought together more than hundred participants and speakers from 19 countries including Canada, USA, Colombia, South Africa and Taiwan. All those with an interest in the challenging task of feeding captive wildlife were in attendance and in an increasingly electronic and digital age, we made the most of this opportunity to interact 'face-to-face', the old fashioned way – in a suitably historic setting – Chester is renowned for both its Roman and Medieval architecture!

Formed since the 4th European Zoo Nutrition Conference in Leipzig (January 2005), the EAZA Nutrition Group (ENG) considers its mission to improve communication and coordination among all those engaged in research, education, or application of comparative (zoo) nutrition with those requiring nutrition information, chiefly within zoological institutions of Europe. Our work aims "to promote and support nutrition in zoological institutions as an essential component of their conservation mission".

Arranging the European Zoo Nutrition Conference series falls within this remit and taking as our theme 'New Directions for Zoo Nutrition', we were incredibly fortunate to be joined by several keynote speakers specifically chosen to stimulate discussion and research in previously under-explored areas of zoo animal nutrition. These included: sustainable and ethical nutrition, nutritional physiology of plants, conservation nutrition and nutrition of fish. Further contributions based on these topics and others were invited and our participants met the challenge – with forty oral presentations and 16 posters there was a wonderfully rich and diverse menu of material presented, as evidenced by the conference programme on page 6-7. The conference abstract book is freely available to download as an electronic file from our new section on the EAZA website (www.eaza.net). See the back cover for more details.

This newsletter continues the precedent set by previous conferences, whereby material of a practical and applied nature is summarised in the short article format of EAZA News and circulated to participants and the wider EAZA membership as a special nutrition issue. More detailed papers are collected to form the series 'Zoo Animal Nutrition' published by Filander Verlag. Volume 4 is currently in preparation; the preceding volumes remain an excellent reference resource and are still available to purchase from the publisher (see page 4 for details).

Since the first conference in 1999, it is hugely rewarding to observe nutrition increasingly being recognised as a vital element of zoo animal care and moreover, that everyone who should be talking to each other on this topic, namely keepers, vets, feed companies and researchers studying animals in their natural habitat, were gathered in one place to exchange information and ideas. Long may the energy, enthusiasm and collaborations continue; planning for the 6th meeting in late January, 2010 is already underway, so mark your diaries now.

I am delighted Chester Zoo allowed me to host this conference and my personal gratitude is due to Luke Harding, Jacqueline Noble, Vicky Ogilvy and Sue Walker, for ensuring its smooth running. On behalf of the EAZA Nutrition Group, I would like to acknowledge the EAZA Executive Office, Bart Hiddinga and Jeannette van Benthem in particular, for their continued advice and support of all our activities.

For this 4th nutrition special, my thanks go to Joeke Nijboer, Cora Berndt, Jurgen Hummel, Helena Marques and Christoph Schwitzer for their conscientious editorial work. The newsletter would not be published without support from our sponsors and we extend special appreciation to Kiezebrink Putten BV, Honeybrook Animal Foods, Brogaarden, PMI Nutrition International (LLC), Crystalyx, Garvo, John E Haith Ltd, Livefoods Direct Ltd, Mazuri Zoo Foods, Versele-Laga, Avian Birdfood Products, St. Laurent, Filander Verlag and Arie Blok Diervoeding.

From left to right: Dr. Ellen Dierenfeld, from St. Louis Zoo (USA) who spoke about conservation nutrition at the conference, Dr Andrea Fidgett, Dr. Stephane Helary, University of Witwatersrand (South Africa) who spoke about rhinos, and Prof. Rob Marrs, University of Liverpool (UK), who spoke about plant nutrients.

# CONFERENCE PROGRAMME

24-27TH JANUARY 2008 – CHESTER – UK

## Friday 25th January ~ Queen Hotel, Chester UK

08.00 Registration, welcome and opening remarks

### Conservation nutrition

09.00 Conservation nutrition: collaborative efforts between nutritionists and field biologists
E.S. DIERENFELD [INVITED SPEAKER]

09.45 Nutritional ecology of the blue-eyed black lemur (*Eulemur flavifrons*): Integrating *in situ* and *ex situ* research to assist the conservation of a critically endangered species
S. POLOWINSKY & C. SCHWITZER

10.00 Mineral requirements as potential reason for insectivory by chimpanzees and gorillas in Southeast Cameroon
I. DEBLAUWE & G. JANSSENS

10.15 Nutrients digestibility and consumption evaluation of a diet established for a group of (*Saguinus leucopus*) at Santa Cruz Zoological Foundation [Colombia]
S. GOMEZ, I. LOZANO ORTEGA, A.F. JARAMILLO & A.F. ARIAS

10.30 **BREAK**

### Nutritional ecology of herbivores

11.00 Nutritional ecology of free ranging black rhinoceros: field solution for optimising zoo diets
S. HELARY [INVITED SPEAKER]

11.45 Dental wear patterns in captive wild ruminant species differ from those of free-ranging conspecifics
M. CLAUSS, J. BRASCH, J.C. CASTELL & T. KAISER

12.00 Differences in food comminution in grazing and browsing herbivores – implications for captive diets
J. HUMMEL, J. FRITZ, E. KIENZLE, P. MEDICI, S. LANG, W. ZIMMERMANN, W.J. STREICH & M. CLAUSS

12.15 Intestinal calcium absorption capacity is dependent on dietary calcium content in rabbits
A. LIESEGANG, B. BURGER, M. CLAUSS & G. KUHN

12.30 **LUNCH**

### Health and breeding programmes

13.30 Frothy bloat and serous fat atrophy associated with insufficient fibre intake in a giraffe (*Giraffa camelopardalis*)
K. COLVILE, T. BOUTS, A. ROUTH & M. CLAUSS

13.45 Diet transition affects serum calcium, phosphorus and fatty acids in captive giraffe
E. KOUTSOS, D. ARMSTRONG, R. BALL, C. DIKEMAN, J. HETHERINGTON, L.G. SIMMONS, E. VALDES & M. GRIFFIN

14.00 Giants with hiccups?
C. BERNDT, D. COSTER & L. HIEMSTRA

14.15 Speculations on pathogenesis of metabolic bone disease in captive polar bears (*Ursus maritimus*) with links to taurine status
G.E. HEDBERG, E.S. DIERENFELD, R.W. CHESNEY & Q.R. ROGERS

14.30 Current feeding practices for captive okapi (*Okapia johnstoni*); how are guidelines used?
D. AZULAI, K. ENGELHART, J. NIJBOER, A. BUIJSERT & T. HUISMAN

14.45 EAZA Penguin TAG nutrition survey evaluation
H. MARQUES, A. RODRIGUEZ & M. BUENO

15.00 **BREAK**

### Zoo diet ingredients

15.30 Development of a Dietary Review Team at Marwell Zoological Park
J. MOODY

15.45 Review and comparing of analysis of animal products
J. NIJBOER, P. WOLF & M. DERKS

16.00 Primate feeding solutions at Mulhouse Zoo
D. GOMIS, P. MOISSON, T. FLAHOU, W. NOORDERMEER, S.D. MICHELIS, A.S. BOURSIER & L. TURNER

16.15 Fruits as foods – common misconceptions about frugivory
C. SCHWITZER, S.Y. POLOWINSKY & C. SOLMAN

16.30 Should zoo food be chopped?
A. PLOWMAN, K. GREEN & L. TAYLOR

20.00 ZOOTRITION software development: informal discussions

## Saturday 26th January ~ Queen Hotel, Chester UK

08.30 Registration

### Plant ecology

09.00 Plants are not all the same nutrition-wise!
R. MARRS [INVITED SPEAKER]

09.45 Comparison of two differing diets on digestion in captive red-flanked duikers
E. KUHN, J. HOLLAND, J. WYNNE, R. NOLL, C. KEARNEY & E.S DIERENFELD

10.00 The apparent digestibility of diets of Formosan Reeves' muntjac
C-W. YANG, S.L. ANG, J.T. HSU, H.T. WANG & M.F. LIN

10.15 Herbaceous forages as components in diets of herbivorous reptiles
J. HUMMEL, D. BICKEL, T. ZIEGLER & A.L. FIDGETT

10.30 **BREAK**

### Growth and development

11.00 Effects of two levels of energy allowances and of hibernation on growth in hatchling (*Testudo hermanni boettgeri*) [Mojsisovics, 1889]
M. DIEZ, B. VANSTRAZEELE, J. DETILLEUX, P. DORTU, L. GROLET, L. ISTASSE & C. REMY

11.15 A simple and effective egg-based hand-rearing diet for flamingos
E.S. DIERENFELD, M. MACEK, T. SNYDER, M. VINCE & C. SHEPPARD

11.30 Crop milk replacers for Columbidae hand-rearing protocols: experiences with Sclater's crowned pigeon and Mauritius pink pigeon at Mulhouse Zoo
D. GOMIS, P. MOISSON, J.F. LEFÈVRE & Y. GRIDEL

11.45 Nutritional aspects of hand-rearing an aye-aye (*Daubentonia madagascariensis*): milk composition and infant growth in relation to mother-reared infants
C. BROWN, C. KIBBEY, K. CUMMINS, S. REDROBE & C. SCHWITZER

12.00 **LUNCH**

### Probiotics

13.00 Do probiotics have a role to play in zoo mammal nutrition?
M. WARD

13.15 Effectiveness of the probiotic, Biomin® PoultryStar, for improving health in canaries
L.J.P. LIPMAN, J. NIJBOER & U. EELMAN

13.30 **POSTER SESSION** [SEE END OF SCHEDULE FOR LIST]

14.30 **BREAK**

### Ethical and sustainable nutrition

15.00 Feeding our animals without wasting our planet – some thoughts about sustainable zoo food
H. SCHRAM [INVITED SPEAKER]

15.45 Reviewing The Deep's animal feed sources for sustainability and nutrition
G.HILL

16.00 Fish analog – a sustainable alternative for feeding fish to captive animals
E. KOUTSOS, K. LANTER & M. GRIFFIN

16.15 Attitude of the general public towards feeding live prey
W. LEMMEN, T. VAN DER HARST, S. OPHORST & T. HUISMAN

16.30 Walking tour of Chester

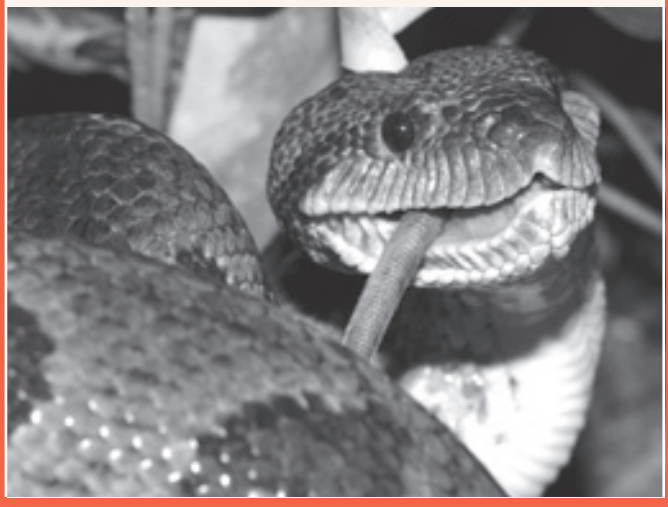
PHOTOS ROB DOOLAARD (IZP)/ROTTERDAM ZOO

## Sunday 27th January ~ Queen Hotel, Chester UK

| | |
|---|---|
| 08.30 | Registration |
| **Fish** | |
| 9.00 | Feeding fish – unique challenges for formulation and feed technology<br>D. SNELLGROVE [INVITED SPEAKER] |
| **Digestibility and energy studies** | |
| 9.45 | Feeding captive cheetahs: bone as animal fibre?<br>G. HANSSENS, S. DEPAUW, H.D. RYCKE & M. HESTA |
| 10.00 | Digestive physiology and feeding of captive tapirs (*Tapirus* spp.)<br>S. LANG, E. KIENZLE, J. HUMMEL, J-M. HATT & M. CLAUSS |
| 10.15 | Comparative digestion studies in wild suids at Rotterdam Zoo<br>J. NIJBOER, M. CLAUSS, J.H.M. LOERMANS, T. ROTH, J. VAN DER KUILEN & A.C. BBEYNEN |
| 10.30 | BREAK |
| 11.00 | Energy and nutrient intake and digestibility in captive mongoose lemurs (*Eulemur mongoz*)<br>E.WILLIS, J. DARTNALL, E. MORGAN, M. KITCHERSIDE, M. GAGE, S. POLOWINSKY & C. SCHWITZER |
| 11.15 | Maintenance energy requirement of birds participating in flying demonstrations at Rotterdam Zoo<br>J. KASDORP, J. NIJBOER & G. JANSSENS |
| 11.30 | Observations on the feeding behaviour of two species of nectar feeding birds at Chester Zoo<br>J.S. JONES, A. WOOLHAM, A.L. FIDGETT, M. JONES & L. ALEXANDER |
| 11.45 | Concluding remarks and thanks |
| 12.30 | Zoo visit |
| 16.30 | Return to Queen Hotel / Conference ends |

## Poster presentations

- Trypsin inhibitor content of parrot cooking diets and other diet components
  E. CLARKE & P. WOLF
- Macroscopic digestive anatomy of a captive lowland anoa (*Bubalus depressicornis*)
  M. CLAUSS, S. REESE & K. EULENBERGER
- Nutritional research at Twycross Zoo
  J.S. JONES, N. MASTERS & J. HOOLEY
- Dietary antioxidants reduce post-exercise oxidative stress in adult budgerigars (*Melopsittacus undulates*)
  S.D. LARCOMBE, C.A. TREGASKES, J. COFFEY, A. STEVENSON, L. ALEXANDER & K.A. ARNOLD
- Welfare is not a privilege of show animals only: carbon dioxide euthanasia of small prey animals
  A. SCHATZ & M. CLAUSS
- Iron metabolite analysis in captive nonhuman primates
  N. SCHMID, M. CLAUSS, P. WAESCHE, W.J. STREICH, M. GASSMANN & J-M. HATT
- Hemosiderosis in captive lesser hedgehog tenrecs (*Echinops telfairi*)
  D. THALLER, N. SCHMID, F. SCHWARZENBERGER, W.J. STREICH, H. KUNZLE & M. CLAUSS
- Effect of a probiotic (Yakult™) on faeces consistency of primates
  I. VALKENBURG, H. DE VRIES, C. BERNDT, A. VELDHUIS, M. HEIDA, E. DE GROOT & T. HUISMAN
- Salt licking of primates is not always a sign of sodium hunger
  S. VERWEIJ, M. ROETHOF, W. JENS, D. KUIPER & T. HUISMAN
- Influence of concentrate or roughage feeding on body weight and blood parameters in captive plains viscachas (*Lagostomus maximus*)
  P. Y. WIELINGA, U. EULENBERGER, T.A. LUTZ, M. CLAUSS & J.M. HATT
- Nutrition of captive tapir (*Tapirus indicus* and *Tapirus terrestris*): a study on feed Intake, daecal consistency, body condition and health problems
  T. WILKINS & M. CLAUSS
- The effect of diet modification on Formosan pangolin (*Manis pentadactyla pentadactyla*) fecal flora
  C-W. YANG, S.C. CHIN, C.W. YANG, Y.H. CHUANG, C.Y. LIEN, C.L. CHEN & H.T. WANG
- Feed and nutrition of amphibians and reptiles at Taipei Zoo
  C-W. YANG
- The effect of concentrate to forage ratio on faecal conformation and bacterial population in Formosan serows (*Capricornis crispus swinhoei*)
  C-W. YANG, C.M. LIN, H.T. WANG, M.F. LIN & J.T. HSU
- Diet selection and nutrient intakes of captive lion tamarins (*Leontopithecus* spp); a preliminary study
  M. YAXLEY, C. SCHWITZER & S. CHIKUNYA
- Rumen pH and claw health in two groups of captive wild ruminants
  W. ZENKER, B. ALTENBRUNNER-MARTINEK, J. HUBER & M. CLAUSS



# **Feeding our animals without wasting our planet;** some thoughts about sustainable zoo food

Harry Schram, Zoo education/interpretation consultant, Antwerp, Belgium

**Whereas most zoos and aquariums have been actively committed to nature conservation for decades, the wider issues of sustainability and environmental impact are a much more recent source of concern. Yet an increasing number of institutions are already making important progress in this area.**

*Sustainable development meets the needs of the present without jeopardizing the future. Sustainability is a long-term endeavor. But the future starts now.*

Historically speaking, waste reduction and recycling programmes were the first practical contributions of zoos to a more sustainable world: a number of North American and European zoos were already making efforts in this field in the 1970s. As the energy crisis became more obvious, and sustainable energy sources became a more feasible option, this was the next area in which zoos and aquariums became more active. Other sustainable and environment-friendly construction methods and techniques soon followed.

## Possible progress

But surprisingly, some important core aspects of the zoo and aquarium business have not yet been significantly reviewed or evaluated on the basis of their environmental impact. One of these is no doubt collection planning, the outcome of which obviously has enormous and long-term impact on elements such as energy and water use.
Another area where a lot of progress is still possible is that of animal nutrition. Individual consumers often find it easier to change their food habits (and subsequently their 'ecological footprint') than any other aspect of their environmental behaviour. To the average consumer or citizen, changing their food consumption is often easier to achieve than transforming their home, switching to renewable energy sources or adapting their transportation behaviour.

But to institutions such as zoos and aquariums, reviewing, evaluating and changing nutrition programmes to reduce their environmental impact is not yet commonplace. Through their education programmes, many (if not all) zoos hopefully make their visitors aware of how agricultural practices (such as pesticide and fertilizer use) are contributing worldwide to a loss of biodiversity. Additionally, aquariums point out the disastrous effects of over-fishing. Yet, how many zoos or aquariums have made the consistent choice to procure as much of their animal nutrition from organic farming as possible? How many are refusing to buy fish from unsustainable or questionable sources?

## Lack of commitment

There are some explanations for this apparent lack of commitment. In our current economic context (where pollution, energy use and transportation are virtually government subsidised, often making non-green food cheaper than the more sustainable alternatives), greening your food shopping list will unfortunately almost always mean increasing your food bills. Animal food origin is not the most obvious aspect of animal husbandry, so zoos and aquariums might prioritize more visible green choices, such as renewable energy or construction, reed bed water filtration or recycling programmes.

But when it comes to 'talking the talk and walking the walk', a more sustainable nutrition programme combined with the right interpretation might still be one of the most obvious policy changes when it comes to empowering your visitors, and making them aware of the ways in which they themselves can also make a change in their consumer-behaviour. Many zoos combine animal feeding with keeper talks – and often visitors can peek into animal kitchens. Why not explain the rationale behind your green nutrition choices, and stress that very inspiring 'yes, you can do this at home!' element?

'Green' your food shopping list PHOTO ROB DOOLAARD (IZP)/ROTTERDAM ZOO

Explain green nutrition choices during animal feeding PHOTO ROB DOOLAARD (IZP)/ROTTERDAM ZOO

## What do we want to achieve?

As in all institutional and operational sustainability concerns, a sustainable zoo or aquarium nutrition programme will try to meet the health and husbandry requirements of the animal collection, while reducing the short and long-term impact on wild habitats and species, on the physical environment in general (including non-renewable energy reserves and the climate), and, last but not least, on present and future human populations worldwide.

Sustainability is a wider concept than 'environment-friendly', as human ethical concerns (such as fair trade) are an integral part of it. In the human green food scene, some hard-line proponents of 'buy organic, buy local' will not accept any food that has to be imported over a significant distance. While transport aspects (food miles) remain important considerations, rejecting any foreign or exotic imports might not always be the best way to serve the interests of both local populations and the habitats we want to safeguard in the rest of the world. Using fair trade (and sustainably produced) coffee, bananas or rainforest products does not only contribute to saving habitats and species, it also creates an economic support basis for conservation measures.

## Ideas to consider (and questions to ask yourself)

- As a good zoo, you are rightfully concerned about the welfare of your zoo animals. You respect (and hopefully exceed) minimum standards; you have adapted your exhibits and improved enrichment. Are you aware of the welfare situation of the food animals that you use to feed your animals? Ethical farming methods do exist.
- How much of your animal food is produced locally (and how much of this seasonally – or in greenhouses?), and how much has to be imported? How many miles does your animal nutrition travel in a day, a month, a year? Can you reduce this?
- Have you looked into organically produced alternatives? Is it feasible? If you think it would cost you more money, do you know exactly how much more? Please note that 'visible quality' requirements that might raise prices for normal consumers are generally not relevant to zoo animals, so there may be organic produce available at lower prices.
- Do any of your animal nutrition products contain GMO's (genetically modified organisms) or soybean or palm oil products from unsustainable (former rainforest) origins? How compatible is this with your institutions commitment to safeguarding biodiversity?
- Do you refuse – reduce – reuse – recycle food packaging material?
- Restaurants can do it. Supermarkets can do it. Your visitors/consumers can do it. Why wouldn't your zoo or aquarium have a policy of buying only fish or seafood from certified and reliable sustainable sources? Are you aware of the environmental risks involved with fish farming (disease, antibiotics, introduced species...)? These are certainly not always a sustainable alternative!
- If your animal nutritionist is already convinced, why not continue with your catering or restaurant manager? What about your staff canteen?

## Can we really make a difference?

There are some 250,000 higher vertebrates living in EAZA member zoos and aquariums. This is equivalent to the population of just one medium-sized European city. There are ten million consumers (and 7.5 million pigs) living in a small country like Belgium...You may wonder if it is all worthwhile, if we as a zoo and aquarium community can really make a significant difference.

I am convinced that we can. Of course there is the famous quote that "no one ever made a bigger mistake than he who did nothing because he could only do a little". Or "every journey begins with the first step".

But there is more. In the future we will be increasingly held accountable for our actions, not just by our visitors, but also by regulation authorities, various NGOs and the media. We cannot claim to make a difference and then not do our utmost to live up to that claim. But above all, our core business is to amaze and inspire people. The overall majority of the 140 million people that pass through our gates every year may feel they have neither the opportunity nor the power to do something about issues such as climate change or the destruction of the rainforest. It is our duty to convince them that they can indeed make a difference, to empower them as critical consumers. As yet, consumers do not rely on GPS navigation systems that tell them in what direction to push their supermarket trolley. They are still making conscious choices every day. Let's do our best to inspire them. •

Fair trade and sustainable produced PHOTO STOCK

# Sustainability and nutrition of The Deep's animal feed sources; a review

Graham Hill, The Deep, United Kingdom PHOTOS BY THE AUTHOR

**The ethical review process at The Deep, as in many institutions, considers all aspects of its organisations' activities. Recently, this has focussed on re-evaluating fish food suppliers and feeding regimes with the aim of improving three key areas: nutritional suitability, environmental sustainability and overall environmental impact of feed purchasing.**

In recent years, The Deep has made significant changes in many areas to improve practices, for example regarding energy and waste management, environmental awareness and an ethical and environmental purchasing policy. This experience was applied to the sourcing of feed in such a way that it met our environmental criteria without compromising animal health. Using the workflow below we developed the necessary processes to conduct a sustainability audit.

## Workflow

- Reviewing current literature on this subject.
- Compiling a list of all the suppliers and food types that were currently used.
- Determining practical considerations of a potential change in feed using the following priority hierarchy:
  - > Essential to animal health
  - > Quantity used
  - > The range of animals a particular item is used for
  - > Availability
  - > Current sustainability
- Posing a series of questions to put to suppliers to determine their over all environmental sustainability.
- Acquiring the information.
- Deciding on each supplier and/or food type.

## Nutritional suitability

Are the feeds we use the best and most appropriate for the animals? A review of the nutritional profiles of each food type is currently underway. The analysis of the information will allow decisions to be made as to whether current feed types are the best available in terms of their environmental sustainability and nutritional composition.

The majority of aquarium feed is frozen. It is well documented that vitamins, in particular water-soluble vitamins and other elements, are quickly degraded in killed fish even in ideal freezer conditions (Bernard and Ellen, 2002). Proximate analysis of frozen feed is therefore an important part of quality control. Whilst this is maybe more commonplace in zoos, aquariums (as far as this writer believes) do not regularly use this technique. As part of this review, frozen feed surveillance will become a regular part of feed evaluation, not only for ascertaining the condition of stored food items but also to monitor seasonal fluctuations in food composition.

The Deep, Hull, UK Environmental Charity

## Advanced feed supplementation

Nutritional supplements can be used to enhance the nutritional profile of a feed item that has been found to be an environmentally sound choice, but placed lower down in the decision hierarchy due to a lower nutritional content. The development of marine fish and invertebrate feed supplementation has advanced significantly in recent years. The Deep and Zoolife Inc. have made significant improvements to overall fish health with the use of specifically developed, patented, emulsion-based liquid vitamin supplementation. This development has demonstrated significant increases in the transfer of bioavailable carotenoids into live food and frozen feeds (Zoolife Inc., data on file). In addition, the natural marine algae and plankton oil components are derived from sustainable sources.

Historically, plant materials used as feed in marine and freshwater aquaria have been terrestrial in origin, and unsuitable nutritionally for aquatic animals, particularly marine organisms. Use of marine algae and a cold set mixed-algae gel used at The Deep results in browsing that is much more similar to that of wild, herbivorous, marine fish, both nutritionally and behaviourally. These changes limit overfeeding and have associated wastage and financial savings. Ultimately, the aim is to maximise sustainability, but the benefit of improved nutritional health could lead to savings in re-stocking and health related expenditure that can always be used to demonstrate the inherent value of conducting such an audit.

## Environmental sustainability

Are the feeds used by The Deep from sustainable sources? How do we obtain this information? There are several sources of information specifically for determining the sustainability of specific fish species. The three chosen were selected for their ease and speed of use, and relevance to the food types The Deep purchases.

### Sustainable fish guides

There are a number of guides produced around the globe, for example: the Marine Conservation Society (MCS) 'Good Fish Guide', the Monterey Bay Aquarium 'Seafood Watch' and the Audubon Society 'Seafood Wallet'. These guides alert purchasers of seafood to species that are, and are not, deemed as sustainable and they have been instrumental in the shift of consumers' attitudes to marine produce (Atkinson, 2007). The MCS 'Good Fish Guide' provided a good starting point in the assessment of stock sustainability of some of the feed species The Deep uses (www.mcsuk.org).


MCS Good Fish Guide PHOTO MARINE CONSERVATION SOCIETY
www.mcsuk.org

### Marine Stewardship Council (MSC)

The MSC is an independent, global, non-profit organisation created by Unilever and the Worldwide Fund for Nature (WWF) in 1997, that has developed an environmental standard for sustainable and well-managed fisheries (www.msc.org). It provided further, more detailed information on feed fish that were extracted from sustainable fisheries.

### Sustainable seafood review

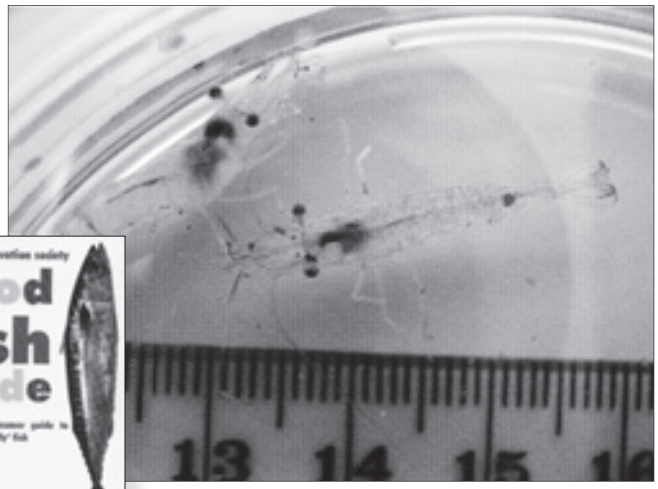
It was very fortunate that during our research that a M.Sc. thesis on sustainable seafood was made available (Atkinson, 2007). It contained specific case studies of both suppliers and feed fish species that were of direct relevance to The Deep. This information allowed the development of specific questions to assess the suppliers' current situation and commitment to environmental sustainability. The questions were distilled to:

- Do you have a written environmental policy?
- Can you identify where the fish are caught?
- What fishing methods are used?
- Do you have MSC or similar accreditation?

## Overall environmental impact of feed purchasing:

Are the feeds being sourced from suppliers, which minimise transport and their 'carbon footprint'? There are a number of online calculators (e.g. www.carbonfootprint.com) that can estimate total carbon footprint, determined by the type of transport and the distance over which feed is transported. The sourcing of locally produce can have a significant impact on the overall sustainability of a feed item by reducing transport miles. In-house processes were also scrutinised to optimise consumption and minimise wastage. A re-assessment of display biomass, food preparation and feeding practices highlighted areas where they can be streamlined to minimise waste and expenditure without compromising animal health.

Enriched live River shrimp with Zoolife Inc. sustainable plankton oil



## The reality – for the suppliers

The reality of trying to acquire the information from a number of different suppliers is somewhat problematic. Whilst our suppliers on the whole were enthusiastic and said they would provide the information we requested, actually receiving the information has been difficult to accomplish. And there maybe a number of factors involved:

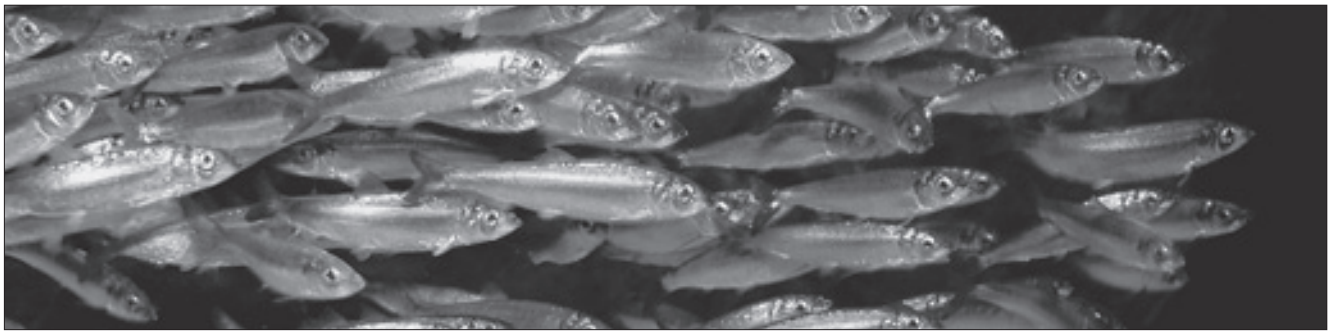
### The size of the company

In relative terms this is still a new and growing area for many smaller companies that have yet to formalise their company's environmental policy. Accommodation of customers' requests for sustainability information can therefore be a difficult task or at this point it may not be a priority for the company.

### Request frequency

For many institutions this re-assessment of practices has yet to take place and the numbers of requests to suppliers has not yet reached a level where they need to focus specifically on sustainability. This is changing however, but it still takes perseverance from the institution to prompt their suppliers into delivering the information.

PHOTO ROB DOOLAARD (IZP)/ROTTERDAM ZOO



# SUSTAINABILITY AND NUTRITION

## The reality – for aquariums

Limited alternatives: there are only a small number of companies that can supply fish for the aquarium industry in large enough volumes to meet its demands. This effects how suppliers need to be approached in order to maintain good relations. The dilemma an institution may find itself in if a supplier is deemed by its criteria to be unsustainable is how to inform the supplier that there are practices in its business that the institution is not happy with whilst still securing a source of food in the interim period? How long should the supplier be given to address aspects of its business? A certain amount of diplomacy is required here.

## Finding a balance

Often a balance must be struck between sustainability of food supply and animal welfare, where practical considerations are addressed. Price, reliability of service and availability of the food item all have an influence on decisions and must be taken into account along with environmental/ sustainable aspects. It may be necessary to find an additional seasonal food species to replace a single year round unsustainable feed source. This has obvious financial implications.

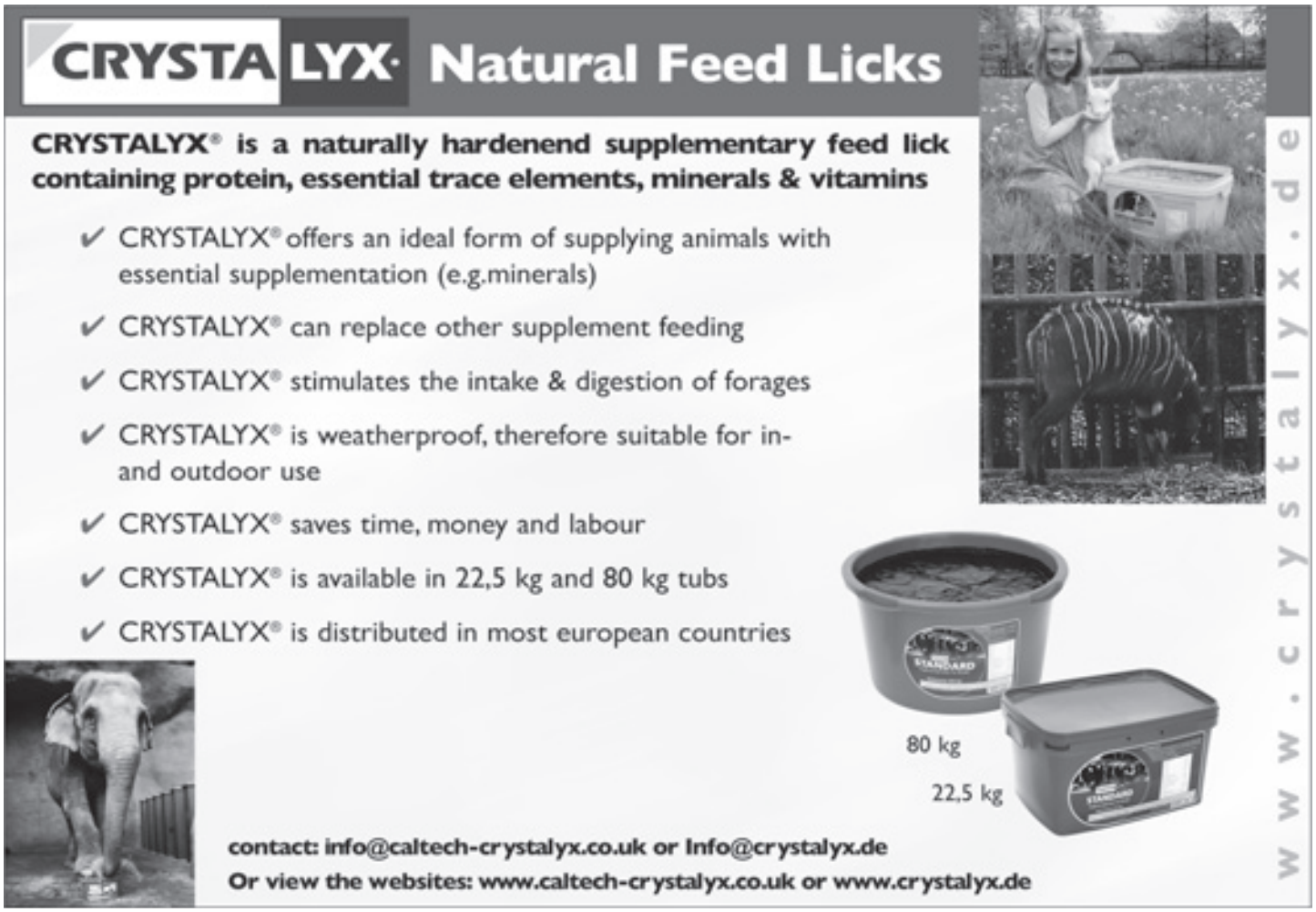
## Customer-driven change

Whilst this review process is not a new concept, in the past it has sometimes been difficult to obtain information from suppliers. Feed supply companies however, are becoming increasingly aware that they need to provide these data and pay more attention to their own environmental activities in order to retain business. As bulk purchasers of a wide variety of foodstuffs, animal institutions represent a significant driving force that can generate momentum within the feed supply industry to continue to develop their environmental profile. The power of customer-driven change is a significant force and has found to be very successful with campaigns like the 'Dolphin-friendly tuna', 'Give a swordfish a break' and many others.

## A dynamic process

The process described above is a dynamic one requiring re-evaluation and an awareness of the rapid evolution in environmental strategies that is taking place and continues to become a more prominent feature. It can be applied not only to sourcing fish feed but is also relevant to all aspects of our businesses. In addition to it being our moral obligation as an environmental and conservation charity, it has led to financial savings, but more importantly, made us think critically about our company as a whole, and the integration of company-wide environmental philosophy, which will hopefully stimulate similar activities amongst our suppliers. •

Atkinson, J. (2007). *Sustainable seafood review for the Zoological Society of London.* M.Sc. thesis, Imperial College London, United Kingdom.
Bernard, J. B. and M.E. Allen (2002). *Feeding captive piscivorous animals: Nutritional aspects of fish as food.* Nutrition Advisory Handbook, fact sheet 005.



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EAZA NEWS
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NUTRITION
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# A personal overview of the development of a dietary review team at Marwell Zoological Park

Jacqueline Moody, Marwell Zoological Park, United Kingdom PHOTOS BY THE AUTHOR

**Captive animal nutrition is an area which is becoming ever more important in the management of captive wild animal populations. The development of a team of keepers, headed by an individual with a keen interest in nutrition, in addition to some form of nutritional background, is one way in which collections can effectively begin to review the diets of all species within their collections. This method has been successfully implemented at Marwell Zoological Park.**

My interest in animal nutrition began when I was studying at the university, where I carried out a nutritional study on captive elephant diets, involving the chemical analysis of hay and browse fed to captive elephant populations within the United Kingdom. A questionnaire was also produced by the EAZA Elephant Taxon Advisory Group regarding general provisions of elephant diets in this country. Shortly after starting at Marwell Zoological Park in 2006, this work was recognised by the general curator, who then approached me about looking at the potential of forming a dietary review team at the zoo.

## Forming a dietary review team

Following a nutritional training day at Marwell Zoological Park in 2006, to which all keeping staff was invited, a dietary review team was established. This provided an excellent opportunity to advance a keen interest I had, and a way in which I could focus on increasing keeper awareness of the crucial importance of captive animal nutrition. This article describes how we have achieved this at Marwell Zoological Park and how keeper involvement is so important in this vital process.

## The importance of dietary reviews

The increase in nutritional knowledge and technology means that we are now able to look into the diets of captive animals in greater detail than in years gone by. Regular dietary review allows keepers to monitor a range of different factors including:

- Exactly how much food is offered to an animal or group of animals in weight form.
- Whether the animals are receiving quantities appropriate for that species.
- The range of ingredients going into a diet. In this way, we can see if the animals are receiving a balanced diet and whether the different ingredients are adequate or indeed even necessary for the species in question.
- Whether we can relate any health issues to potential dietary problems.
- Whether the implementation of any dietary changes was the best decision to make in terms of factors such as improved animal health and condition, reduced selectivity and improved reproductive performance.
- Ensuring that feeding practices are standardised throughout the zoo. This may highlight a need for clearer feeding instructions.
- Comparison with feeding practices employed at other zoos, as well as with wild feeding ecology and published husbandry guidelines.

## Objectives of the dietary review team

The primary purpose of establishing a nutrition team was to initially document the diets of all species within the zoo, and this would provide a foundation for further dietary investigation. Members of the dietary review team were selected for their individual interest in nutrition. The team currently consists of nine keepers and section managers representing all animal sections across the zoo. The objectives of the team were as follows:

- To primarily document the diets of all vertebrate species across the zoo.
- To analyse all of the diets using ZootritionTM software.
- To identify and highlight any nutritional problems such as diet ingredient composition, food presentation and selective feeding.
- To identify relevant nutrition projects for team members to undertake.

These would be areas requiring further dietary investigation and also which are of interest to the team members.

## Stages of diet documentation

The first stage of the process was to update a previously drafted up diet sheet. Copies were then distributed to team members, who proceeded to weigh out the diets of all species on their sections. Specific guidelines were handed out regarding the information required. For example, details on hay and browse provisions where possible, the range of fruit and vegetable extras given in appropriate species and details of any supplements given. Any other relevant dietary information was asked for which might

# DIETARY REVIEW TEAM

aid the analysis. Over the period of a few months, diet sheets were collected and filed in appropriate taxonomic categories.

## Dietary analysis using Zootrition™

My initial training using the Zootrition™ software was gained through attending a course at Chester Zoo, run by Andrea Fidgett. This provided me with the knowledge required to analyse all diets at Marwell Zoo. Each diet was then analysed on an individual animal basis using the programme. Therefore, where diets were documented on a group basis or for herd situations, an average was taken to give an indication of what each animal would receive if the diet was shared out equally. Measures were taken to ensure the analysis of all diets was as accurate as possible. This included:

- Entering the nutrient composition data for the feeds we use at Marwell Zoological Park to increase accuracy.
- Where diets vary daily; with many of the reptile species for example, analyses were carried out to represent the variety of feed ingredients given.
- For hay and Lucerne, values for forage analysed at Marwell Zoological Park were entered into Zootrition™ and used to try and increase accuracy. These values were however fairly restrictive.

I have now provided training for several members of the team to give them an overview of the programme. In this way, they are able to see exactly how it works and understand the process from diet documentation to nutritional analysis.

## Identification of problematic diets

This whole process of diet documentation and analysis has led to the identification of certain diets which are potentially problematic or in need of further review. The main diet highlighted as a result of this work is that of our giant anteater (*Myrmecophaga tridactyla*). The diet of this species has now become a major project in itself. From the initial basic analysis of the anteater diet, we have since achieved a number of objectives. A wide range of diets and dietary details for this species from collections has been collected on a global scale for comparative purposes. The diet has been chemically analysed in the laboratory to obtain an idea of the nutrient levels present as well as bacteriology procedures carried out on diet samples. The main aim of this work is to produce a new diet for our anteaters. We have been working in close connection with Mazuri Zoo

Foods, to initially develop a powdered diet, which we can form into a dry meal consistency. If this diet was eventually produced on a commercial scale, we would hope to develop it into an expanded 'termite-sized' pellet. Trials of this new diet should commence very soon.

## Setting nutrition projects

A list was drawn up of some other species whose diets also require further investigation, and projects were allocated to team members based on their individual interests. These are mostly species they work with on a regular basis and which are on their own sections. This was felt to be more beneficial as the team members are then able to weigh out the diets, closely monitor feeding behaviour and note any changes or issues that may need addressing. They are also able to dedicate a higher proportion of time to species on their own sections.

## Dietary change implementation

It must be emphasised that any decisions regarding a potential dietary change made by the dietary review team must go through a strict curatorial and veterinary process. Under no circumstances are any major dietary changes made without such consultation. Once it is felt appropriate, a protocol is drawn up containing full details about a dietary change and how it should be implemented. Communication with animal keepers is essential beforehand to ensure that everybody understands the process and is fully compliant.

## Time may be an issue

There are a number of problems that may occur as a result of forming a dietary review team. However, once these problems have been addressed, there is no reason why the team should not continue to run successfully. One of the biggest problems is the issue of time. Once the process of diet documentation and analysis begins, you soon realise how much work there is to complete. Particularly during the winter months when keeper working hours maybe shorter, keepers often find it difficult to find the time to carry out some of this work. Effective time management can help to address this problem.

## Negative staff attitudes

Staff motivation can sometimes restrict progress as well. Negative attitudes towards dietary work amongst established keepers may divert team attention away from the real purpose of the work. However, providing everybody with a clear explanation of what is trying to be achieved and the reasons why can help to increase awareness of this important work. It is essential that team members realise the importance of their role within the team from the very beginning. As nutrition representatives for their sections, they have a vital role in relaying information and in ensuring steady progress of dietary work. For example, if a diet is inaccurately weighed, this may affect the nutrient levels that result from the analysis and so judgements may be made about the diet that may not be completely true.

## Using different resources

Inaccurate information can be another problem. Different keepers relay sometimes different information about a particular diet, so it is important to ensure the correct information is being received. This may mean asking team members to reweigh a diet so that the information is correct. To maintain momentum within the team, regular contact is essential; both to monitor progress of keepers and to offer any support or answer any questions. Again, this can depend on keeper time, especially during the winter months. Regular meetings are a good way to discuss progress and exchange ideas. The value of individual catch up sessions cannot be underestimated though, as these provide valuable time to focus on each team member and their specific project.

## Outcomes of forming a dietary review team

The outcomes of forming a dietary review team are numerous. Primarily and most importantly, is to increase awareness of the need for dietary reviews within captivity. It is no longer acceptable to take the attitude that the animals have always been fed a particular diet, so why change this. Although a diet may appear to maintain a species, potential improvements could be made to further improve health and reproduction. The technology and skills are now available, so they should be used to their full potential. A dietary review team allows zoos to highlight problematic diets and to address them. It also results in increased communication with a whole range of people including zoo nutrition professionals across the world and feed suppliers and manufacturers. Finally, such a dietary review allows us to share the information out there and to consequently identify areas in need of further research.

## Some advice

Before forming a nutrition or dietary review team, there are various factors to take into consideration. The first and most important step is to choose a motivated team of keepers, which all have a keen interest in animal nutrition. The importance of their role within the team must be enforced from the very beginning. Any support must be provided as, and when, necessary. It is important to nominate one coordinator who is responsible for the collection and storage of diet sheets and for their subsequent analysis. This is to standardise the process and minimise the risk of error. It maybe advantageous for this person to have some form of nutritional background, although an enthusiasm for the subject is equally as important. To maintain momentum, holding regular meetings, both on a group and an individual basis, is crucial. Providing regular feedback to team members will help install this. Finally, it is vital to set realistic timescales. Choose problematic diets which are of highest importance, focus on them and produce the desired outcome before starting a new project. Dietary work needs to be approached with a degree of caution, skill, expertise and time; but the development of a dietary review team can be an excellent starting point for carrying forward the increasingly expanding area of animal nutrition.

Should any zoological collection be interested in investigating the potential of forming a dietary review team, please feel free to contact me for further information at jackiem@marwell.org.uk •

NUTRITION RESEARCH PROGRAMME

PHOTO SARAH FORBES

# Setting up a nutrition research programme at Twycross Zoo

Julie S. Jones, Nic Masters, Jackie Hooley, Twycross Zoo, East Midlands Zoological Society, United Kingdom

**"As a basic foundation of animal management, nutrition is integral to longevity, disease prevention, growth and reproduction" (Dierenfeld, 1997). Because zoos are responsible for the care of their animals they should invest in nutrition research to ensure they get this basic foundation right; in recognition of this, nutritional research is a vital component of the research focus at Twycross Zoo.**

Close links with the University of Nottingham and its newly established School of Veterinary Medicine and Science have driven a progressive nutrition research programme and created opportunities for students to experience zoo life for themselves. The appointment of Nic Masters of the International Zoo Veterinary Group (IZVG) as the resident veterinarian at Twycross Zoo and more recently the addition of Julie Jones as a voluntary consultant nutritionist have enabled animal nutrition at Twycross Zoo to progress enormously.

## Nutrition information storage and analysis

The purchase of the Zootrition™ software by Twycross has also provided an excellent tool for nutrition information storage and analysis. This programme allows a large facility such as Twycross Zoo to manage the dietary needs of the animals and assist with diet planning which, once established, can follow the animals should they move. It is hoped that this information can be shared with other facilities to build a network of information, to compare husbandry practices and to offer information valuable to other collections.

## Bringing together expertise

A nutrition research group has been formed at Twycross Zoo, which will bring together the expertise of the nutritionist, veterinary team, associates of the University of Nottingham and key decision-makers at the zoo, including the newly appointed head of research, Dr. Lisa Yon, to plan the future of nutrition research at the zoo. This group will collaborate to identify priority research needs and design nutrition projects accordingly.

## Collaborative nutrition research

An excellent example of collaborative nutrition research is the red-fronted macaw (*Ara rubrogenys*) project, which commenced in 2007. Funding was secured enabling Twycross Zoo, the University of Nottingham School of Veterinary Medicine, and John Ray, the EEP coordinator for the red-fronted macaw, to work together to collate and assess the current feeding practices in captivity and nutritional requirements of this species. The aim is to produce a nutrition chapter for the optimal feeding of this species in captivity, following the recommendations made by the chair of the EAZA Nutrition Group, Andrea Fidgett (2005), for inclusion into the Red-fronted macaw EEP husbandry guidelines. Additional information on the captive breeding success and husbandry of the red-fronted macaw will also be collected as part of this project. We are grateful to Sarah Forbes (2007) for her initial work on this project and all EAZA member institutions that have helped so far by completing surveys and providing invaluable information.

## Customising Zootrition™

The next task for Twycross Zoo, and specifically the nutritionist, will be to customise the Zootrition™ software for the zoo's collection. Zootrition™ is an excellent tool for information handling and combined dietary and individual food item analysis, but it will need to be provided with information specific to the animals and diets offered at Twycross Zoo. Research will focus on both the food items offered, which may require some nutritional analysis where published analysis is not currently available, and the full diets offered to the animals. All items ordered by the commissary team will need to be itemised and added to the database. Once this information has been stored, animal diet sheets can be included and cross-referenced to produce a nutritional analysis of the combined diet, which can then be compared to published nutritional requirements. Study of dietary intakes and refusals of food by individual animals will allow the team to assess dietary balance by comparing what is offered with what is consumed. Assessments can be made for groups of animals and, where necessary, improvements can be implemented.

## A more efficient way of working

The nutrition programme is ambitious and very time consuming. Constant change within the zoo environment and the inclusion of life style and life stage requirements, such as breeding and gestation/lactation needs, will complicate the task even further. However, once established it will provide the veterinary team with an invaluable resource to support clinical evaluation. In addition, the keeping teams will have a dedicated and fluid feeding programme which will help to shape husbandry regimes and provide sound nutrition programmes for all the animals in their care and upon which to work towards a leaner, healthier, and more efficient way of working. •

Dierenfeld, E.S. (1997). *Captive wild animal nutrition: a historical perspective.* Proceedings of the Nutrition Society, 56, 989 – 999.

Fidgett, A.L. (2005). *Standardizing nutrition information within husbandry guidelines: the essential ingredients.* International Zoo Yearbook. 39. 132 – 138.

Forbes, S.K. (2007). *Nutritional analysis of the diet of red-fronted macaws (*Ara rubrogenys*) at three zoological collections in the United Kingdom.* M.Sc. thesis, Institute of Zoology, Zoological Society of London, Regents Park, London, United Kingdom.

Zootrition™ *Dietary Management Software*, Wildlife Conservation Society (2001).

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Chopping food PHOTO PAIGNTON ZOO

CHOPPING ZOO FOOD

# Should zoo food be chopped?

Amy Plowman, Whitley Wildlife Conservation Trust, Paignton Zoo, Kiri Green and Laura Taylor, School of Biological Sciences, University of Plymouth, United Kingdom

**The food provided for many zoo animals is often chopped into small pieces. What are the reasons for chopping food and should zoo food even be chopped?**

## Abstract

Food provided for zoo animals is often chopped into small pieces even if the animals are capable of processing much larger items. Chopping food takes time and increases the risk of bacterial contamination and nutrient loss. Anecdotally, keepers chop food because: it enables all individuals in a group to obtain enough of each food type and reduces aggression; it prevents wastage caused by animals taking one bite and discarding the rest of a large item; it enables a wider scatter feed to encourage foraging behaviour and prolong feeding time.

We investigated these explanations in a primate and an ungulate species. Food was provided in four conditions: chopped/clumped, chopped/scattered, whole/clumped and whole/scattered. Study subjects were observed individually at feeding time, during which number and type of each food item eaten, instances of aggression and total feeding time were recorded. The behaviour of each subject was also observed for two thirty-minute sessions at other times throughout the day. Neither food size nor distribution significantly affected any of the variables measured for most of the subjects. However, the most subordinate primate was able to obtain significantly more food ($P = 0.008$) when it was whole rather than chopped and the chopped/clumped condition resulted in significantly less foraging throughout the day ($P = 0.013$) by the ungulates in one of three zoos. Chopping food does not appear to have any of the advantages keepers assume, suggesting that if animals are capable of processing it, food should be provided whole to avoid the increased risk of contamination and nutrient loss and to save keeper time.

## Why chop food?

Chopping food has several disadvantages: it takes large amounts of keeper-time, the chopped edges increase the risk of bacterial contamination (e.g. Gleeson and O'Beirne, 2005) and the rate of nutrient loss (e.g. Brecht, 1995). Conversely, leaving food whole may allow the animals to express more natural feeding behaviour (e.g. Young, 1997) and increase their food processing time (Smith *et al*., 1989). So why do keepers chop food? Reasons offered are:

1) It reduces aggression and enables all individuals in a group to obtain enough of each food type.
2) It enables food to be scattered more easily across large areas of the enclosure to encourage foraging behaviour and prolong feeding time.
3) It prevents wastage caused by animals taking one bite and discarding the rest of a large item.

## Effects of food item size and food distribution

However, there are inconsistent reports of the above-mentioned effects and it appears that food item size and distribution are often confounded, i.e. chopped food is scattered whereas whole food is presented in clumps, and so their separate effects may not be apparent. In this study we attempt to distinguish between the separate effects of food item size and food distribution and to investigate whether the suggested advantages of chopping food are valid in a primate (Sulawesi crested black macaque *Macaca nigra*) and an ungulate (Brazilian tapir *Tapirus terrestris*) species.

## Methods

### Study subjects

Three adult female Sulawesi crested black macaques (in a group of 3.5.3) were studied at Paignton Zoo. The subjects, the most dominant female, the most subordinate female and a female of intermediate status, were selected on the basis of their known dominance status. Eight Brazilian tapirs served as study subjects, including 1.2 at Paignton Zoo, 1.1 at Newquay Zoo and 1.2 at Bristol Zoo. The Paignton and Bristol groups consisted of an adult pair and their latest infant (both four months old at the time of study), whilst at Newquay Zoo there was a female and her infant (six months old at the time of study).

Tapir eating whole 'greens' PHOTO PAIGNTON ZOO

# CHOPPING ZOO FOOD

Macaque eating whole 'fruits' PHOTO PAIGNTON ZOO

## Feeding conditions

The usual diet for all animals in the study included a mixture of dry feed and various fruit and vegetables, with the exact variety and quantity of food items varying between groups. Each group was provided with its normal diet at the usual time during the study, in all cases the produce part of the diet was provided once per day. For the study this produce part of the diet was presented in two size conditions (chopped or whole) and two distribution conditions (clumped or scattered) resulting in four conditions overall: whole/clumped, whole/scattered, chopped/clumped and chopped/scattered. The same weight of each produce type was provided on each study day within each group.

In the chopped condition food items were chopped into four to 12 pieces of as consistent size and shape as possible. In the whole condition similar sized items of each type were selected and left unchopped, except for some very large items such as pineapples and watermelons, which were chopped into two or four pieces. The clumped condition consisted of two or three large clumps of food depending on discussions with keepers; no keepers would allow only one clump of food due to the perceived risk of aggression. In the scattered condition food was scattered over the entire enclosure.

For the macaques each feeding condition was repeated on 15 days in a random sequence, allowing each macaque to be observed five times in each condition. For the tapirs each feeding condition was repeated on 12 (Paignton and Bristol) or eight (Newquay) days in a random sequence, allowing each tapir to be observed once in each condition.

## Data collection

The total weight of each fruit or vegetable type offered each day was recorded. The average piece weight of each produce type was determined each day by weighing a subset of pieces. Any uneaten food was retrieved from the enclosure and weighed to determine wastage each day.
Each study subject was observed individually using continuous focal sampling for the first thirty minutes after providing the food. The number and type of each food item eaten was recorded, allowing calculation of the weight of each food type eaten and total weight of food eaten from the known average piece weight. The diversity of food eaten was calculated using Shannon's diversity index. Any instances of aggression were also recorded along with the total time spent feeding during the thirty minutes. Each subject was also observed for two thirty-minute sessions at other times throughout the day and his or her behaviour (Table 1) recorded using instantaneous sampling every minute.

Table 1 Basic ethogram for Brazilian tapirs (*Tapirus terrestris*) and Sulawesi crested black macaques (*Macaca nigra*) for observations outside of feeding times.

| Behaviour | Description |
|---|---|
| Resting | Standing still, sitting or lying with head raised or lowered, not engaging in other activity except sniffing or observing surroundings. |
| Foraging | Searching for food (not including browse) on ground or in substrate and consuming it if found. |
| Suckling | Infants and mothers only – recorded when infant being suckled |
| Active | Any active behaviour not defined above including walking, running or other movement (not foraging), eating browse, drinking, defecating, urinating, social behaviour, investigative behaviour e.g. playing or sniffing environment, sexual behaviour, scent marking. |
| Not visible | Animal out of sight or otherwise not possible to determine its behaviour |

## Analysis

The data were analysed using randomisation tests equivalent to two-way ANOVAs (design 7; Todman and Dugard, 2001) to determine the effects of food item size and distribution on the total weight of food consumed, diversity of food items consumed, total feeding time, aggression during feeding, total food wasted and occurrence of other behaviour types throughout the day. Analyses were performed for the three macaques as a group (using group daily means, N = 5 days), for the most subordinate macaque individually (using individual daily values, N = 5 days) and for each tapir group separately (using individual daily values, N = 3 or 2 tapirs). In all tests thousand re-randomisations were used and the resulting P-value is the proportion of re-randomisations that returned a difference between the means of the feeding conditions equal to or greater than that observed.

## Results

For the macaques neither food size nor distribution significantly affected any of the variables measured when looking at the whole group. However, the most subordinate individual consumed significantly more food (P = 0.008) when it was left whole rather than chopped, but food distribution had no significant effects (Fig. 1).


Figure 1 Mean (± SE) total weight of food eaten by the most subordinate adult female macaque in four feeding conditions.

For the tapirs there were no significant effects of food size or distribution on any of the variables measured, except at Paignton Zoo where the chopped/clumped condition resulted in significantly less foraging behaviour throughout the day than the whole/clumped condition ($P = 0.013$) with both the whole/scattered and chopped/scattered conditions being intermediate (Fig. 2). It was not possible to test the effect of food presentation on aggression since only two instances of aggression were observed during the study.

It was not possible to test for differences in food wasted across the four conditions in either species since there were very few days on which any food at all was left uneaten.

## Discussion

The reasons offered by keepers for chopping food offered to zoo animals were not supported by the results of this study:

### *Chopping food allows all animals to obtain a fair share of food and reduces aggression*

Contrary to this assumption, the most subordinate female macaque consumed significantly more when the food was left whole. Although unexpected, this result is actually quite intuitive: if access to food is restricted by the presence of other individuals it will be easier to acquire fewer large pieces than many small pieces. The diversity of food consumed did not differ significantly across the four conditions for either species.

Aggression among the tapirs was extremely rare and apparently not affected by feeding condition. In the macaques aggression was more common, but usually not associated with food and it did not differ significantly across the four feeding conditions. This is in contrast to some other studies (e.g. Ganslosser and Brunner, 1997), which found a significant increase in aggression when food was clumped. However these studies often include a single clump condition, which we did not due to keeper concern over potential aggression in this situation.

### *Chopping food allows a wider scatter feed to promote foraging behaviour and prolong feeding time*

Feeding time and foraging behaviour tended to be greater when food was left whole, but in contrast to other studies neither scattering food (e.g. Lutz and Novak, 1995) nor leaving food whole (e.g. Smith *et al*. 1989) resulted in a statistically significant increase in feeding time.

### *Chopping food prevents wastage*

For both species there was very little uneaten food in any condition and neither food size nor distribution appeared to affect the amount of food wasted.

Overall we found no evidence for any advantage to chopping food to the extent that is currently typical in many zoos. The potential for increased nutrient loss and risk of bacterial contamination at cut edges of chopped produce are well documented and chopping food often takes considerable keeper time. Therefore, we suggest that most food should not be chopped as a matter of course for those species that are capable of processing large items. Clearly, there may be some circumstances when food size needs to be small (e.g. young animals, individuals with poor dentition, for a particular enrichment method) but in general there appears to be no benefit to chopping food as the normal routine for many species. ●

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# **Chasing away visitors?** The attitude of the general public towards feeding vertebrate live prey

Wouter Lemmen, Thijs van der Harst, Susan Ophorst and Tjalling Huisman, Department of Animal Management, Van Hall Larenstein, Leeuwarden, The Netherlands

**Live prey items are probably the ultimate environmental enrichment for captive carnivores (Young, 1997). However, it is against the ethical code of the Dutch Zoo Federation (NVD) to feed live, actively predator-avoiding animals to other animals (NVD, 2001).**

The next best thing: feeding whole carcasses as enrichment for carnivores? PHOTOS GERT JANSSEN

An important reason for this policy is the obvious welfare problem of live prey in an environment with no possibilities for escape. Furthermore, it is expected that zoo visitors will not accept viewing of actual killing and devouring of live prey. Another reason is that legislation prohibits feeding live animals. However, hunting – including prey-catching behaviour – is an important part of the behavioural repertoire of carnivores.
Denying these animals the opportunity to hunt and kill could possibly compromise their welfare (Young, 1997; McPhee, 2002; Bashaw *et al.*, 2003). The current trend of more spacious and 'natural' enclosures could tip the welfare balance in favour of the captive carnivores instead of their prey in some cases. Consequently, it is important to have a general idea of how (potential) zoo visitors will react. Thus a project to Asses this was carried out in 2006 (Harst and Lemmen, 2006).

## Methods

People in ten Dutch cities (40,000 – 700,000 inhabitants) were questioned about their attitude towards feeding live prey in zoos during street interviews in June and July 2006. Some qualities of the persons interviewed were also noted, such as age, sex, education and whether they were zoo members.

Four different situations were presented:
- Chameleon catching an insect.
- Penguin catching a fish.
- Bear catching a rat, mouse or guinea pig.
- Cheetah catching a rabbit.

The interview had two parts: the interviewee's opinion about feeding live prey off-exhibit or outside opening hours as well as towards feeding live prey in full view of the visitors was asked, and whether people did or did not agree with statements on subjects related to live prey feeding.

## Results

Approximately 25% of the people approached for an interview were willing to participate, resulting in 560 respondents. The age category '15 – 24 years' was over-represented in the sample, while there was an under-representation of people above the age of 65. Almost 60% of the respondents were female. The categories 'person with an university education' and 'zoo members' were slightly over represented.
Figure 1 shows that only a small minority of the respondents (6%) was against feeding live insects to insectivores behind the scenes.

Table 1 Agreement of respondents (n = 560) with statements related to live prey in carnivores' enclosures

| Statement | % agreement |
|---|---|
| 1. A prey animal must have the opportunity to hide in the enclosure | 91.4 |
| 2. A captive predator must have the opportunity to hunt | 85.2 |
| 3. Prey animals in an enclosure increase its educational value | 81.0 |
| 4. To watch predators catching their prey is unpleasant | 40.0 |
| 5. Prey remains are an unpleasant sight 41.0 | |
| 6. I will avoid zoos which offer live fish to their animals | 10.0 |
| 7. I will avoid zoos which offer live small mammals to animals | 20.0 |

This percentage increased to 13% when feeding takes place in the presence of visitors. When asked about feeding live fish behind the scenes, 11% of the respondents were against it. This percentage increased to 21% when the option was feeding in front of visitors. Twenty one percent were against feeding live rodents to bears behind the scenes and 41% were against feeding in visitor view. Twenty-two percent were against feeding live rabbits to cheetahs behind the scenes and 48% were against feeding on exhibit. The agreement of respondents with statements related to the use of live prey is presented is shown in Table 1.

Over 90% of the respondents agreed that a prey animal must have a hiding place in an enclosure with predators. Over 80% agreed that captive predators must have the opportunity to hunt and also thought that this will increase the educational value. However a sizeable minority (40%) was negative about watching actual catching of prey or the sight of prey remains. A smaller but not negligible minority of the respondents (20%) agreed with the statement that they would not visit a zoo where live small mammals are offered to carnivores. This decreased to 10% when live fish was the prey item. Respondents with children (n=92) were asked until what age they wanted to protect their children from the sight of live prey catching in an enclosure. Forty-three percent of the respondents mentioned an age of one to three years, 44 % an age of four to 12 years and 12% an age of 13 or higher.

## Discussion, conclusions and recommendations

The agreement of interviewees to the idea of feeding live prey on and off-exhibit in this study is comparable to results of Ings *et al.* (1997). They interviewed 200 visitors to Edinburgh Zoo, United Kingdom. The results obtained were slightly different, because in this study there was a higher disagreement with feeding live insects on and off exhibit, but a lower disagreement with feeding live rabbits to cheetahs. However, the general trend was the same; feeding live insects was more accepted than live fish, while feeding live mammals was least accepted. Ings *et al.* (1997) found that significantly more female than male visitors objected to the idea of feeding live fish and rabbits. Also visitors in the age class from 12 to 25 years were significantly more against feeding live vertebrate prey than visitors above 25 years. The study of Harst and Lemmen (2006) did not show a significant age or gender effect on the acceptance of feeding live vertebrate prey.

There was scarcely any difference in attitude towards feeding live rodents to bears and feeding live rabbits to cheetahs in this study (see also Figure 1). This lack of difference may be because guinea pigs as well as rats and mice were mentioned as examples of rodents. The latter animals probably have a similar 'pet status' as rabbits.

This study is of course an example of a 'what if?' research. The people were not interviewed in zoos. Interviews in a zoo setting would also have offered the opportunity to confront people with prey remains, the sight of whole rats and other recognisable animal parts, facilitating a more reliable insight in the attitude of visitors. However, since it is against the ethical policy of Dutch zoos to offer live vertebrate prey, it was decided not to associate any individual zoo with this subject. Nevertheless, the results of this study show that there is a risk of losing potential visitors when live vertebrate prey items are fed to the animals. It can therefore be recommended to look for alternatives, such as feeding whole carcasses. McPhee (2002) showed in her study that offering whole carcasses to large felids increased feeding behaviour and decreased off-exhibit stereotypic behaviour. Bashaw *et al.* (2003) showed that offering live fish or bones also produced similar effects in large felids. It is thus recommendable to increase the practice of offering carcasses, if possible intact. Additional research when carcass feeding takes place could teach us more about the effect on attitude and education of visitors. •

Enrichment for carnivores with 'live-like' prey in Ouwehands Zoo, an alternative for live prey PHOTO JOSE KOK

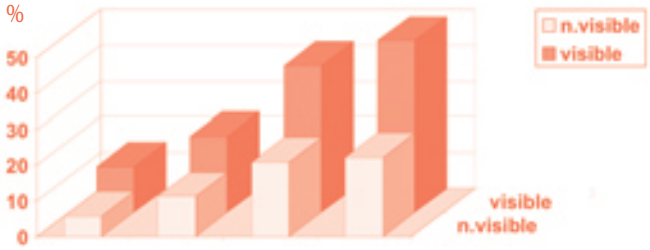


Figure 1 Percentage of respondents against feeding live prey in different cases

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OKAPI FEEDING

# Current feeding practices for captive okapi; how are guidelines used?

Tjalling Huisman, Dafna Azulai, Kim Engelhart and Alice Buijsert, Van Hall Larenstein, Leeuwarden, The Netherlands and Joeke Nijboer, Rotterdam Zoo, The Netherlands

**A joint European and North American project was carried out in 1997 and 1998 that aimed at establishing feeding guidelines for okapi (*Okapia johnstoni*, Crissey *et al*., 2000). The nutrition guidelines in the okapi husbandry manual, which were published in 2001 (Crissey *et al*., 2001), were a result of this project. The guidelines' recommended ingredient composition is a maximum of 25% browse, fruits and vegetables, a minimum of 50% alfalfa hay and a minimum of 25% concentrate (all on an as fed basis). The recommended nutrient composition (dry matter) is Crude Protein 17-20%, NDF 20-35% and ADF 13-18%. A project aimed at evaluating current okapi feeding practices in European zoos was initiated in 2007 (Engelhart and Azulai, 2007).**

## Methods

To evaluate current okapi feeding practices and the use of feeding guidelines in European zoos, a questionnaire was sent to the 18 European zoos keeping okapis. The main sections in this questionnaire were: general information on animals, group composition and housing, feeding and health. Information was asked about the ingredient composition of the diet in the feeding section. Other questions in this section were about food weighing practices, diet adaptation in different life stages and the use of feeding guidelines.

The nutritional composition of all diets was calculated using Zootrition 2.6™ and the tables from Jansen and Nijboer (2003). The following components were calculated: dry matter (DM), crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF) and non-fibre carbohydrates (NFC). The energy content of the diet was also calculated. Ingredient and nutrient composition of the diets were compared with the present feeding guidelines for okapi (Crissey *et al*., 2001). Zoos were also asked to report on possible nutrition-related health problems, such as hoof problems, obesity and diarrhoea.

## Results

Twelve of the 18 zoos sent the questionnaires responded, these zoos collectively held 42 okapis.

### Ingredient composition

The total amount of food offered to the okapis varied from 4 kg to 17 kg per okapi per day (as fed). Ten zoos offered more vegetables, fruits and browse than the recommended maximum of 25% (as fed basis). Within the category browse, fruit and vegetables, nine zoos offered more fruit and vegetables than browse, in the three other zoos the proportion of fruit and vegetables was between 35% and 48%.
Nine zoos offered less than the recommended minimum amount of 50% alfalfa hay. Seven zoos offered less than the recommended minimum amount of 25% nutritionally complete concentrate.

The ingredient composition of the diet was in accordance with the nutrition guidelines in only two zoos. Table 1 summarizes these results.

PHOTOS ROB DOOLAARD(IZP)/ROTTERDAM ZOO

Table 1 Ingredient composition of okapi diets according to nutrition guidelines 2001 compared to range in 12 zoos in 2006.

| Ingredient profile | Nutrition guidelines '01 | Current captive diet '06 |
|---|---|---|
| Fruits & Vegetables | 0 – 25% | 5 – 48% |
| Browse | | 0 – 33% |
| Lucerne hay | = > 50% | 22 – 77% |
| Concentrates | = > 25% | 7 – 35% |

The few available data on the composition of the *in situ* diet as mentioned in Crissey *et al.* (2000) indicate that the natural okapi diet is higher in NDF and ADF and lower in NFC than the values given in the 2001 guidelines. In all responding zoos, NDF and ADF values were also lower and NFC values higher than values in the *in situ* diet. This, especially the high NFC values, could contribute to present and potential health problems in okapi, specifically rumen disorders and hoof problems (laminitis).

## Nutrient composition

The amount of dry matter offered in responding zoos varied from 1% to 4.3% of the body weight (average 2.3%). The energy content of the diets offered was higher than recommended in nine zoos, and in four cases it was at least twice the calculated maintenance requirement.
Average CP content of the diets was 16.5%. Dietary CP content was below the recommendation in six zoos. The NDF content was within the recommended range or slightly above it in the majority of zoos. The ADF content was slightly above the guideline value in most cases. No zoo fully met the recommendations in the guidelines. Table 2 summarizes the results for nutrient composition.

Table 2 Nutritional profile according to nutrition guidelines 2001 and nutritional composition range in 12 zoos in 2007.

| Nutritional profile | Nutrition guidelines 2001 (offered basis) | Current captive diet (offered) |
|---|---|---|
| DM % | – | 46.9 – 78.4 |
| DM as % of BW | 2 – 2.4 | 1.1 – 3.5 |
| Energy (total MJ ME ) | 28 – 41[1] | 26 – 101 |
| CP (% DM) | 17 – 20 | 13.7 – 18.3 |
| NDF (% DM) | 20 – 35 | 18.4 – 41.8 |
| ADF (% DM) | 13 – 18 | 12.2 – 26.1 |
| NFC (% DM) | 36 – 54[2] | 26.8 – 56.9 |

1 Calculated by applying Kleiber's rule for maintenance energy requirement to the average weight of males (253 kg) and females (284 kg)
2 Calculated from NDF% and CP% range in guidelines and average EE% and Ash% in ingredients used

## Use of guidelines

Eight of the 12 respondents stated that they were satisfied with the 2001 guidelines. However, only four actually made use of the guidelines. Six zoos proposed a more detailed nutrition guideline. A more practical and keeper-friendly guideline was also suggested in two cases. Two zoos proposed other values for the ingredient composition.

## Health problems

Seven zoos reported hoof problems. Two zoos reported GIT obstruction (both feeding *Robinia pseudoacacia* as browse) and one reported obesity as a health problem. Diarrhoea was also reported by one zoo.

## Discussion and conclusion

Table 3 shows the average age of okapis and diet composition in zoos with and without reported hoof problems. Zoos experiencing hoof problems fed more fruit and vegetables (2.9 kg daily average) than zoos not experiencing these problems (2.0 kg daily average). A similar difference was seen in concentrate use (2.2 kg in zoos with hoof problems, 1.7 kg in zoos without). However, okapis with hoof problems were on average four years older than okapis without hoof problems. Due to the nature of the data no separate effect of diet or age on the occurrence of hoof problems could be shown.

Table 3 Age, sex and diet composition in zoos with okapis with no hoof problems (nhp) and zoos with okapis with hoof problems (hp).

| Zoos | Average age | Sex | Average fruits and vegetables offered/okapi/day as fed (in gr.) | Average concentrates offered/okapi/day as fed (in gr.) |
|---|---|---|---|---|
| **7 zoos** 12 hp, 20 nhp | **12 hp:** 11 y, 6m<br>**20 nhp:** 6 y, 6 m | **hp:** 8 ♀ 4 ♂<br>**nhp:** 10 ♀ 10 ♂ | **2850 grams** (offered/okapi in zoos with hp) | **2188 grams** (offered/okapi in zoos with hp) |
| **5 zoos** 0 hp, 10 nhp | **10 nhp:** 7 y, 5 m | nhp: 3 ♀ 7 ♂ | **1964 grams** (offered/okapi in zoos with nhp) | **1720 grams** (offered/okapi in zoos with nhp) |

This project gives some more insight into feeding practices for okapis kept in European zoos. However, the most important lesson to learn from this project is about the use of feeding guidelines. The okapi feeding guidelines were the result of a large joint European and North American project supervised by well-known specialists in this field. What sense does such a project make when only a minority of the zoos use the results? As mentioned before, only four of the responding zoos stated they were using the guidelines. Diet calculations showed that only one of these four zoos met the dietary requirements as stated in the guidelines. Designing scientific nutrition guidelines is without doubt an important activity. However, we should also have a look at the mechanisms that ensure that these guidelines are actually used. Contrary to a general belief, a good product does not sell itself. Probably more effort is needed to introduce feeding guidelines to stakeholders and also to evaluate the use of these guidelines. •

Crissey, S, E.S. Dierenfeld, J. Kanselaar, K. Leus, J. Nijboer (2000). In: Nijboer, J., J.M. Hatt, W. Kaumanns, A. Beijnen, U. Ganslosser, eds. *Zoo Animal Nutrition*. Furth: Filander Verlag. 257-270.

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# **Welfare is not a privilege of show animals only;** carbon dioxide euthanasia of small prey animals

Andre Schatz and Robert Zingg, Zurich Zoo, Switzerland, Jean-Michel Hatt and Marcus Clauss, Clinic for Zoo Animals, Exotic Pets and Wildlife, Vetsuisse Faculty, University of Zurich, Switzerland

**To ensure the hygienic state of prey animals, zoos are often forced to buy prey animals alive and perform the killing (and storing) themselves; additionally, zoos may receive live prey animals as donations. Welfare concerns are often voiced in zoos with respect to display animals, but welfare of prey animals purchased by, transported to, and killed at a zoo is rarely discussed.**


Figure 1 Historical tools for the blow killing of prey animals at Zurich Zoo: from top to bottom a 'mouse-killer', a 'rat-killer' (both made of wood) and a 'rabbit-killer' (metal).

A blow on the head is still a method used in zoos to kill prey animals such as day chicks, mice, rats, or rabbits (see the 'historical' blow-delivering tools from Zurich Zoo, Fig. 1). This procedure usually involves individual handling of each animal, which has to be taken out of its transport container in order to receive the blow. The efficacy of the method is rarely monitored and will vary according to the experience of the performer and the number of animals he or she has to kill. Precision of movement may be lost, especially after longer periods of blow killing, resulting in an increased number of animals that are not hit effectively. Additionally, this activity is hardly cherished by the zoo personnel assigned to the task, as demonstrated by the printout of the 'chicken kill schedule' at Zurich Zoo (Fig. 2).


Figure 2 Note from the message board of the Zurich Zoo commissary indicating the delivery days of live day chicks, evidently not an event looked forward to by the personnel.

## Switching methods

The death by blow procedure has been replaced by carbon dioxide ($CO_2$) euthanasia (Fig. 3) at Zurich Zoo. Carbon dioxide is introduced into a plastic container designed to hold several typical rodent transport boxes. The prey animals, still in the cardboard transport boxes in which they arrive, are placed in this container only after the $CO_2$ has displaced all the oxygen (as assessed by a match or lighter). Approximately five minutes are allowed to pass between the last visible movement of the animals and their retrieval from the container.

## Advantages

Carbon dioxide euthanasia offers several advantages over death by blow. It has been described as 'humane' method for killing animals (e.g. Hewett *et al.*, 1993). As the animals remain in their transport boxes and are not handled individually, the performing personnel at Zurich Zoo believe it to be less stressful. A written standard protocol is followed that does not depend on the experience of the performer, making the method reliable, with a predictable outcome for each individual animal. Compared to the 'individual blow' method, $CO_2$ euthanasia is time-sparing, thus potentially compensating for the cost of the gas. If performed in large, well-ventilated rooms (see Fig. 3), the method poses no health hazard for the performing personnel. Professional satisfaction of the commissary personnel (the department responsible for this task) is higher with the $CO_2$ method.

## Further refinements

Although the $CO_2$ procedure now used is an obvious improvement in welfare factors compared to the single-blow method, further refinements of the method should be assessed, such as using other inhalation agents (e.g. Conlee *et al.*, 2005). •

Figure 3 Plastic container, designed to hold several typical rodent transport boxes, linked to $CO_2$ gas bottles.

Conlee K.M., M.L. Stephens, A.N. Rowan and L.A. King (2005). *Carbon dioxide for euthanasia: concerns regarding pain and distress, with special reference to mice and rats.* Laboratory Animals 39: 137-61.

Hewett T.A., M.S. Kovacs, J.E. Artwohl and B.T. Bennett (1993). *A comparison of euthanasia methods in rats, using carbon dioxide in prefilled and fixed flow rate filled chambers.* Laboratory Animals 43: 579-82.

# EAZA Penguin TAG; nutrition questionnaire evaluation

Helena Marques and A. Rodriguez, ConZOOlting Wildlife Management, Barcelona, Spain, Miguel Bueno, chair EAZA Penguin TAG, Zoo-Aquarium Madrid, Spain and Pierre de Wit, vice-chair EAZA Penguin TAG, Emmen Zoo, The Netherlands

**At the EAZA Penguin TAG meeting was determined to evaluate the feeding and nutritional management of all the penguin species held by EAZA institutions. Thus Pierre de Wit, now vice-chair of this TAG, designed a nutrition questionnaire, which was sent to all institutions holding penguins. The objective was to gather information on how penguins were being fed and to start the process of developing general feeding guidelines. The aim of these guidelines is to compile information, establish protocols according to the penguins' nutritional requirements and needs, and standardise feeding and fish handling protocols.**

The completed questionnaires were sent to the TAG nutrition advisor, Helena Marques, for data processing and analysis. The surveys were processed at the end of 2006 and the beginning of 2007, and the first results were presented during the EAZA Penguin TAG meeting at the EAZA Annual Conference 2007. This paper presents part of the results regarding the captive diet and feeding protocols used by the institutions.

## Material and methods

The questionnaire addressed different aspects of the dietary management. Fourteen questions (most of which were subdivided into other questions) were asked. Some of the questions could be answered quickly, using check boxes that were easy to evaluate. There were also questions with some space for a written answer, which were much more difficult to assess.

Macaroni penguin PHOTO STOCK

The survey analyzed the following topics:

- **General information**: e.g. species held, number of animals, their sex and other relevant characteristics of the exhibits, such as water type in the pool (fresh, salt or brackish).
- **Diet**: fish and marine invertebrate species offered to the penguins, as well as the variety and amount of food offered, how the quantities were established and seasonal dietary changes.
- **Supplementation**: multivitamins, minerals and salt supplements used.
- **Fish handling**: thawing and feeding methods.
- **Diet design**: how diets were established, whether institutions relied on their own experience, other institutions' experience or literature.
- **Other aspects** included problems encountered with other animals at feeding time, food quality requirements and fish suppliers.

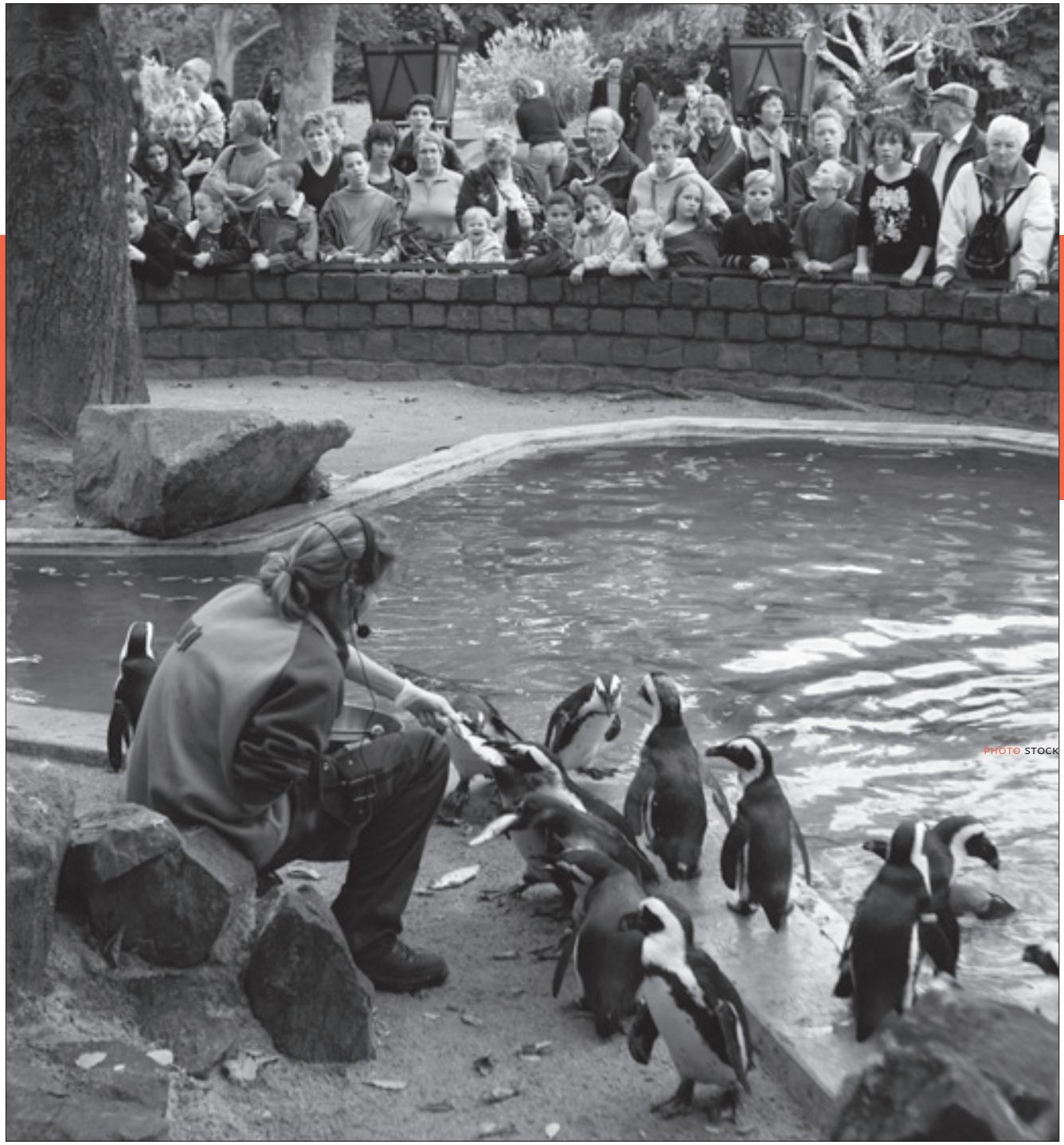
Each institution was asked to fill out one questionnaire for each species kept. The total number of questionnaires sent in 2004 is unknown because it was not recorded at that time. However, 79 surveys from sixty institutions were received. Of those, 76 (from 57 institutions) were processed. The remaining three were not evaluated due to the lack of relevant information such as the species or the institution.

## Results

The results presented in this article are based on the data gathered through the check box questions of the penguin species more common in European institutions. The open questions are currently being evaluated and the results will be presented in the near future.

The surveys received revealed that a total of 2,114 penguins, including nine of the 18 penguin species, were present in EAZA zoos at that time in 2004. The most common species were Humboldt penguin (*Spheniscus humboldti*) and African penguin (*Spheniscus demersus*), kept in 37 and 19 institutions respectively. The species least represented were chinstrap penguin (*Pygoscelis antarctica*) [present in two institutions], Adelie penguin (*Pygoscelis adeliae*) and Macaroni penguin (*Eudyptes chrysolophus*) [present only in one institution each].

Feeding time for Humboldt penguins PHOTO ROB DOOLAARD(IZP)/ROTTERDAM ZOO



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## Diet

General results showed that across the institutions a wide variety of food categories were used to feed the penguins. However, the most common items fed were herring, sprat and mackerel. Other items offered in the diets were capelin, squid, shrimp, anchovy, sardine, whiting, krill, smelt and mussel. Only one item was offered by 40.0% of the respondents, 50.0% offered between two and four and less than 10.0% fed five or more different items.

The results obtained per species of penguins showed some differences. *Spheniscus humboldti* was kept by nearly 65.0% of the institutions. The results demonstrated that a wide variety of food categories were offered, although herring and sprat were the items most commonly used, offered by 75.0% and 65.0% of the institutions respectively (Figure 1a). Of the institutions holding Humboldt penguins, 35.1% fed only one food type, whereas 29.7% offered two and another 29.7% offered between three and four types of food. Only 5.4% of the institutions offered five or more different items (Figure 1b).

The results obtained for *Spheniscus demersus*, held by 33.3% of the institutions, showed that less variety of food categories were given (Figure 2a). Herring and sprat were also the most common food types offered to these penguins by institutions (60.0% and 45.0%, respectively). However, 63.1% of institutions fed only one type of food and the rest (36.9%) offered between two and four food categories. There were no institutions that fed five or more items (Figure 2b).

# PENGUIN NUTRITION

H=HERRING M=MACKEREL S=SPRAT C=CAPELIN SQ=SQUID SH=SHRIMP A=ANCHOVY SA=SARDINE W=WHITING K=KRILL SM=SMELT MU=MUSSEL O=OTHER

Fig. 1a **Humboldt penguin** (*Spheniscus humboldti*)

Food categories offered

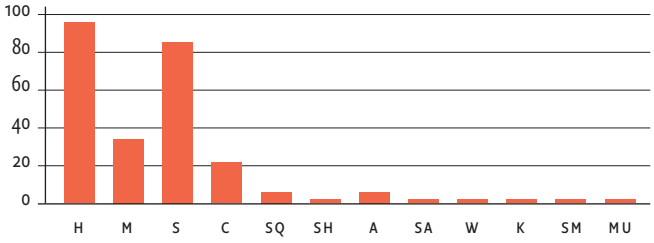



Fig. 1b

Number of species fed

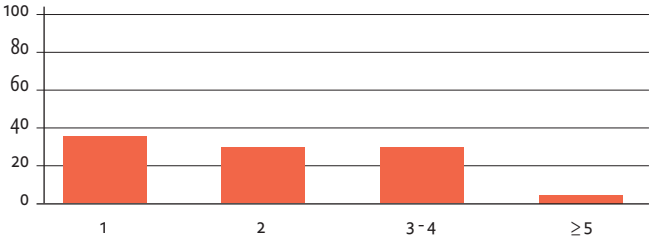



Fig. 2a **African penguin** (*Spheniscus demersus*)

Food categories offered

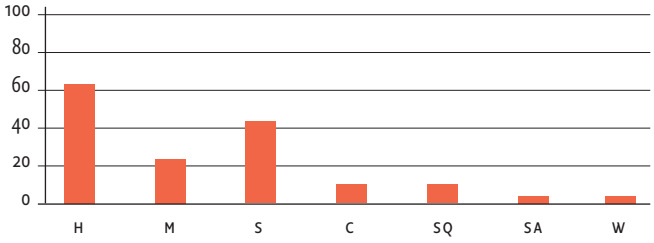



Fig. 2b

Number of species fed

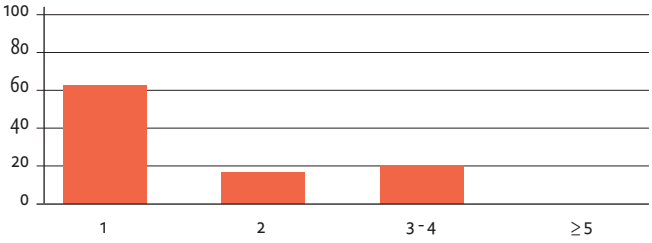



Fig. 3a **Gentoo penguin** (*Pygoscelis papua*)

Food categories offered

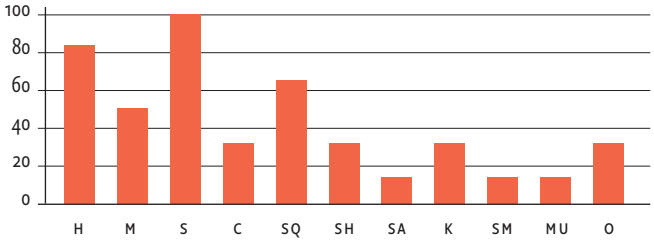



Fig. 3b

Number of species fed

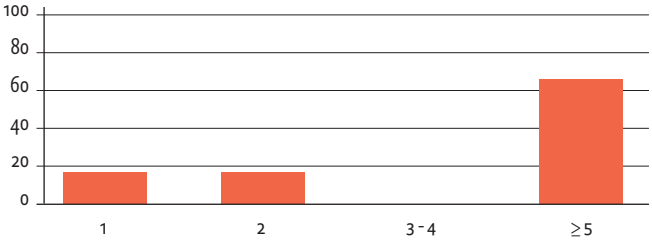



Fig. 4a **Southern rockhopper penguin** (*Eudyptes chrysocome*)

Food categories offered

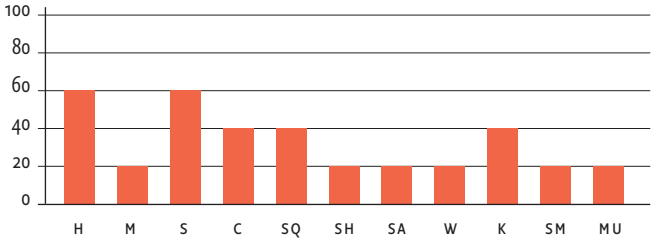



Fig. 4b

Number of species fed

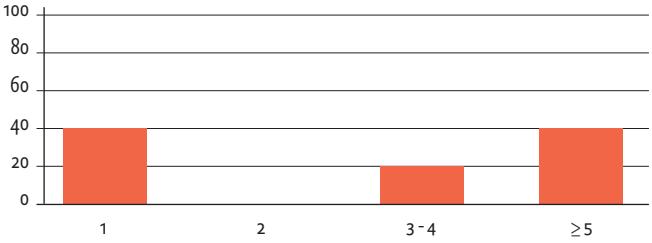



Fig. 5a **King penguin** (*Aptenodytes patagonicus*)

Food categories offered

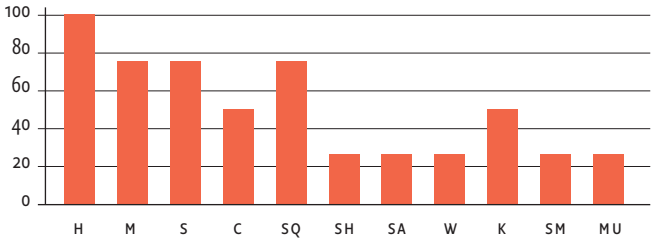
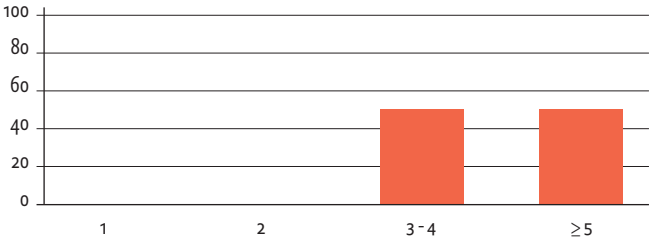



Fig. 5b

Number of species fed



*Pygoscelis papua* was kept by 10.5% of the institutions. The results showed a wide variety of food offered by institutions. All (100%) provided sprat to the penguins and 83.3% also used herring. Squid was offered by 66.7% of the institutions and mackerel by half of them (50.0%) whereas 33.3% fed capelin, shrimp and/or krill (Figure 3a). Compared to the previous results, this species received a higher variety of food categories across institutions. It is also remarkable that more than 60.0% of the institutions offered five or more types of food (Figure 3b).

The variety of food types fed to *Eudyptes chrysocome* (held by 8.8% of the institutions) was similar to those described for *Pygoscelis papua*. The most common items provided were herring and sprat (both offered by 60.0% of the institutions) whereas capelin, krill and squid were offered by 40.0% of institutions (Figure 4a). Two of the institutions keeping this penguin species fed only one type of food, one offered between two and four food types while the other two provided between five or more food types (Figure 4b).

Finally, the diet of the king penguin (*Aptenodytes patagonicus*) (kept by only 7.0% of institutions) included a wide variety of food. Again, the most common fish species fed were herring (fed by all institutions) and sprat. Nevertheless, mackerel, squid, capelin and krill were also quite common, offered by more than 40.0% of the institutions (Figure 5a). All institutions had at least three different types of food in the diet: half of them fed between three and four different food types and the other half offered five or more food types (Figure 5b).

## Supplementation

The type of supplements provided by the institutions was also determined. The supplements were categorized by nutrient composition into: vitamins; minerals (excluding salt); salt; vitamins and minerals; vitamins and salt, salt and minerals; and all together (vitamins, minerals and salt). The results obtained showed that more than 40.0% of the institutions offered only a vitamin supplement and around 30.0% offered a supplement that included vitamins and minerals. Less than 20.0% of the institutions offered all three components. There was only one institution that offered no supplements at all.

The type of water used by the institutions to keep the penguins (salt water, fresh water or brackish water) was taken into account to evaluate the salt supplementation. Slightly over 42.0% of the institutions used fresh water and supplemented the diet with salt; 40.0% used fresh water and did not use any salt supplementation (Table 1). Salt water was used by 12.3% of the institutions, 3.5% supplemented the penguins with salt whereas 8.8% of them did not give salt supplementation. Only two institutions used brackish water, one of the institutions used salt supplementation while the other did not.

## Thawing method

Another point evaluated through the survey was the different fish thawing methods used by the institutions before feeding the birds. The results showed that a wide variety of methods were used. Most of the institutions (40.3%) used different methods together to thaw the fish; e.g. refrigerator plus ambient temperature or refrigerator plus running fresh water. Only 26.3% of the institutions used just the refrigerator for thawing fish as recommended in the literature (Crissey, 1998), and 17.5% used only running freshwater. Some institutions (10.5%) still thawed the fish at ambient temperature and 1.7% of them used the standing freshwater method. One of the 57 institutions thawed the fish in a heating room for 17 hours; one institution used methods to thaw the fish that were not an option on the questionnaire and another one did not answer the question.

## Diet design

Finally, it was determined how each of the institutions formulated the diet for the penguins. Almost half (47.4%) of the institutions used different sources (e.g. own experience, other institutions' experience and/or literature). Slightly over 28% based the diet offered only on their own experiences and 21% established the diet based on other institutions' experience. There were no institutions that formulated the diet based on literature only. The question was not answered by 3.5% of the respondents.

## Conclusions

Based on the results obtained it is possible to confirm that there is no consistency in penguin dietary husbandry among EAZA institutions, not even within the same species:

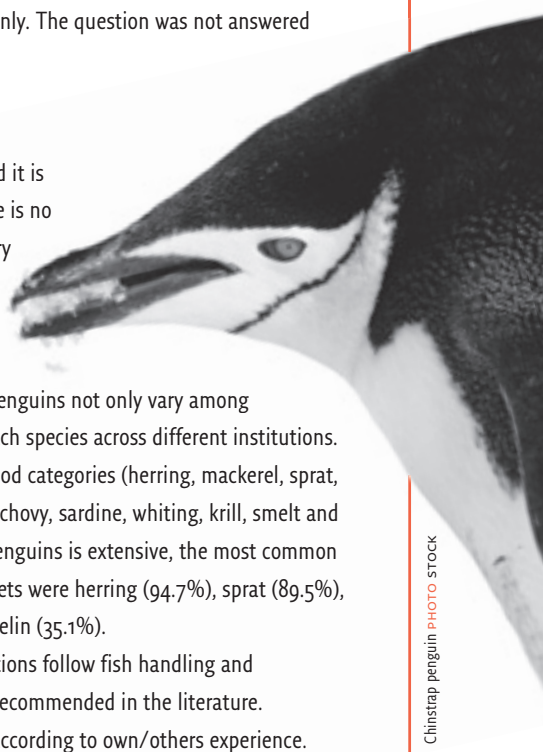
1. Diets offered to captive penguins not only vary among species but also within each species across different institutions.
2. Although the variety of food categories (herring, mackerel, sprat, capelin, squid, shrimp, anchovy, sardine, whiting, krill, smelt and mussels) offered to the penguins is extensive, the most common species included in the diets were herring (94.7%), sprat (89.5%), mackerel (42.1%) and capelin (35.1%).
3. Only 26.1% of the institutions follow fish handling and preparation protocols as recommended in the literature.
4. Most diets are designed according to own/others experience.

## Next steps

The EAZA Penguin TAG nutrition advisory will use these results and the ones obtained from the open questions (currently being processed) to:

- Establish and standardise general feeding practices across institutions.
- Develop a fish handling protocol in order to provide a practice guideline as a reference starting point.
- Give species-specific recommendations when necessary. •

Crissey, S.D. (1998). *Handling fish fed to fish-eating animals: a manual of standard operating procedures*. US Department of Agriculture, Agricultural Research Service, National Agricultural Library, USA.



Chinstrap penguin PHOTO STOCK

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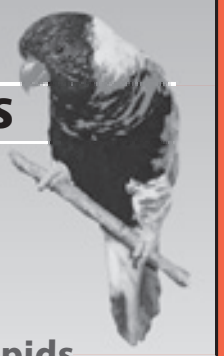

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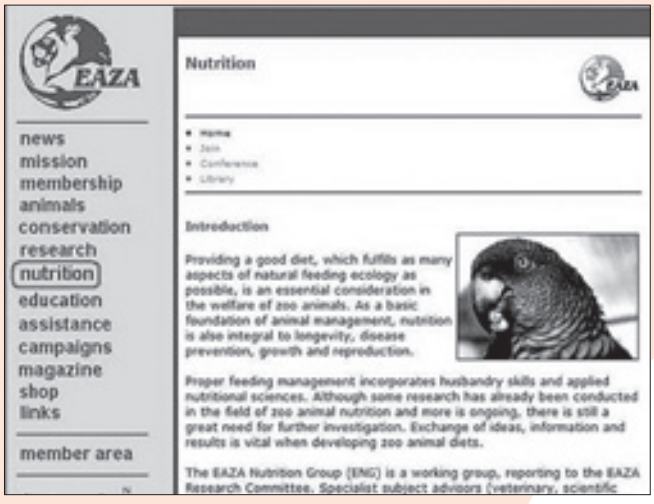
Specialist subject advisors (veterinary, scientific etc.) are increasingly being added to steering committees for zoo-based conservation breeding programmes worldwide and the EAZA Nutrition Group (ENG) is a working group, reporting to the EAZA Research Committee.

The current committee members are:
- Dr. Andrea Fidgett, Chester Zoo [chair]
- Dr. Marcus Clauss, University of Zurich
- Dr. Tjalling Huisman, Van Hall Institute
- Prof. Geert Janssens, University of Ghent
- Michael Jorgensen, Copenhagen Zoo
- Dr. Joeke Nijboer, Rotterdam Zoo

A primary responsibility of the ENG and its members is to provide nutrition advice to zoo-based conservation breeding programmes, developing guidelines and protocols for general use.

Following extensive discussion on how to freely share information generated, a dedicated 'nutrition' area was added to the EAZA website, which in due time will be moved to the new EAZA website which is currently under construction.




Probably the most useful section for any collection or individual is the **library**. Here you will find a number of ENG publications available to download, including:
- EAZA Nutrition Group E-Newsletters
- European Zoo Nutrition Conferences - Programmes and abstracts
- EAZA News - Special Issues on Zoo Nutrition (Issues 1-3)

Abstracts of the first three volumes of Zoo Animal Nutrition are also online, with direct links to Filander Verlag should you want to purchase the books themselves.

In keeping with the theme of creating a nutrition 'library' of reference material, publishing agreements with similar, like-minded meetings have been established. On this basis you will find abbreviated abstracts from the International Symposiums on Pet Bird Nutrition (Issues 1 and 2), plus details of how to purchase the complete versions at very reasonable cost.

A number of books are recommended, as are some useful weblinks for nutrient requirements and food composition in particular. Of course this area should not remain static and suggestions for links are always welcome.


Membership is open to all individuals who support the aims of the EAZA Nutrition Group or need to know how they can improve nutrition in their zoo – more details can be found under the '**Join**' heading.

Information about the 6th European Zoo Nutrition Conference in January 2010 will be posted on the '**Conference**' section. Meanwhile this is where you can freely download the most recent conference abstract book. •