A multidimensional approach to managing the European brown bear in Croatia

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Abstract: Because of its biological characteristics, its important place in the minds of humans, and the considerable international interest for its conservation, management of the brown bear (Ursus arctos) in Europe is challenging. The Brown Bear Management Plan for Croatia (BMPC) was approved in 2004 and addressed interests such as ecology, aesthetics, and economics, as well as concern for the safety of people and property. It attempts to ensure conditions for the long-term survival of the brown bear, a species listed as endangered by some international regulations but as a game species (subject to regulated hunting) in others, including Croatia. Careful evaluation of actions affecting population size represents the most critical part of this plan. Those actions should sustain long-term viability of the bear population while maintaining densities at a level that minimize human–bear conflict. To achieve this goal, a series of actions and measures have to be regulated that are related to (1) bear habitat, (2) human activities in the habitat (e.g., highway construction, feeding of bears by humans), (3) prevention of problematic bear occurrences, and (4) the scientific monitoring of population changes. Although the plan’s development and implementation is the responsibility of bear management experts, various interests groups were considered. In large carnivore management, and especially in bear management, there are no final and universal solutions. Changes in the number of bears, areas of their presence, or behavior require new decisions. This plan offers guidelines for the decision-making process, and, because it includes a revision process, can be adapted to address new circumstances that arise. Citizens interested in conservation, not only in Croatia but also in neighboring countries, expect Croatia to work toward maintaining the long-term existence of as many bears as possible in appropriate habitats, with as few negative effects as possible. This plan is an important step in fulfilling those expectations.

Key words: Croatia, European brown bear, hunting, management, Ursus arctos

Most western and southern European countries exterminated their brown bear (Ursus arctos) populations before World War II, leaving only a few remnant nuclei (Abruzzo, Trento, Cantabria, Pyrenees) of fewer than 100 individuals each (Servheen 1990). This period was followed by the occasional and slow return of bears to some parts of their previous range (Clark et al. 2002). European countries that currently have bear management plans include Austria (WWF Austria 2005), Spain (Wultsch 2004), France (L’Ours Pyrenees 2006), Greece (Zedrosser et al. 2001), Latvia (Ozolins 2003), and Switzerland (Oberle 2006). These plans tend to be very protective, and only in the case of problem bears is the removal of certain individuals considered. In countries like Slovenia (Zavod za gozdove 2002) and Finland (Wultsch 2004), management plans allow a limited bear hunt. In contrast, Romania (Wultsch 2004), Sweden (Zedrosser et al. 2001), Estonia (Lõhmus 2001), and Croatia resumed or continued hunting as one option for management where sufficient numbers survived. In North America, hunting of brown bears is controlled under management plans in Canada (McLellan and Banci 1999) and Alaska, but brown bears are strictly protected in the contiguous United States (Interagency Conservation Strategy Team 2003). In 2007, grizzly bears in the Greater Yellowstone Ecosystem were delisted as an
endangered species (US Department of Interior Fish and Wildlife Service 2007).

During many centuries of uncontrolled persecution, bears in Croatia were hunted by still-hunting, tracking, leg-hold traps, snares, and poisoning (Frković 1999). Beginning in 1915, bounties were established to encourage the killing of brown bears without limits or closed seasons. With the end of World War II came the need to protect brown bear populations through management. Hence in 1947, the first Hunting Act was introduced, followed by the listing of the brown bear as a game species in 1949. Additional measures adopted to better conserve brown bears included formation of forest management units (1960), prevention of illegal killing of bears, banning the use of poison to control wolf (Canis lupus) and fox (Vulpes vulpes) populations (1973), and the introduction of supplemental feeding of bears (1960s). In 1994, the Hunting Act was amended to reflect the dissolution of forest management units and the formation of a public corporation. Even with all that has been implemented, bear management in Croatia lacks coordination and, in some mountainous counties, still lacks appropriate control measures. Regardless of the approach, bear management is always challenging due to brown bears’ biological characteristics (slow reproduction, primarily vegetarian food habits for a species with a carnivore digestive system, winter denning behavior), its significance in the minds of humans, and the considerable international interest for its conservation and hunting. Croatia was one of the first countries in Europe to classify the brown bear as a game species.

In 2005, Croatia published its Brown bear management plan for the Republic of Croatia (BMPC) (Dečak et al. 2005). The BMPC’s overall goal is to “maintain a stable brown bear population in Croatia at a level that secures its long term survival and enables co-existence with man” (Dečak et al. 2005:66). Specific objectives include habitat preservation, compliance with international legislation, avoidance of risks for humans and their property, determining and maintaining a desired bear population level, providing economic benefit for local residents through tourism and hunting, raising public awareness, and involving a broad spectrum of interest groups in management decisions. We describe how these objectives are being achieved, present the results of the first 2 years of the plan’s implementation, and provide recommendations to address its initial shortcomings.

**Background**

Croatia is both a central and south-eastern European country. All brown bear habitat in Croatia is within the Dinara Mountain Range, which runs parallel to the Adriatic Sea coast, from northwest to southeast, and extends from Slovenia to Bosnia and Herzegovina (Fig. 1). Consequently, Croatia shares its bear population with these 2 countries. Currently, bear range in Croatia extends over 11,824 km², which represents 20% of the Republic and 34% of the Republic’s forests. Within this range, bears permanently occupy 9,253 km², whereas 2,571 km² has occasional bear presence (Dečak et al. 2005). Elevations in the Croatian part of the Dinara Mountains vary from sea level to 1,831 m. Forest covers about 70%, which is dominated by a mixture of beech (Fagus sylvatica), fir (Abies alba), spruce (Picea abies), and other tree species varying in composition with elevation and exposure. Mountain peaks and steep slopes (≥60°) are formed of bare rocks. Mean January temperatures range from −1.2°C in Delnice to −3.6°C on the Risnjak Mountain (Makjanić 1971/72), and snow cover extends 60–165 days (Bertović and Martinović 1981), depending on elevation.

As requested in the Action plan for the conservation of the brown bear in Europe (Swenson et al. 2000), interest groups were invited to participate in the development of the BMPC. A workshop was held at the beginning of the process and a final one before the plan was accepted. Interest groups invited to workshops were hunters, foresters, researchers, backpackers, non-governmental organizations, professional conservationists, and other government people. The BMPC incorporated the results of a 2003 study that assessed public attitude toward brown bears (779 responses to a questionnaire), including those of foresters and hunting unit leaseholders (Dečak et al. 2005:37; A. Majić, 2003, Human dimensions in brown bear management, Zagreb, Croatia).

In accordance with the agreement reached at the first workshop and with the responsibilities originating from international conventions, directives, plans and recommendations, the Ministry of Agriculture and Forestry (later renamed the Ministry of

Agriculture, Forestry and Water Management) and the Ministry of Environmental Protection and Physical Planning (later renamed the Ministry of Culture) each appointed 4 members to an expert committee to develop the BMPC. External experts were consulted for specific issues before a draft of the plan was adopted.

**Bear management plan for the Republic of Croatia: Approach, process, and structure**

The BMPC summarizes international and national legal provisions relevant to bear conservation and management (Part 1), the situation in Croatia (Part 2), and the management plan (Part 3). Here we present the goals and actions from Part 3. Elements of the first 2 parts are included for context.

**Monitoring the bear population and mortality**

Under the BMPC, the brown bear population is to be monitored through the systematic collection of data regarding bear population size and demographic characteristics such as reproduction, mortality, and population trend. Population trend monitoring is to be performed by field bear managers through observation and counting of bears at supplemental feeding sites and through monitoring of signs of bear presence (property damage, scats, tree marks, footprints). In particular, records are to be kept of family groups (mother and 1- or 2-year-old cubs), and sex and age groups (cubs, yearlings, sub-adults, and adults). Forms were designed for observations at feeding sites on moonlit nights.

The approximate number of bears is to be determined by genetic methods. Samples of fresh bear scats and tissue from dead bears will serve as material for DNA analysis. An adequate sample of scats collected in a specified area during a limited period and tissue samples from all dead bears should provide an estimate of the size of the bear population with an anticipated error of 10%. These data will be used as a baseline to calibrate the index of population trend acquired through counting bears.

Every known bear mortality is to be recorded. Standard measurements and samples such as tissue, teeth, and parasites of dead bears are to be taken and recorded according to standardized procedures. This information is to be reported to the relevant ministry within 24 hours. Every bear hide and skull is to be individually marked. Marking tags, their distribution, and method of application are determined by the relevant ministry. The typical penalty for unreported bear mortality is the suspension from the privilege of receiving the hunting quota in the next year.

**Estimation of ecological and social carrying capacity**

One of the most demanding issues facing those preparing the BMPC was agreeing on how many
bears would live in Croatia if the population were left unmanaged and untouched (i.e., ecological carrying capacity). The initial estimation of the biological carrying capacity was calculated in 2 ways: (a) by summing the numbers of bears expected in each hunting unit (base game stock; \(n = 85\)), based on contracts indicating how many bears must be in the unit at the termination of contract, and (b) by summing the capacity estimations of areas with different densities of bears.

The estimated range for the current bear population was a compromise. Local estimates were collected from experts in hunting management and bear biologists for the bear range in 1999, and the sum was used as the lower limit of the range. The upper limit was the sum of the hunting management programs plus bears in the National Parks and in areas where bears are not hunted. None of these methods is scientifically based, but this initial value can be corrected as better data are available.

As a basis for management, the current bear range in Croatia was mapped (Fig. 2), distinguishing areas where bears are permanently present from where they are only occasionally present. The bear range in Croatia is continuous with no isolated populations. The easternmost range is contiguous with Bosnia and Herzegovina; the northern part adjoins Slovenia’s bear population (Fig. 1). Although bears are to be maintained in the entire permanent range, the occasional range was divided into desirable and undesirable. Within permanent range, bears are present during all seasons and local inhabitants accept bears as part of their natural environment. In areas with an occasional presence, bears are present sporadically, or the number of bears does not guarantee the continued existence of the species. These are habitats to which bears are returning that are connected to areas with a permanent presence of bears in Croatia, Slovenia, or Bosnia and Herzegovina (Fig. 1).

**Fig. 2.** Brown bear Range in Croatia with the zone categories (Dečak et al. 2005).
A separate issue is the likely difference between biological capacity of the habitat and the so-called social carrying capacity, of how many bears local inhabitants are ready to tolerate. For all large carnivores, including bears, the social carrying capacity is lower than the ecological capacity. The general public questionnaire and contacts with locals at workshops were used to help estimate this number. The initial estimate was used only for orientation purpose.

**Removal quotas and methods of take**

Removal quotas include legal harvest, poached bears, lethal removal of problem bears, mortalities due to traffic and other anthropogenic causes, and non-lethal removal of bears from the population. Although sex and age of bears to be shot are not predefined, young bears following their mother and females leading young cannot legally be shot.

The basic criteria for the allocation of quotas among hunting units (assignment to leaseholders) are quality and size of the unit and the bear population density. On the national level, a total annual removal of 10–15% of the estimated number of bears is planned. The annual removal quota is based on short-term population trend information. A higher quota (15%) will be used if the trend shows an increase or if the extent of bear-caused damages requires stopping population growth. If a negative growth trend is recorded, the quota can be set lower (10%) or the hunt could be suspended in certain years or areas. The percent for calculation of the quota and the total number of bears planned for removal in the next calendar year are determined based on the population estimate and trend in relation to the projected habitat capacity (i.e. how many bears are desired in each area). If in any year the annual quota is exceeded, this surplus is to be subtracted from the next year’s quota. Likewise, if deviations appear from the expected proportion of harvest in total removal, the percent for calculation of quota is also to be amended. Problem bears removed from the population are not treated as part of the harvest quota, but rather as ‘other population losses.’ The increase of losses may reduce the hunting quota, and fewer losses may result in more bears to be hunted in the next year. On the basis of current experience, the BMPC anticipates that the proportion of total removals attributable to hunting will be 80%, and that 20% will be attributable to other losses (Dečak et al. 2005:70).

The BMPC sets hunting seasons as 1 March–15 May and 1 October–15 December, which is 2.5 months shorter than hunting seasons in effect prior to the plan. The shorter season helps avoid the denning period, and more importantly, makes it possible to manage bears on the calendar year basis. In late December and January, the results of the previous year are to be collected and analyzed as a basis for decisions for the next year.

In Croatia, bears are hunted with the hunter on an elevated stand next to a feeding site during at night during a full moon. Hunting from a high hunting stand provides a good vantage point for observation, allows for the determination of age and sex, reduces the possibility of wounding a bear, minimizes disturbance of the habitat, provides for the safety of hunters and others, and enables better control of harvest.

Supplemental feeding with food of plant or animal origin is an accepted bear management measure in Croatia, and the BMPC allows for feeding up to 120 days/year in November, February, March, and April. Grain (corn, oats, barley), wet fodder (sugar, fodder beet, fruit), meat products (inspected carcasses or condemned meat), and special plots planted with annual and perennial crops can be used for supplemental feeding of bears. No processed foods are to be used at bear feeding sites. A maximum of 300 kg of grain and wet fodder or 400 kg of meat foods/adult bear is permitted during each supplemental feeding period (Dečak et al. 2005:73–74).

The BMPC permits only 1 feeding site to be constructed per 40 km². These sites must be located, ≥2 km from permanently inhabited human settlements and ≥300 m from National Park boundaries. Locations must be chosen that prevent the contamination of water sources (Dečak et al. 2005:73–74).

**Habitat conservation**

Another priority of the BMPC is habitat conservation. Croatian bear ranges, including those of the entire Dinaric and Pindos mountains area, are very valuable and are comparable to the highest quality habitats in the Carpathian region of Romania. These habitats allow for high population increases, population stability, and hunting that would not be possible in many parts of Europe with bear presence (Cienjak et al. 1987; Huber and Frković 1993; Huber and Roth 1993, 1997; Kusak and Huber 1998; Frković et al. 2001; Majnarić 2002).

Recording the changes of habitat status is required for the identification and implementation of conser-
vation measures. In particular, effects on bear habitats are to be assessed for forest operations, agricultural development, sport and tourist facilities and activities, garbage treatment, and proposed transportation infrastructure: all roads are to be permeable to bears and other animals with mitigation measures such as tunnels, viaducts, green bridges (Huber et al. 1998).

**Problem bears**

According to the BMPC, the primary measure to prevent the occurrence of problem bears is to reduce conditioning bears to foods from human sources. Every food source treated as garbage (food scraps, garbage in containers, garbage deposited in legal or illegal dumps) must be inaccessible to bears. Measures to prevent bear access to garbage include removal, electric fencing, use of bear-proof containers, and penalizing violators. Bear cubs that become orphaned or separated from their mother before the natural family separation typically develop into problem bears. Therefore, additional measures include reducing the incidence of orphaning bear cubs through special care in hunting, prevention of poaching, avoiding disturbance in denning habitats during winter, and prohibiting feeding of a motherless cub.

Measures to deal with problem bears include prevention of access to food sources they regularly visit, aversive conditioning (noise, shocks from electrical fences, discharge of noise-making ammunition or rubber bullets) and, if none of these measures is effective, removing the bear.

Under the BMPC, lethal removal of bears to avoid conflicts with local residents is to be regulated by the ministry authorized to issue a permit after the presence of the bear or bear damage has been confirmed several times, regardless of the bear hunting season. The removal of undesirable bears will be done by a local hunting unit leaseholder, who is allowed to use group or individual hunting methods. If they do not wish to, or are not able to perform this task within the specified time frame, the ministry will allow others to remove the bear.

**Minimizing and compensating damage**

Measures for preventing damage by bears under the BMPC include gathering and distributing instructions on actions to prevent damage, feeding bears to keep them away from human sources, and keeping the size of the population at a level with tolerable damage. Current legal practice, as defined by the BMPC, makes hunting unit leaseholders responsible for damage caused by game, including brown bears. If the person suffering the damage has not added to the damage through irresponsible behavior, the compensation has to cover the entire damage. In cases where a bear causes damage in an area with only occasional presence of bears or in national parks, damage will be compensated by the state.

**Bears and tourism**

Bears are a symbol of the richness of nature, and the quality of the natural environment affects tourism. Communities can use bear presence to increase the value of local products, such as handicrafts. For instance, the creation and use of a ‘bear label’ on products would mean that they are derived from a forest managed for bear habitat. Beyond hunting tourism, bears can promote ecotourism, which includes so-called non-consumptive use of natural resources (Shackley 1996).

**Public information and participation in decision making**

To improve the quality of bear management in Croatia and to avoid conflicts among interest groups, the BMPC calls for education and information campaigns for inhabitants, visitors to bear areas, and students. By working with the local population, the social carrying capacity of the area can be improved. Monitoring public attitudes toward bears and bear management is to be continuous. The results of public surveys are one of the indicators for setting the social carrying capacity.

**International cooperation**

Croatia’s main international legal obligations are the Convention on Biological Diversity, the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention), and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The Croatian brown bear population is shared with the Republic of Slovenia and the Republic of Bosnia and Herzegovina. Because bear population management in Croatia can influence bear populations in neighboring countries, the BMPC commits Croatia to management that will keep its bear population in balance so that a similar magnitude of migrations across the borders in both directions can be
expected. Croatia expects a similar approach to bear management from neighboring countries. Scientific knowledge on Croatian bears will be available to experts in neighboring countries. Yearly meetings of bear managers are planned to exchange experiences and jointly plan quotas for the upcoming year.

**Bear emergency team**

The Bear Emergency Team (BET) is an intervention group set up by the BMPC of 7–10 experts tasked with visiting areas reporting exceptional damage caused by bears, an accident or a death of a bear, or a problem bear. BET members will attempt to alter the behavior of problem bears through aversive conditioning. Where this is not effective, other options will be employed such as capturing and marking problem bears (for easier tracking of the bear’s behavior), translocation, placing in captivity, and as a final resort, lethal removal of the animal.

**Funding**

Funding is to come primarily from 2 sources: domestic (the state budget of the Republic of Croatia, hunting unit leaseholders, local and regional administrations, scientific and academic institutions, Croatian Hunting Associations), and international (the European Commission, through various programs such as LIFE [a European Union program for projects related to nature and environmental conservation], for certain years and for certain projects, and foreign donations).

**Implementation and revisions of the BMPC**

The Ministry of Agriculture, Forestry and Water Management and the Ministry of Culture, Department for Nature Protection are to cooperate in the implementation of the plan; however, the practical implementation is overseen by the former. The committee set by these bodies is to carry out revisions of the management and the action plans. The revisions are to be open to the interest groups and the general public.

**The BMPC: Content and resulting activities**

The final document was approved in 2004 and released in 2005. The development process took 2 years, during which an initial and a final workshop with wide participation and 7 working committee meetings were held. The main results from the first 2 years (2005 and 2006) of implementing the BMPC were prepared. The implementation of these actions is a process that is expected to take from one to several years. Here are presented results relevant to certain actions.

**Monitoring the bear population and mortality**

Prior to the BMPC, a subjectively decided percent (between 10 and 50%) was added to the number of bears seen and was used as the actual count. The BMPC now accepts counts at feeding sites as an indicator of trend. To improve objectivity, a standardized recording procedure has been developed. It will allow for set feeding sites with the same type of bait from year to year. This standardized system began in 2007.

To better estimate population, we collected 750 scat samples. (In addition, 120 tissue samples of bears shot in legal hunts or found dead from other causes were collected for genetic analyses.) In the initial phase we extracted DNA from 350 scat samples and applied polymerase chain reaction (PCR) to 170. Overall PCR success rate is currently 74%. Current plans include genotyping fecal samples at 6 microsatellite loci (Mu10, Mu23, Mu50, Mu51, Mu59, G10L) as well as using the SRY locus for sex determination (Waits et al. 2000).

A population estimate using these genetic markers is expected to be available for the 2008 quota setting process. Because the authors and the field team of game wardens and park rangers sampled only 3 areas of about 250 km² each and not the entire bear range, an extrapolation will be necessary, leading to a wide margin of error. However, we expect our DNA-based estimate to yield superior data to traditional counting methods, and it will be used as the basis for all future management decisions. It will also be used to calibrate estimates obtained from observations at feeding sites.

**Ecological and social carrying capacity**

The provisional ecological carrying capacity for brown bears in Croatia was defined and set by the BMPC at 1,100. The methods of calculation yielded results close to this number: (1) the sum of numbers of bears expected to be in each of the 85 hunting units (base game stock) was calculated at 1,134, and (2) the sum of the capacity estimations of the portions of bear range in Croatia was 1,140. This
estimate of ecological capacity was slightly greater than the current population estimate of 600–1,000 bears, which, in turn, came from (1) an estimate made in 1999 (600), and (2) the sum of current local base game stocks plus an assumed reproductive increase of 15% (850 bears), plus 50 bears in the national parks and 100 bears in areas where bears are not managed with hunting (1,000 bears; Dečak et al. 2005:56–57). The outcome is that the estimated current population size is between 100 and 500 bears below the ecological capacity of the habitat.

BMPC objectives were set so that desirable occasional range (1,793 km²) would become permanently occupied and undesirable range (778 km²) would be kept free of bears. The later includes urban areas, a narrow costal zone, and the island of Krk; the latter 2 are tourist areas.

The zone (approximately 2,400 km²) with the best quality habitat and permanent bear presence was deemed to be able to support a population density of 2.0 bears/10 km² and to sustain an annual harvest of 15%, or 36 bears (1/67 km²). In the remaining zone with permanent bear presence (6,300 km²), the presumed average density was 1.0 bear/10 km², for which the BMPC predicts a sustainable annual harvest of 10% (63 bears, or 1/100 km²). In the part of the zone with occasional bear presence where there are no conflicts between bears and residents, the permissible annual harvest was set at 9 bears (1/200 km²), which is close to 10%. In the part of the zone where bear presence is not desirable, there is no limit for the number of bears that can be harvested to minimize conflicts with residents.

The anticipated public acceptance of bear densities, referred to as the social carrying capacity, was provisionally set at 20% lower than biological capacity (900 bears). This took into account data showing that 72.7% of people surveyed “would agree with increasing the number of bears in Croatia” (Majić, unpublished report, 2003), but also demonstrated that the BMPC was not pushing the limits set by biological capacity. The general goal for the Croatian bear population was to keep it close to the biological capacity of the habitat while minimizing bear–human conflict.

**Removal quotas and methods of take**

Most actions during 2005 and 2006 were in accord with standards set in the BMPC. However, during 2005, only 46 of the quota of 80 bears (58%) were killed by hunting (23 M, 8 F, 15 with incomplete records). Another 22 bears, of expected maximum of 20 (110%; 5 M, 10 F, 7 with incomplete records) died due to other losses, 10 as traffic kills. Consequently, the quota for 2006 and 2007 was reallocated at 70% hunting and 30% other losses. In 2006 recorded bear mortality was 85: 49 from hunting (38 M, 11 F) and 36 (12 M, 17 F, 7 unrecorded) from other losses (24 from traffic kills). Non-hunting mortality (42% of all deaths in 2006) were higher than initially expected (20 or 30%). Ten problem bear kill permits were issued in 2005, but in 8 cases the bear disappeared or was shot but unreported. In 2006, 7 bears were shot as problems out of 12 permits issued.

Incomplete reporting of hunted bears was identified as a major problem in the first year of implementation. Coverage improved in the second year due to more clearly explained regulations and better acquaintance by hunters. Poaching was more prevalent than suspected (7 in 2005 and 3 in 2006).

The nationwide hunting quota was apportioned among hunting units based on size, habitat quality, and previous management of each unit. Total recorded bear mortality (n = 281) for 1946–85 included 54% adults (>4 yrs old), 34% bears >150 kg mass, and 77% males (Frković et al. 1987). Recent data for 1997–2003 included 46% adults and 67% male in total recorded mortality (n = 167) (Majnarić 2004). During the first 2 years of BMPC implementation (2005 and 2006), 78 of 124 dead bears of known sex were males (63%). The bias toward males is partly due to hunters seeking bigger trophies and wanting to protect females with cubs; females with new litters were less frequent visitors at feeding sites during the spring hunting season. However, of 56 live captures for research purposes, 36 (64%) were males. Bigger movements and less cautious behavior of male bears may explain part of this bias, but also indicate that hunting may have not yet distorted the sex balance.

**Habitat conservation**

Habitat conservation goals have already been achieved in mitigating effects of new highway construction. The total permeability of new highways (built since 1996) within bear range (225 km) in Croatia is 18.6%. Structures conducive to permeability include tunnels, viaducts, and 6 overpasses ('green bridges') 100–120 m wide. Several management authorities are in charge of controlling human use of bear habitat. Hunting authorities take care of non-disturbance and poaching in hunting grounds,
whereas state-owned forestry organizations control use of forest roads and timber extraction. National parks and nature parks have their own personnel to protect their nature reserves. Among other aspects of habitat conservation, actions to reduce access to garbage have been promoted by publishing brochures and through the donation of 2 bear-safe garbage bins, 6 garbage baskets, and 1 electric fence for a communal garbage dump in Delnice. Unfortunately, maintenance of this fence by the communal company has been poor. All construction and development actions have to go through the Ministry of Environment and Physical Planning.

**Problem bears**
Actions to reduce access to garbage by bears and to reduce the number of orphaned cubs are helping to reduce the occurrence of problem bears. In one case, we immobilized and transplanted a garbage-habituated bear, although it returned from the release site 20 km distant after 5 days. In other cases we used rubber bullets on problem bears, although with no clear success. In most cases, special kill permits have been issued by the hunting unit of the Ministry for Agriculture, Forestry and Water Management. However, only 9 of 24 (38%) problem bears were reported to have been removed.

**Minimizing and compensating damage**
Luckily, bears in Croatia do not damage human property very much: recorded cases of damage were 24, 88, and 16 in 2004, 2005, and 2006, respectively, and mean yearly damage compensation paid by hunting managers was 7,000 euros. Funds provided by the LIFE project “Improving coexistence between large carnivores and agriculture in Southern Europe (LIFE COEX)” supported the donation of 8 electric fences to beekeepers and 2 to livestock owners, as well as a pilot project to demonstrate better means of property protection.

**Bears and tourism**
With respect to bear tourism, in 2006 Risnjak National Park posted on its website Bear Trail Walks. Several groups have since used this program. We approached 4 local producers of cheese and drinks from local herbs and they all gladly signed ‘bear friendly’ contracts, which permit them to display their products with the bear friendly logo.

**Public information and participation in decision making**
To enhance public participation at the 12 presentations of the BMPC, open house events were held in communities within bear habitat. The results of the questionnaire on attitudes (Majić, unpublished report, 2003; 779 returned questionnaires, response rate of 37.9%) revealed that the bear is highly valued (94% believe it “good to have bears in Croatia” and 73.9% have feelings “in favor of bear”) among the Croatian public, but the majority (53.7%) of respondents support trophy hunting of bears.

**International cooperation**
A Croatian–Slovenian meeting on bear management, with political and expert participation, was held in February 2007; another one is scheduled for early 2008.

**Bear emergency team**
The BET members had two 2-day training seminars on working protocols and field procedures to solve problem bear situations in 2005 and 2006. In 2005, BET members rescued a bear from a poacher’s snare and translocated another bear from a garbage dump. The dump bear returned within 5 days and was shot later that year. The BET also investigated and reported on bear damage sites and on problem bear behavior. All decisions on removal of bears were based on those investigations.

**Funding**
During 2004–08, the main funding to implement the BMPC came from the LIFE COEX project and the Ministry for Agriculture, Forestry and Water Management. Additional funding came from EURONATUR (for the initial workshop), BBI-Matra (for genetic work), and the Research Council of Norway (for monitoring hunting). During these 5 years the total amount spent was 240,000 euros (US$287,500 [Jan 2006] or 48,000 euros/yr).

**Discussion and recommendations**
Before adoption of the BMPC, the traditionally acceptable harvest rate was calculated as 15%. The main weakness of this approach was the uncertainty surrounding the population estimate against which the 15% was applied. Although it remains unclear whether the harvest was actually 15% or the population was larger than estimated, the previous
management approach did lead to a remarkable population increase. There were >100 bears in the late 1950s when trophy hunting started (Frković et al. 1987, Huber and Frković 1993) compared to the 600–1,000 bears estimated in 2005 (Dečak et al. 2005).

There is no doubt that this population has high reproductive potential (Frković et al. 2001) and that the habitat has a high suitability index (Kusak and Huber 1998). Nevertheless, the harvest percentage may likely change (in either direction) when better data on population trend and size becomes available. The BMPC introduced the calculation of annual bear removal quotas on a national basis. That is, the total quota is decided first and later allocated among hunting units. Likewise, losses from non-hunting reasons are to be counted in the same way. In the previous system, all losses were included in the quota for the local hunting unit. This led to some deaths not being reported to maintain the opportunity to shoot a trophy bear and earnings from the hunter's fee, which is proportional to trophy size of the bear.

Feeding of bears for hunting and other management purposes remains controversial. Current management is a compromise, which is at least temporarily helping to reduce conflict. Supplemental feeding is permitted to keep bears in a desired part of the habitat, prevent them from getting close to human settlements, reduce damage to property, provide a chance to observe and monitor trends of bear population growth, treat eventual health problems, increase the habitat's carrying capacity, increase population growth and reproductive potential, develop eco-tourism (photo-hunting) and education, and execute the planned harvest. To deter bears from becoming accustomed to or dependent on anthropogenic food, supplemental feeding is limited to 120 days.

In accordance with the Bern Convention, education and information campaigns for different target groups among local inhabitants should be further developed. Interest groups as representatives of the public in bear management should be identified and their involvement increased.

The committee involving the Ministry of Agriculture, Forestry and Water Management (Department of Game Management) and the Ministry of Culture (Department of Nature Protection) has been established to revise the BMPC and to produce yearly action plans. The BMPC is not a final document. It can be adapted to any change if necessary. Revisions should be open to the comments and proposals of interest groups and the general public.

We recommend establishing a working group that includes representation from neighboring countries to develop a joint management approach that maintains an ideal population level. Annual meetings of international bear managers should be held to improve cooperation with the intent of exchanging experience and jointly planning quotas for the upcoming year. The BMPC recommends estimating the total brown bear population size every 3–5 years.

A standardized method for evaluating bear damage, as well as criteria related to justification of compensation claims, should be developed. The efficiency of the BET can be improved by paying individuals on a 24-hour duty basis. Research should be initiated to quantify the amount of non-natural food bears ingest and the proportion these foods represent in a bear's total diet, as well as the effect these foods have on the behavior of bears, both on an individual and population basis. Education and awareness programs that teach visitors about appropriate behavior in bear habitat through brochures, flyers, signs on the hiking trails, and lectures should also be developed. Areas accessible to visitors should be restricted, or the number of visitors in certain areas or times (e.g., denning sites in winter) should be limited. Institutions that keep bears in captivity should be encouraged to educate and entertain their visitors, as well as create economic profit.

Acknowledgments

We thank the authors of the Croatian brown bear management plan and the numerous co-workers who helped with certain parts of it. We also thank EURONATUR, LIFE COEX, BBI-Matra (through ALERTIS) and Research Council of Norway (through NINA) for financial support. Special thanks go to Ursus editors and reviewers who invested their expertise and time to improve this manuscript. They indirectly also helped to clarify a number of issues during revision of the BMPC.

Literature cited


Oberle, B. 2006. Managementplan für den Braunbären in der Schweiz. (Brown bear management in Switzerland.) Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation UVEK, Bundesamt für Umwelt BAFU. (In German.)


US Department of Interior Fish and Wildlife Service. 2007. Endangered and threatened wildlife and plants; Final Rule designating the Greater Yellowstone Area population of grizzly bears as a distinct population segment; removing the Yellowstone distinct population segment of grizzly bears from the federal list of endangered and threatened wildlife; 90-day finding on a petition to list as endangered the Yellowstone distinct population segment of grizzly bears. Federal Register March 29, 2007:14865.


WWF Austria. 2005. Bears in Austria — a management plan, revised version. WWF Austria, Vienna, Austria.

Zavod za gozdove. 2002. Strategija upravljanja z rjavnim medvedom (Ursus arctos). (Brown bear (Ursus arctos) management strategy.) Ministrstvo za okolje in prostor Slovenije and Ministrstvo za kmetijstvo, gozdarstvo in prehrambo Slovenije, Ljubljana, Slovenia. (In Slovenian.)


Received: 31 October 2006
Accepted: 12 October 2007

Associate Editor: R. Shideler