Correction factors for important brown bear foods in Europe

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Abstract: Correction factors that relate the dry mass of food items consumed by brown bears (*Ursus arctos*) to the volume of the corresponding residue in the feces have been determined for various foods consumed by brown bears in North America, but the values of some important foods used by European populations remain unknown. We estimated the correction factors for wild cherries (*Prunus avium*), beechnuts (*Fagus sylvatica*), hazelnuts (*Corylus avellana*), and supplemental foods (corn, oats, and sugar beets) provided to bears in many areas of Europe. In 2011, we fed captive bears from the Warsaw Municipal Zoological Garden, Poland, with known amounts of these foods and measured the volume of their remains in their feces. Overall, correction factors for supplemental foods were lower than for natural foods. We recommend use of the values estimated in this study and further evaluations of correction factors for bear food items not yet assessed.

Key words: brown bear, correction factors, diet, Europe, fecal analysis, food habits, supplemental food, *Ursus arctos*

The brown bear (*Ursus arctos*) is an omnivorous species that consumes a wide variety of foods across its geographical range (Bojarska and Selva 2012). Despite possessing the morphological traits of carnivores and digesting meat efficiently, in many ecosystems brown bear diet consists mainly of plant matter (Bojarska and Selva 2012). Food habits are pivotal to many ecological and life-history traits of brown bears, such as reproduction, population densities, and habitat selection (Hilderbrand et al. 1999, Ferguson and McLoughlin 2000). The study of brown bear diet is, therefore, crucial to understanding the species' ecology and behavior.

Brown bear diets have typically been assessed using fecal analysis (reviewed in Vulla et al. 2009). Although all methods of diet assessment have sources of potential error, estimating ingested biomass seems to best represent the real diet and is the most useful when investigating patterns in feeding ecology of brown bears (Bojarska and Selva 2012). This method takes into account differences in the digestibility among food types, which is inversely related to the relative amount of food remains that appear in feces. For example, when using the frequency of occurrence or percentage of volume, the importance of highly digestible food, such as meat, is underestimated (Pritchard and Robbins 1990, Hewitt and Robbins 1996). To account for this bias, Hewitt and Robbins (1996) proposed correction factors (CFs hereafter), which relate the dry mass of food items consumed by brown bears to the volume of the corresponding residue in the feces. They estimated CFs for 26 food types consumed by brown bears in North America. These have been applied in numerous studies on brown bear diet (Vulla et al. 2009; reviewed in Bojarska and Selva 2012). However, the CF values of several important bear foods has not yet been assessed, particularly for European and supplementally-fed populations.

Hard mast and fleshy fruits are among the most important components of brown bear diets (Frackowiak 1997, Naves et al. 2006). Hard mast seems especially important for European populations (Bojarska and Selva 2012). However, food items for these populations, like hazelnuts (*Corylus avellana*) and beechnuts (*Fagus sylvatica*) or fleshy fruits of wild cherry (*Prunus avium*), do not occur in the diet of North American brown bear populations, and the CFs for them have not been assessed. Moreover, in the last century, supplemental food for baiting bears or other species (such as ungulates) has become a major food resource for many brown bear populations. This is especially true for bear populations of Eastern and Central Europe (Rigg and Gorman 2005, Sidorovich 2006, Vulla et al. 2009). In the Carpathian Mountains, for instance, corn, oats, and sugar beets are commonly used for supplemental feeding of ungulates, and bears frequently consume these foods (Frackowiak and Gula 1992, Rigg and Gorman 2005).

Our objective was to estimate the CFs for several important brown bear foods of both natural origin

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and provided by humans, thus extending the list provided by Hewitt and Robbins (1996). This will increase our knowledge of the nutritional value of supplemental and natural foods consumed by brown bears and allow for more precise assessment of their food habits from fecal analyses.

Methods

Four adult brown bears (1 M, 3 F) housed in Warsaw Municipal Zoological Garden, Poland, were used in this study. The bears were 27–29 years old and weighed 140–200 kg. Feeding trials were conducted in November 2011; mean daily temperature during the study was 4°C. The bears in the Polish part of the Carpathian Mountains were still active at that time, feeding intensively on fleshy fruits, hard mast, and supplemental food for ungulates (authors' unpublished data).

We performed 2 feeding trials during which bears were maintained in individual indoor pens with concrete floors. Feeding trials were conducted following methods described by Hewitt and Robbins (1996). Each trial lasted 2 consecutive days and involved 2 identical meals consisting of 3 food types. Once each day, bears were fed a meal consisting of 150 g of each food type. Meals in the first trial included beechnuts, cherries, and corn; the second trial included hazelnuts, oats and sugar beet roots. Before each trial, bears were fasted for 24 hours to clear their digestive tracts and encourage ingestion of the test meals. Uneaten remains of food and all scats were collected. To ensure the collection of all scats containing test food, the bears were fed with commercial dog chow 24 hours after the end of each trial, and all scats were collected until the chow passed.

We dried a subsample of about 50 g of each food item at 100°C for 24 hours to estimate dry mass content. We washed all fecal samples on a 2-mm mesh sieve and separated the residuals of the different food types provided in the trials. We squeezed the excess water and measured the volume of the residuals using water displacement in a calibrated cylinder. Following Hewitt and Robbins (1996), CFs were calculated for 2 bears individually as CF_i = dry matter of item i ingested (g)/fecal volume of residue of item i (ml). Because some bears refused to consume some of the foods, we chose 2 individuals with sufficient intake rates to calculate average value of each CF.

Table 1. Correction factors for food items given to 2 captive brown bears from the Warsaw Municipal Zoological Garden, Poland, in feeding trials, expressed as dry mass ingested (g)/residual volume (ml) in feces.

Food item	Correction factor	
	Average	Range
Supplemental food		
Oat	0.59	0.58–0.61
Sugar beet	1.08	0.97–1.19
Maize	1.18	0.90–1.46
Natural food		
Beechnut	1.18	0.89–1.46
Hazelnut	1.58	0.95–2.21
Cherry	1.93	1.72–2.14

Results and discussion

Natural foods we tested had generally greater CF values than supplemental foods (Table 1). The CF for cherries was greater than other fleshy fruits tested by Hewitt and Robbins (1996). Among hard mast, beechnuts and hazelnuts had a CF similar to American pinyon nuts (*Pinus edulis*), reported by Hewitt and Robbins (1996). The supplemental foods varied considerably in terms of CFs, with corn showing the highest, and oats the lowest, CF values. The large range in CF values for hazelnut was a result of different ways of consuming them by 2 bears. One of the individuals did not break all the shells and swallowed and excreted some of the nuts whole, thereby increasing the relative amount of their remains in the feces and reducing the CF value.

Bears have seasonal cycles of energy intake (Stelmock and Dean 1986). For example, black bears (*Ursus americanus*) have significantly higher digestion of gross energy and significantly lower digestion of crude protein in November than in August (Brody and Pelton 1988). To ensure the digestibility coefficients reflect natural conditions, we conducted this study during the time when test foods are intensively consumed by free-ranging bears in the Carpathians.

The variability of CF values among foods we tested show that application of the same CFs for different food items may lead to biased results when assessing brown bear diets. For instance, the same CF value was previously applied to corn and oats (Vulla et al. 2009), whereas in our study CF values between these foods varied 2-fold. We recommend use of these CFs in future studies. Diet studies should include assessments of the CF values for bear

food items whose CFs have not been estimated, especially of those foods which are crucial in certain periods or have a significant contribution to bear diet. When this is not possible, the application of CF of similar food items and interpretation of results should be made with caution.

Acknowledgments

Literature cited

Bojarska, K., and N. Selva. 2012. Spatial patterns in brown bear Ursus arctos diet: The role of geographical and environmental factors. Mammal Review 42:120–143.

Brody, A.J., and M.R. Pelton. 1988. Seasonal changes in digestion in black bears. Canadian Journal of Zoology 66:1482–1484.

Ferguson, S.H., and P.D. McLoughlin. 2000. Effect of energy availability, seasonality, and geographic range on brown bear life history. Ecography 23:193–200.

Frackowiak, W., and R. Gula. 1992. The autumn and spring diet of brown bear Ursus arctos in the Bieszczady Mountains of Poland. Acta Theriologica 37:339–344.

———. 1997. Diet and food habits of the brown bear (Ursus arctos L.) in Polish eastern Carpathians. Journal of Wildlife Resources 2:154–160.

Hewitt, D.G., and C.T. Robbins. 1996. Estimating grizzly bear food habits from fecal analysis. Wildlife Society Bulletin 24:547–550.

Hilderbrand, G.V., C.C. Schwartz, C.T. Robbins, M.E. Jacoby, T.A. Hanley, S.M. Arthur, and C. Servheen. 1999. The importance of meat, particularly salmon, to body size, population productivity, and conservation of North American brown bears. Canadian Journal of Zoology 77:132–138.

Naves, J., A. Fernández-Gil, C. Rodríguez, and M. Delibes. 2006. Brown bear food habits at the border of its range: A long-term study. Journal of Mammalogy 87:899–908.

Pritchard, G.T., and C.T. Robbins. 1990. Digestive and metabolic efficiencies of grizzly and black bears. Canadian Journal of Zoology 68:1645–1651.

Rigg, R., and M. Gorman. 2005. Diet of brown bears (Ursus arctos): New results from the Tatras region and a comparison of research methods. Výskum a ochrana cicavcov na Slovensku 7:61–79. (In Slovak with English abstract.)

Sidorovich, V.E. 2006. Ecological studies of brown bear (Ursus arctos) in Belarus: Distribution, population trends and dietary structure. Acta Zoologica Lituanica 6:185–190.

Stelmock, J.J., and F.C. Dean. 1986. Brown bear activity and habitat use, Denali National Park — 1980. International Conference for Bear Research and Management 6:55–167.

Vulla, E., K.A. Hobson, M. Korsten, M. Leht, A-J. Martin, A. Lind, P. Männil, H. Valdmann, and U. Saarma. 2009. Carnivory is positively correlated with latitude among omnivorous mammals: Evidence from brown bears, badgers and pine martens. Annales Zoologici Fennici 46:395–415.