

**Influence
of human disturbance
towards brown bear**

**Expert opinion
based survey**

INFLUENCE OF HUMAN DISTURBANCE TOWARDS BROWN BEAR

Expert opinion based survey



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The present document is a section of: *Dal rapporto con l'uomo alle strategie di svernamento: le ultime ricerche del Parco Naturale Adamello Brenta per l'orso*. Parco documenti n. 20. Published in December 2013 by Adamello Brenta Nature Park. Printed by: Tipografia Mercurio (Rovereto - TN). Authors: Maria Cavedon, Andrea Mustoni and Filippo Zibordi. 434 pp.



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Introduction

Adamello Brenta Nature Park, the largest protected area of Trentino (Italy), hosts the only Italian alpine brown bear (*Ursus arctos*) population for which reproductive events have been ascertained. This nucleus derives from the reintroduction project named *Life Ursus* promoted by the Park in 1996, in cooperation with Trento Province and Italian Wildlife National Institute.

Notwithstanding the positive outcomes of the project, witnessed by the number of reproductions of the last years in Western Trentino, the risk of extinction remains very high, for the low number of individuals (esteemed, in 2007, in more than 20; nowadays - 2013 - in approx. 50) and also because the Park territory - which represents the core area of the population - is characterized by a considerable anthropization. Human activities are various and influential, especially but not exclusively those connected with summer and winter tourism: the Park is, in fact, one of the most famous resorts on the Alps, thus subject to a high development of human activities.

Although the effects of such activities on bear population are scarcely known, their impact could be significant on the species, invalidating the conservation efforts until now realized and preventing the steadying and expansion of the actual nucleus.

For these reasons, it appeared essential to deepen the knowledge about the potential impacts of human activities on bears in order to supply the Park with an instrument that can help to guide Park policy and practice concerning bear conservation and management in the future.

This document, compiled between 2007 and 2008 by the Park itself through its Brown Bear Research and Conservation Group (in particular Andrea Mustoni, Filippo Zibordi, Elena Maffini, Vanessa Donnini and Stefano Liccioli), represents the result of such objective: it is the synthesis report of the expert based opinion survey realized with the aim of acquiring useful elements to deal with the complex problem of evaluating the possible effects of various activities and situations on bears.

It will certainly be of help for bear conservation in Adamello Brenta Nature Park: the hope is that it can become a useful instrument for bear safeguard also elsewhere.



Methodology used for the analysis

The evaluation of the level of disturbance that human activities cause on wildlife has been analysed in various contexts. At present, though, there lacks an overall methodology useful to quantify the entity of disturbance sources, both for the complex interactions between human activities and wildlife, and for the hard definition of indicators that can correctly represent such interactions. More than that, from a review of existing bibliography about human activities influence on brown bear populations, it appears that literature about these issues is pretty scarce: also considering the great behavioural plasticity of brown bear, for the species it is not even available a widely accepted list of the activities or situations of human "origin" that can affect its conservation.

On the other hand, an estimation of anthropic impacts on the species appears critical, especially to give scientific support to decisional process referring to territorial management of the protected area.

For this reason the Adamello Brenta Nature Park decided to conduct a survey based on summary of qualified and scientifically accredited opinions (expert based opinions). Such an objective was realized compiling and distributing an appropriate questionnaire to bear experts: knowing their opinions and advice, supported by acquired experiences and eventually by some scientific researches, is thought to be of help to evaluate bear/human activities relationships.

In order to identify experts qualified to give advice on assessing and managing human impacts on brown bears, the Park asked assistance to the *International Association for Bear Research and Management* (IBA). After consulting with the Bear Specialist Group of World Conservation Union (IUCN) and its European brown bear team chairs, IBA's governing Council provided a list of top European and North American biologists with expertise and practical experience in this field, to whom the Park submitted a questionnaire related to the possible effects caused on brown bears by structures (forestry roads, ski lift, etc.) and various activities (forestry cuts, off-the slopes skiing, etc.).

Among the identified experts, the following 8 have agreed to cooperate to the present project taking part to the work group:

1. Mike Gibeau (Canada - University of Calgary)
2. Kerry Gunther (USA - National Park Service U.S. Dept. of the Interior)
3. Djuro Huber (Croatia - University of Zagreb)
4. Jonna Katajisto (Finland - University of Helsinki)
5. Bruce McLellan (Canada - Ministry of Forest and Range- B.C. Government)
6. Yorgos Mertzanis (Greece - Callisto: Wildlife and Nature Conservation Society)
7. Chris Servheen (USA - University of Montana)
8. Jon Swenson (Norway - Norwegian University of Life Sciences)

The questionnaire submitted was realized following an accurate analysis of the existing bibliography and was subdivided in 5 thematic branches (for an overall of 39 questions):

- disturbance on bear: this section aimed at defining what could be detrimental for the species and at analysing the effects of disturbance on habitats and individuals;
- ideal and disturbed bear habitat: loss and fragmentation: the goal of this branch was to examine in detail causes of fragmentation and loss of bear



habitat, as well as the resulting effects on bears (including the role of dispersion);

- human activities and impacts on bears: it aimed at analysing in detail effects, influence area, influence on bear behaviour and on bear habitat of 13 “human activities/situations” such as:
 1. forestry
 2. agriculture
 3. animal farming/grazing, zootechnical activities
 4. apiarian activities
 5. mining
 6. hunting
 7. tourism/recreation activities (playgrounds, golf-courses, riding-schools, boating, flying, trekking, climbing, etc.)
 8. winter recreation activities
 9. skiing areas
 10. roads (main and secondary) and railways
 11. forestry roads
 12. human structures and development (resorts, villages, towns, dams, factories, etc.)
 13. garbage/feeding sites (for bears and/or for other wildlife).

References were asked to the work group about any realized research concerning the effects of human activities towards the species; experts were also invited to suggest management measures to solve the mentioned problems;

- bears habituation: the attempt of this section was to understand if and to which source of disturbance bears can habituate, which are the related (positive or negative) consequences and if habituation can modify bear reactions to disturbance;
- bears and cumulative effect: the goal was to understand the overall effect on bears and their habitat of more activities or conflict situations that simultaneously occur in an area, in order to deepen the involvements for bear conservation.

First draft of the survey was realized preparing a synthesis document which included all opinions expressed in the above mentioned questionnaire, highlighting all cases in which (all or some of) the experts agreed. The document was then refined giving the draft of the elaboration back to the above mentioned experts, so that they could propose advices, modifications and integrations.

This feedback process set up between the experts and the compilers of the report (Brown Bear Research and Conservation Group of Adamello Brenta Nature Park) assimilates the used method to the “Delphi process”. Such methodology is, in fact, widely used in scientific literature to synthesize the opinion of a group of experts in order to obtain a consensual opinion when neither field data nor enough time nor resources are available. For such purpose, it is based on questionnaires sent separately to experts and then revised and returned to the same work group in order to re-evaluate its original answers after examination of the group response. To a degree, Delphi process is thus a combination of a polling and a conference procedure: its interactive method offers both the opportunity to underline prevailing view of one issue and to stress the eventual disagreements.



Although present survey did not foresee the development of different questionnaires for the respondent group, it started from similar assumptions and adopted similar methodological solutions to “Delphi process”.

Note to the following report

With reference to the above mentioned goals, as one of the aim of the report was to emphasize all cases in which (all or some of) the experts agree, each paragraph of the report is preceded by an “expert opinions summary” where similar answers were assembled. Reading such summaries helps to get a general view of the experts opinions, showing how many people answered to the related questions and how many of them agreed.

In this sense, it is useful to note that sometimes the experts gave more than one answer to the same question, thus the sum of the authors answering to a given question may exceed the total of the ones that have given an opinion. Moreover, in the summaries we tried to collect also the opinions of authors that answered to the question in a different part of the questionnaire.

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Chapter 1: Disturbance on bear

1.1 Definition of disturbance with regards to bears

Experts opinion summary

Disturbance can be defined as:

- a change in bear activity in response to human activity: 5 out of 8 authors;
- any stimulus that cause a reaction: 1 out of 8 authors;
- any action by humans with negative effects for bears: 1 out of 8 authors;
- a perturbation situation: 1 out of 8 authors.

Disturbance would be defined differently in different studies, depending on the goal of the study (Swenson).

Broadly, disturbance can be defined as a stimulus that causes a reaction (McLellan) or altering bears temporal and spatial activity patterns in response to human activity (Gibeau); it is any cause that results in a change of current activity (Huber). In details, disturbance can be defined as harm to bears health, or detectable changes in behaviour including alteration of bears home ranges, diel activity patterns, habitat use, food habits, distribution, abundance, reproduction, and survivorship, as well as disturbance related changes in a bear populations genetic composition (Bowles 1995 quoted by Gunther). The behavioural response results generally in avoidance of areas with the disturb factor present or interruption of normal behavioural activities (Servheen), that leads the animal to be more attentive, rapidly flee or even attack the stimulus or more gradually move away or avoid areas and times if it associates the stimulus with a place or time (McLellan). The response depends on the experience of the bears in question. Bears that have experience with a particular human activity (such as use of a highway by vehicles, or presence of humans at close range), and have little or no negative experience associate with it, can become habituated to this activity and will lose their fear or avoidance of it. However, bears that have experience with a particular human activity and have negative experience with it will tend to avoid that activity. Thus, bears outside north-american national parks tend to avoid roads and close human presence. So the question is not an easy one and depends on the circumstance. In general terms bears outside of US national parks tend to be disturbed by motorized human activity and by high levels of human recreational use in areas where motorized use does not occur (Servheen).

Bear may permanently change the activity pattern to adapt to the cause of disturbance. In many cases that may cause no troubles to the bear or to the acceptance of bears to the people. However, the accumulation of altered activities likely over-exceeds the adaptation ability and results in biological failure (no reproduction, low litter survival, accidental deaths) or problems with people (Huber).

A disturbance may result in a behavioural reaction as well as a physiological one. Bears reactions may even be limited to biochemical changes due to the secretion of epinephrine and norepinephrine. These hormones cause an almost immediate



increase in heart rate, metabolic rate, glycogen breakdown, glucose release, release of fatty acids, or, in general, prepare the body for an extreme action. In addition to these fast-acting hormones, biochemical reactions to disturbance also include increased production of corticosteroids that effect bioenergetics (McLellan).

A bear may have biochemical reactions to a disturbance without a clearly noticeable behavioural reaction (McLellan): not all bear reactions to disturbance are overt (Herrero *et al.* 2005 quoted by Gunther). Bears may also react internally to disturbance and have energetic costs from the stress or an increased heart rate caused by disturbance (Herrero *et al.* 2005 quoted by Gunther).

Disturbance could again be meant as any intentional or unintentional action by humans that affects negatively the natural survival or reproduction of bears. Most detrimental form of disturbance would be harvest, but also just the presence of humans may cause bears to move to areas with suboptimal food sources and through that affects their fecundity or survival (Katajisto). Sometimes disturbance doesn't necessarily lead to decreased survival or cub production even though it causes behavioural changes (Gill *et al.* 2001 quoted by Katajisto).

Disturbance (in relation to bears) could be seen as a perturbation situation (of variable duration) which (in the European context) could be mainly attributed/related to the human factor (human activities). The amplitude of this perturbation and the feedback from bears depend also on the intensity level, duration, nature and type of human activities occurring in a given bear area (Mertzanis). Important for the final effect is also the frequency (repetition) of any perturbation that results in a change of current activity (Huber). Disturbance could affect bears at two different levels as defined by Servheen (1985):

a. Ecological disturbance: this category of disturbance is mainly related to a change of the physical landscape structure (within bear habitat) and usually results from such human activities as: forest exploitation (timber harvesting, etc), road construction, fire, agricultural activities, urban development or livestock grazing.

b. Behavioural disturbance: this category of disturbance causes an influence to the behaviour of bears through the loss of "solitude" from such activities as: vehicle use of roads, hunting or other recreational activities occurring within bear areas.

It is important to realize the extent and type of the different human activities (as disturbance factors) in a given bear area so that the level of ecological and behavioural disturbance can be evaluated in a given habitat. Disturbance can be measured in many ways: i.e. density of roads (roading), extent of timber harvest, logging practices, number of visitors, number of hunters, number of residents in the area, number of domestic livestock grazed, number of settlements (Servheen 1994 quoted by Mertzanis).

Effects of disturbance could be immediate (short term effects) or on a long term basis (Mertzanis). Some human actions such as construction of developments, homes, villages, towns, or cities can cause long-term loss of habitat which is developed or paved over. Other human activities such as timber harvest may cause short-term disturbance or displacement (from noise associated with



timber harvest) and long-term habitat alteration (from change in vegetation cover-type), but not complete loss of habitat. Some activities such as road building may alter a relatively small portion of the overall habitat available to bears (the area paved over), but significantly increase bear mortality (from vehicle strikes and by allowing increased hunter access to the area). Some human disturbance may not impact bears directly, but may lead to indirect impacts such as the introduction of exotic organisms which impact bear habitat, food habits and survival (Reinhart *et al.* 2001 quoted by Gunther).

Weaver *et al.* (1985) have made an attempt to group and categorize human activities by the degree and type of related disturbance using the following criteria:

- type of activity (motorized, non-motorized or explosive)
- nature of the activity (linear, point or dispersed)
- time length of activity (diurnal or 24-hour)
- disturbance intensity (high or low).

All this being said, some authors are starting to question some of the long held "truths" about how bears perceive human activity (Gibeau).

1.2 In which habitat is disturbance stronger on bears?

Experts opinion summary

Disturbance on bears is stronger in the following habitats:

- in open habitat, where visual cover is minimal and bear cannot hide: 4 out of 7 authors;
- in high quality habitat (less disturbed habitat, where all human-related factors occur at a minimum level or rarely occur, and habitat with high quality food): 3 out of 7 authors.

Answering this question is not easy because an amount of factors play a role in determining the strength of disturbance perceived by bears.

First of all, it has to be considered that the "strength" of disturbance upon bears in a given habitat depends on the type, amplitude/magnitude and duration of the human-related disturbance factor (activity) as well as on the type of its impact (short/medium/long term) without excluding the cumulative effect of more than one disturbance factors occurring at the same time (Mertzanis).

Another more or less arbitrary (and maybe unrealistic) assumption would be to consider that all possible (human-related) disturbance factors in a given bear habitat area at a given period of time would have the aforementioned parameters equally and evenly stabilized in such a way so that we would be able to examine only their global effect versus the parameters "habitat" and "strength" upon bears (Mertzanis).

Given this, we can answer this question by assigning to the term "habitat" a more generic (coarse scale) "structural" meaning which would include the overall physical features and structure of a bear area (such as topographic



characteristics, vegetation types and structure, density of human settlements, etc.) (Mertzanis).

In this case, the authors agree with the fact that one feature of the habitat that affects the level of disturbance is cover.

Naturally the closer habitat to humans, the stronger the potential disturbance on bears; but, among habitat types equally close to humans, very open habitats are worst in the sense that in open habitats bears cannot hide from humans (Katajisto).

In general the effect is related to the possibilities for bear to escape and hide and it grows when the total available habitat is limited. The horizontal cover, comprised by vegetation and topography, may help to reduce disturbance, as the limited visibility helps the bear to hide (Huber). Consequently, response to human disturbance is usually higher where visual cover is minimal and bears cannot hide (Servheen). Bears do react less to a given disturbance when visually separated from the disturbance. A sound and odour block will likely also reduce a bear's reaction to disturbance. Visual cover in the form of vegetation, terrain or darkness, and an odour or sound block such as a natural noise (such as water or prevailing wind), will reduce a bear's reaction (McLellan).

Since bears are most affected in open habitats, when there is human disturbance in the landscape rough terrain is more preferred by bears. That is, with little disturbance, flat forested terrain is fine; but if humans are present, it seems that rough terrain becomes more important (Nellemann *et al.* 2007 quoted by Swenson). What "rough terrain" is, might vary from study area to study area. There certainly is more rough terrain in the Italian Alps than there is in central Sweden (Swenson).

Food abundance and quality will also affect a bear's response to a disturbance, or at least the shifting of the reaction between biochemical and behavioural reactions. In areas of high quality food, a bear may show less behavioural response (remain and feed), but may have a heightened biochemical response or at least maintain biochemical response for a longer period (McLellan). Some authors believe that high quality habitats will override disturbance. That is, bears will find a way to use higher quality habitats despite disturbance by altering their use patterns (Gibeau).

However, disturbance in the primary, good quality habitat of bears could cause displacement to less favourable areas or otherwise disturb feeding, which may affect the nutritional condition of bears (Nevin and Gilbert 2005a, Rode *et al.* 2006 quoted by Katajisto). In general, good advice is to avoid human disturbance in good quality habitats for bears. Note also that disturbance in high quality areas for bears may increase the likelihood of bear-human conflicts (Wilson *et al.* 2005, Wilson *et al.* 2006 quoted by Katajisto).

Another factor interacts with cover and food quality and availability in determining the bears reaction to a disturbance: habituation. Like all animals, bears do habituate to stimuli that are innocuous and predictable in space and time. An individual bear will likely react differently to the same stimulus depending on how often it has encountered it, and where and when it encounters the stimuli (McLellan). Therefore, a disturbance will have a stronger effect on bears in a habitat where the disturbance rarely happens. So, a person hiking in a remote area where people rarely travel will elicit a stronger response from a bear than the same person hiking where people often hike (Jope 1985, McLellan and Shackleton 1989 quoted by McLellan). Thus another habitat feature



that affects the reaction to a given disturbance is the amount of predictable (same time, same type of activity) human use. In conclusion, for a given disturbance (for example, a person walking), a bear's reaction would be the greatest in open habitat during the day, where there is little food and where people rarely if ever walk (McLellan), namely, in general, in habitats where all the human related factors described above occur at a minimum level (Servheen 1994 quoted by Mertzanis). A relatively little reaction would be expected to the same stimulus (a person walking) if in a time and place where persons often walk, or where there is thick vegetation and high quality bear food is abundant (McLellan).

It is also possible to answer the question by assigning to the term "habitat" a "temporal" fine scale quality: i.e. the related seasonal attributes in a given area that are needed to cover bears seasonal ecological requirements throughout a given season over a year cycle (Mertzanis). That is, the periodical bear food sources may occur in different habitats creating seasonal variability in which habitats are most affected by disturbance in different season (Nielsen *et al.* 2004 quoted by Katajisto). This means that it is not only habitat type but also the temporal use of that habitat that should be taken into account when planning bear conservation. For example, often bears do not use clear cuts areas, so most of the time human use of them is not a problem. But during the berry season, bears may use clear cuts areas a lot, because there are a lot of berries, so during that season human use of clear cut habitats may disturb bears strongly, because it would prevent bears from getting their food source. In other words, clear cuts areas are not often considered good quality habitat for bears, and thus they should not be protected from human activities. However, it might be that during the berry season clear cuts suddenly provide a good source of food, and during that period human activities on clear cuts might be strong disturbance. This of course may apply to some other habitat types too (Katajisto).

Again with reference to the temporal use, spring habitat can be identified through the presence of important food resources and items used by bears in the spring season. Their availability and use is of vital importance in this period of hypo-phagia stress. Spring habitat can be also identified by the distribution and presence of females with cubs of the year (who at this season have usually relatively clear spatial and movement patterns). It is estimated that in these aforementioned cases of seasonal habitat, human related disturbance factors could have a pronounced (strong) effect upon bears (in terms of behavioural disturbance) given the fact of their exposure to other already existing environmental and potentially negative factors (i.e. cubs mortality due to depredation, spring food shortage etc) (Mertzanis). On this basis, of particular importance is the disturbance in relation to habitat used by adult females during the various stages of reproduction - with cubs, with yearlings and when breeding (Servheen 1994 quoted by Mertzanis).

The bear feedback to this effect depends on the existing alternatives (in terms of availability and accessibility) of other (less disturbed or undisturbed) suitable bear habitat units. The impact (effect) of a disturbance factor should be also correlated to the spatial magnitude (amplitude/extent) but also to the degree of reversibility of the disturbance or its immediate effect. For example clear cutting of an oak forest (a common logging practice in Greece) would definitely have a strong and prompt (but not permanent) impact upon this given type of bear



habitat by dramatically decreasing the surface of a vital autumn food resource (hard mast: acorns) (Mertzanis).

Again to evaluate the “strength” of a disturbance factor upon habitat and bears we should also take into account the duration of its effect (short/medium/long term) and the promptness (how suddenly a disturbing factor occurs?) as well as the cumulative effect (in case of multiple factors) (Mertzanis).

Many important brown bear foods occur in non-forested valley bottoms and meadows. Short-term disturbance associated with human activity and noise are generally greater in non-forested habitat types than in forested habitats due to the lack of hiding cover and the greater visibility and greater distances that noise travels in non-forested areas. Impacts on bears of disturbance in either forested or non-forested habitats are the greatest if the disturbance is long-term and occurs in habitats containing concentrations of important high calorie bear foods. This kind of disturbance in habitat containing concentrations of important high calorie bear foods is most likely to have significant effects on bear habitat use, food habits, reproduction and survivorship (Gunther).

1.3 Can disturbance modify the carrying capacity of bear habitat?

<u>Experts opinion summary</u>
Disturbance can modify the carrying capacity of bear habitat: 8 out of 8 authors.

There are only few studies about this issue, but they support a positive answer to the question.

First of all, with carrying capacity we mean the maximum number of individuals that a given environment can support without detrimental effects.

To answer this question we should, in any case, consider the concept of “disturbance” under its ecological dimension (defined as “ecological disturbance”) (Mertzanis).

Long-term persistence of brown bear populations usually depends on preservation of large expanses of good habitat (Boyce *et al.* 2001 quoted by Gunther).

Habitat structural modifications due to a severe disturbing factor usually affects habitat components such as: forest cover, vegetation composition and thus availability of food resources and safety in terms of cover. In some cases it may also affect critical sectors such as denning sites. As severe disturbing factors having this type of effect we could define: construction of roads, timber harvesting, construction of water dams for electricity power, etc.. Certain human-related disturbance factors (in the case of Greece such as: highways and other large infrastructure constructions, criminal forest fires, clear cutting of oak forests) may cause severe changes of the bear habitat structure in a given area. In some cases these habitat modifications may be irreversible (highway constructions i.e. the case of Egnatia highway construction) and in some others they may have a certain degree of reversibility over time and under certain



conditions (i.e. oak forest recovery). The above described disturbing factors and situations may result in reducing the surface of available and/or suitable bear habitat and the related "habitat value" and therefore have a direct or indirect influence on the carrying capacity of bear habitat in a given area (Mertzanis).

If bears avoided or reduced their use of a habitat that does influence the population size, there would be fewer bears at carrying capacity than there would be if the entire habitat was available to them (McLellan). That is, if disturbance results in avoidance of key habitats by bears, the energy per unit area of available habitat within their home ranges could be reduced and thus carrying capacity could be reduced (Servheen).

It has to be considered that most bear populations are not at ecological carrying capacity (McLellan).

Long-term habitat loss or long-term habitat alteration that reduces the availability of high quality bear foods can lower the carrying capacity of bear habitat, especially in small bear populations that are isolated from other populations (Gunther). Again the disturbance could sure cause more competition for resources within less disturbed areas and through the competition lower the carrying capacity (Katajisto), as the bears are pushed to the remaining undisturbed areas (Huber).

Namely, disturbance can create food stress, which in turn has an effect on reproductive rate. It has been documented the lowest recorded reproductive rate for the species in and around Banff National Park and Kananaskis Country, Alberta, because of the combination of poor quality habitat and high human use (Garshelis *et al.* 2005 quoted by Gibeau).

However, in most bear populations human-caused mortality of bears is a limiting factor generally higher than food. In addition, because bears are omnivore generalists, it is often difficult to measure the effects that disturbance towards food resources or habitat has on bear reproduction and survival. The impacts of disturbance that result in significant direct or indirect mortality are the easiest to measure and have the greatest impact on carrying capacity, especially in small isolated bear populations (Gunther).

Disturbance, if it leads to higher mortality, may also create so called attractive sinks (Naves *et al.* 2003 quoted by Katajisto), that attract bears e.g. because of good food quality but actually are bad for the population because of higher mortality. In case of attractive sinks, the human-caused change in conditions has been so fast that bears have not adjusted their behaviour yet (Katajisto). Interestingly, disturbance may also create refugees for some sex-age-groups of bears, if it causes displacements of otherwise dominating individuals (Nevin and Gilbert 2005b quoted by Katajisto), and in that sense it may affect the local carrying capacity of some cohorts also positively (Katajisto). This positive effect is also due to an unequal reaction to disturbance by individuals or, often, categories of individuals (age, sex, reproductive status), which can ameliorate the effect of disturbance and displacement (McLellan).

Weaver *et al.* (1985) have worked on modelling the relation between: habitat quality, disturbance and habitat effectiveness (carrying capacity) for grizzly bears in the Yellowstone ecosystem. They have defined these three components as follows (Mertzanis).

- *Habitat quality* determines the ability of a specific habitat area to support a bear.



- *Disturbance* determines the ability of a bear to use a specific habitat area (it is related to the displacement effect – see relevant question further below).
- *Habitat effectiveness* (carrying capacity) is the product of the aforementioned two components and identifies the habitat's actual capacity.

To achieve a quantification of loss of habitat carrying capacity due to disturbance, the aforementioned authors have assigned a set of parameters and coefficients interrelated in the following equation.

Habitat effectiveness (carrying capacity) is determined using:

1. the surface of optimal habitat in a given spatial unit (for example, 40 acres¹ of 0.5 quality rating equals 20 optimal acres);
2. percent of the unit affected by the zone of influence of the disturbance factor
3. the disturbance coefficient involved (disturbance coefficient ranges from 0.0 – when the entire unit is unavailable to bears due to disturbance- to 1.0 – when habitat is not affected by the activity).

The product of these 3 factors divided by the total optimum habitat surface equals the % loss of habitat effectiveness (carrying capacity) (Weaver *et al.* 1985 quoted by Mertzanis).

In Sweden it has been documented that there is a zone around towns and tourist developments that has a lower density of bears. This zone is 10-30 km wide and appears to be greater when the terrain is flat (Swenson). Bear use increased substantially with increasing distance to towns and resorts for comparable habitat and terrain types, also according to independent scat surveys using DNA-analyses. More than 74% of all female bear locations were in the 29% of the terrain classified as "rugged" and located >10 km from any town or resort, whereas similar habitats closer to towns or resorts was avoided. Bears closer to larger settlements and resorts (<10 km) were on average 27–51% younger than in areas beyond (mean 4.4 ± 0.4 versus 8.9 ± 0.8 years for males and 4.4 ± 0.4 versus 6.0 ± 0.2 years for females). Sub-adult bears (<4 years) comprised up to 52% of all bear use within 10 km from resorts and settlements, likely representing exploratory dispersing individuals. These areas, however, contained only 8% of the old males (>7 years): the remaining 92% located beyond 10 km from major resorts and settlements (Nellemann *et al.* 2007 quoted by Swenson). The effect may be less where bears have smaller movement patterns and home ranges, like in Italy (Swenson).

¹ Measure of surface, equal to 4047 m².



1.4 In which period is disturbance on bears stronger?

Experts opinion summary

Disturbance on bears is stronger:

- in winter: 3 out of 7 authors;
- when the food sources are more limited: 2 out of 7 authors;
- in fall, because of the critical accumulation of disturbing factors: 1 out of 7 authors;
- on very young cubs or cubs that are just separated from their mothers: 1 out of 7 authors.

This issue is quite complicated, as it depends on several factors. The authors have a different approach to the word "period".

We can treat the different approaches to this question separately.

a) We can consider the annual behavioural cycle of bears divided into five basic seasons based on major changes in bear behaviour and food habits (Mattson *et al.* 2003 quoted by Gunther):

- 1.) hibernation (mid November-February²),
- 2.) spring (den emergence: 15 May),
- 3.) estrus (16 May-15 July),
- 4.) early hyperphagia (16 July-31 August),
- 5.) late hyperphagia (1 September-den entrance)

During hibernation, the bears in the GYE are fairly secure from disturbance because den sites are generally located in remote, rugged, very steep, fairly inaccessible terrains. Disturbance near dens would have the greatest impact if the disturbance was near the time of den entry: this would, in fact, cause the bears to abandon the dens (Craighead *et al.* 1995 quoted by Gunther). The disturbed maternal den means the loss of litter. Therefore the disturbance in the denning period is the most harmful (Huber).

In the GYE, bears are generally not very vulnerable to disturbance during spring because they are still located in relatively remote areas with limited human access due to steep terrain and remaining snow cover (Gunther). But mothers with cubs of the year can not move easily over large distance and over man made barriers. The first spring vegetation may be out of reach for many bears (Huber). Disturbance during estrus is also less critical because travel (Gunther) - the mating season requires the biggest movements of males in search for females in heat (Huber) - leisure, play and mating are the primary behavioural activities and food is less critical (Gunther).

During early hyperphagia, there is generally a wide variety of plants, berries and root foods available over a large geographic area, so if bears are disturbed they have many alternative foods, habitats and places to forage in (Gunther). But bears need free and undisturbed access to these areas (Huber).

² Dates are referred to the Great Yellowstone Ecosystem (GYE) - USA.



Overall, the effects of human disturbance probably have the greatest potential impact upon bears during late-hyperphagia, when bear foods are more limited in abundance and distribution, and bears are concentrating their activity on gaining sufficient weight to support their energetic needs for upcoming hibernation (Gunther). Thus the access to areas with abundant food sources (hard mast) is critical for building up the fat reserves for overwintering (Huber).

More in general, if we consider only the availability of food sources throughout the year and during several years, bears are most affected when food resources are most limited (Gibeau): in the Canadian Rocky Mountains this is the berry season, when bears rely almost exclusively on one species of berry for much of their yearly weight gain (Gibeau).

In many ecosystems, bears are also most vulnerable to human-caused mortality during late-hyperphagia (Schwartz *et al.* 2003 quoted by Gunther), when they are also most likely to come into conflict with people and be killed, especially during years when native bear foods fail during the fall (Gunther *et al.* 2004a quoted by Gunther).

On the other hand, it can be said that bears are disturbed, to various degrees, during both the non-denning and the denning period (Swenson).

b) The impact of the response to disturbance may vary depending on the availability of key habitats that may have to be avoided. Thus in winter, disturbance in denning habitats could have severe impacts due to the energetic needs of bears at that time period and the limited availability of denning habitats (Servheen). In fact, bears choose the dens that are away from human disturbance (Elfström *et al.*, in press, quoted by Swenson) and they often leave their dens as a consequence of human disturbance, with disturbance seeming to be more important during the early than the later denning period (although this may be a reflection of when people are out in the forest) (Swenson *et al.* 1997 quoted by Swenson). In general, if more habitats are available during a season, the impacts of individual disturbances might be lower (Servheen).

c) There are unequal reactions to disturbance by individuals, often categories of individuals (sex, age, reproductive status) (McLellan).

Bears live alone but maintain complex communication with other bears. Marks on trees and various scent marks make the presence of a bear known to the others. The success in the game of finding and avoiding other bear decides if a bear can stay in one area or not. The error might result in the death of a weaker one. Finding a sexual partner during the mating season is specially demanding. Males roam over vast areas trying to fertilize as many females as possible. They must be capable of detecting the olfactory signals sent by females in heat and, at the same time, have the control of other males in order to be able to accurately decide where to fight and where to retreat (Huber). A female with cubs is the only bond within the species that lasts for at least one and half year (Frković *et al.* 2001 quoted by Huber). During that time a female has to skilfully avoid big males that may try to kill her cubs in order to mate and spread their own genes. Hence, social and reproductive requirements in bears also ask for a large habitat, excellent knowledge of this habitat and skilful behaviour (Huber).

Probably the most vulnerable age class of bears is represented by very young cubs or cubs that are just separated from their mothers. Many studies evaluate adult females, that are the reproducing cohort, being the most vulnerable sex-age-group to human influence on habitats (Gibeau *et al.* 2002 quoted by Katajisto). However, females often tolerate better contact with humans (maybe



as a strategy to avoid large males) (Nevin and Gilbert 2005a, Smith *et al.* 2005 quoted by Katajisto). Disturbance during the mating season could affect infanticide (Agrell *et al.* 1998, Katajisto 2001, Swenson *et al.* 1997b quoted by Katajisto); disturbance when bears are collecting fat resources for overwintering could affect the winter survival; on the other hand, disturbance during the feasting period in winter could also cause problems (Petram *et al.* 2004, Swenson *et al.* 1997a quoted by Katajisto).

d) A different approach to the issue refers to the cause of disturbance: i.e. chronology (time frame and periodicity) of human activities. Therefore it would be useful to incorporate two other related parameters: duration and intensity (Mertzanis).

In the context of Greece, an attempt has been made to categorize human activities that can be considered as potential or effective human related disturbance factors occurring within bear habitat, according to their nature and duration. Basic temporal (timing/seasonality) and spatial criteria were used to identify four main categories (Mertzanis):

1. human activities constant in time and space and therefore becoming somehow "predictable": occurring mainly around human settlements (i.e. small scale cultivations close to villages, etc.) in spring, summer and fall (Mertzanis);
2. human activities of periodical regime but constant in time and spatially punctual: i.e. transhumant livestock raising, apiculture, occurring mainly from end of spring to mid fall of the same year (Mertzanis);
3. human activities of periodical regime but spatially chaotic or unpredictable (in the scale of perception of bears) i.e.: timber harvesting, rotation of felling areas, hunting. Logging occurs from spring to fall and hunting period starts in fall and ends in February of next year (Mertzanis);
4. human activities with immediate effect and with unpredictable temporal and spatial frame, i.e.: roading, water dams, highway construction, criminal forest fires (Mertzanis).

By superimposing the temporal dimension of the above 4 categories we could consider that, within the Greek context, fall appears to be the period during which accumulation of disturbing factors becomes more critical for bears (Mertzanis).

A first step in order to better understand the temporal dimension of disturbance importance on bears would be to produce habitat use data based for example on the distribution of major seasonal foods and to combine them with season disturbance information. Then the spatial and temporal effects of disturbance on bears could be better understood (Servheen 1994 quoted by Mertzanis). The different disturbance factors should all be measured (quantified) as possible and they should be categorized by season of disturbance (Mertzanis).

e) Time of year will affect the factors discussed above (habituation, cover, food abundance, quality and availability etc.) and thus they may co-vary in different seasons. For example, some seasonal factors that may likewise affect bears reaction to disturbance include foods, cover (leaf flush of vegetation), and perhaps mating season, when bears may not be as easily disturbed by people (McLellan).



Bears may also show some level of habituation within the year. If they do, then reactions may be stronger early in the year. It means, habituation happens when an animal is exposed to predictable but non-harmful stimuli. When first encountering these stimuli, the animal may react to them but then, as time passes and the stimuli are “always there” (i.e. predictable), then the animal’s reaction decreases until it no longer reacts. So, “within-year” habituation may occur when a “new” stimulus is present at the emergence of a bear from its den. For example: a new trail is opened. Early in the year, the bear may react to people walking on this new trail, but as time passes the bear may reduce its reaction to people on the trail as it learns that people are often there and they don’t harm the bear. Now, whether or not there is any loss of habituation over the time when a bear is either using a different part of its home range or over the winter denning period is more difficult to say. There may be some loss of habituation with time away but the bear is expected to “re-habituate” quickly when it “remembers” that the area is the known place where people often are and that these people really don’t do anything harmful (McLellan).

1.5 Which are the effects of disturbance on bears?

Experts opinion summary

The effects of disturbance on bears are:

- alteration of bears home range, diel activity patterns, habitat use, food habits and distribution: 4 out of 8 authors;
- increase of mortality and decrease of reproduction rate: 4 out of 8 authors;
- several, as each individual reacts differently: 1 out of 8 authors.

At least the following two types of disturbance can be recognized.

Ecological disturbance: related to a change of the physical structure of the landscape, it affects the presence and availability of resources in a given bear habitat unit and can have a short, medium or long term effect upon bear habitat quality (Mertzanis). For example, disturbance during the season when foods are most limiting for the population (usually late summer and autumn) would have the greatest effect on the population. When seasonal foods are highly abundant (often green vegetation during spring), then bears can move away from the disturbance and still find ample food (but it is usually not of great quality at this time of the year) (McLellan).

Behavioural disturbance: it is usually temporary, but when bears are affected by this kind of disturbance, they change their habitat use patterns to avoid it. This behavioural change is usually long term or permanent. Thus, behavioural disturbance changes the use of existing resources without changing the actual existence and availability of these resources (Mertzanis). Disturbance can influence bear habitat use in two ways (Mertzanis):

- causing actual bear displacement;



- producing modifications in use patterns that reduce the time available for a bear to use a given area (Mertzanis).

Also the level of human disturbance affects the degree of accessibility of the habitat to bears (Servheen 1994 quoted by Mertzanis). In such situations a specific type of management called "time-of-entry-limitation" is necessary (Servheen 1994 quoted by Mertzanis). It allows a balance between the needs of bears for food and security and the needs of humans for things like timber harvest or recreation. Unless this type of approach is taken, human activities can essentially eliminate the accessibility of available habitats to bears because of disturbance factors (Mertzanis).

A possible approach to evaluate effects upon bears is the analysis of bears' spatial use in areas of comparable energetic value but with different levels of human activity. This may lead to the possibility to assess the influence of human activity (Weaver *et al.* 1985 quoted by Mertzanis).

In any case the effects of disturbance can be behavioural or physiological.

As for the first ones, they can vary depending upon the individual. There is, in fact, a large continuum of behavioural responses. Some bears are very wary and some are very gregarious. Bears that can tolerate humans will actually thrive in human dominated landscapes because they don't have to compete with other bears. Evidence in Banff National Park (Canada) suggests that some bears can do quite well in proximity to people. The difficulty is that these bears have a much higher probability of dying because of humans (Gibeau).

In general, 2 impacts of disturbance are evident:

1. avoidance of disturbed habitats by some bears that generally avoid human activity;
2. increased mortality risk to bears that do not avoid human disturbance (such bear may be habituated to the human activity) (Servheen).

But disturbance can affect the mortality either directly (e.g. road kills) or indirectly by increasing the competition on undisturbed resources (Katajisto).

For example, disturbance at den sites during the period of den entrance or hibernation can cause bears to abandon dens and potentially can result in litter mortality (Gunther). Spring disturbance can cause unfertilized females (Huber). Disturbance in other seasons may cause alteration of bears home ranges, diel activity patterns, habitat use, food habits and distribution (Gunther). For example, disturbance during fall may question survival of winter and increase the likelihood that some bears search for food around houses and do not den (Huber).

As for the physiological effects, significant long term disturbance causing destruction of food resources, or displacement from important high quality food sources, could delay age of first reproduction or interbirth interval, thus lowering reproductive rate (Gunther). Disturbance could again affect the fecundity either by lowering the quality of resources and thus mother's condition or indirectly by disturbing the social system of bears (infanticide) (Katajisto). Female disturbed during fall may not develop fetuses or experience a decrease in their number. The lactation may be insufficient or stopped (Huber).



1.6 Does disturbance change its effects during the day?

Experts opinion summary

Disturbance changes its effects during the day, in particular:

- human activity generally occurs during daylight, therefore its effects are concentrated in that period: 6 out of 8 authors;
- bears react differently to disturbance if it occurs in different time of the day: 4 out of 8 authors.

If with the term "day" we define the 24hour dial cycle, and given the fact that in most situations disturbance is related to human activities which are usually concentrated during daylight, then we may assume that disturbance impact upon bears may vary within a 24h cycle. The fact that human activities are usually reduced or null during the night hours supposes that the related disturbance impact upon bears is lower during the same time period with subsequent effects on bears behaviour and habitat use (Mertzanis).

Behavioural plasticity in bears has been documented (Schleyer 1983, Harting 1985, Ayers *et al.* 1986, Gunther 1990, Gunther 1991, Matthews *et al.* 2006 quoted by Gunther). Harding and Nagy 1980, Archibald *et al.* 1987, McLellan and Shackleton 1988, Mace *et al.* 1996, Mueller 2001, Gibeau *et al.* 2002, Wielgus *et al.* 2002 have reported that bears in North America do avoid areas or change their behaviour by increasing their nocturnal activity in order to avoid disturbance related to road use, mining activities and infrastructure construction with all the subsequent negative effects that these factors have upon the bear population (Mertzanis).

Mueller (2001) found that bears were using lower altitude habitat units and at a closer distance from high traffic roads only during the night hours when related disturbance was at its lowest levels (Mertzanis).

In remote areas isolated from humans, many bear populations exhibit crepuscular and diurnal activity patterns. However, in areas near human developments or activities, bears often switch activity patterns to nocturnal and crepuscular time periods (Ayers *et al.* 1986, Matthews *et al.* 2006 quoted by Gunther). So some bears become nocturnal when using habitats close to people (Servheen). They are believed to do this in order to use these habitats at a time when humans are not present, thus reducing their mortality risk (Servheen) and to take advantage of high quality foods (this means foraging at night, when humans are not active) (Gibeau). Namely, bears would be diurnal if there were no people; through centuries they adapted to nocturnal and crepuscular activity rhythm to avoid encounters with humans. Nowadays they can cope with a certain degree of daytime disturbance, but when it extends over the night as well it creates serious problem. Daytime disturbance is a problem if it happens off roads and off trails in the areas where bears are used to make "day beds" (Huber). Even worse appears continuous disturbance, because bears cannot adapt their temporal behaviour to that source of disturbance (Nevin and Gilbert 2005b quoted by Katajisto).

In Yellowstone National Park subadult brown bears and females with cubs-of-the-year tend to be more day-active than other cohorts of bears (possibly to



avoid encounters with larger male bears) (Gunther 1990, 1991 quoted by Gunther), therefore daytime human activity likely causes the most disturbance to subadults and females with cubs. If human-caused mortality on bears is low, bears may simply habituate to human disturbance rather than change diel activity patterns (Gunther *et al.* 2004b quoted by Gunther).

Bears use darkness as security cover, so reactions should generally be less at night. They approach locations where people often are more at night than during the day, so the "avoidance" reaction is much less at night and bears do not respond to an "unpredictable" stimulus as much at night as during the day (McLellan).

After a meeting with a person, bear changes its behaviour during daytime resting periods, but not during the normal active periods which occur at darker times of the day. Bear moves much less during daytime resting periods following a disturbance (Pedersen 2007 quoted by Swenson).

In North-east Pindos, Greece, in an area where a highway (*Via Egnatia*) is under construction, results from a 2 year period of GPS telemetry monitoring of 5 adult bears (3 males, 2 females) showed a differentiation of bear activity within a 24h cycle. During daylight bears became more "static", with slow and short distance movements preferring the forested parts of the habitat. During the night hours the pattern was inverted, with more time spent in movements both from day resting places to night feeding spots and to night resting spots as well (Kallimanis *et al.* 2005 quoted by Mertzanis).

Or again bears can avoid locations where people are common during times when people are common (McLellan).

1.7 How can bear react to disturbance?

Experts opinion summary

Bears can react to disturbance in the following ways:

- changing diel activity patterns and habitat use: 5 out of 8 authors;
- running away: 4 out of 8 authors;
- stopping their previous activity and increasing vigilance, staying hidden: 3 out of 8 authors;
- through displacement (long term avoidance): 3 out of 8 authors;
- through habituation: 3 out of 8 authors;
- different individuals or groups of individuals react differently: 2 out of 8 authors;
- attacking the disturbance source: 2 out of 8 authors;
- through biochemical reactions: 2 out of 8 authors;
- being attracted by the disturbance source: 1 out of 8 authors.

As discussed above, reactions can be both biochemical and behavioural. Biochemical reactions have been already mentioned in sufficient detail. Behavioural reactions could be an immediate and short term reaction or a long term one.



As short term reactions we have:

1. stopping pre-disturbance behavior and increased vigilance or some other behavior (McLellan),
2. moving away (McLellan; Katajisto), either quickly (fleeing) or slowly, from disturbance (McLellan).

Namely, the strategies may be to run away or to stay hidden. The bear usually feels safe at a hidden spot until somebody approaches to about 30 m. This distance may greatly vary depending on topography and cover. If and when the bear runs away, the distance of displacement depends on the intensity of the disturbing stimulus as well as on topography and cover. Typically the bear will calm down as soon as it feels safe again. The repeated disturbance is much worse than a single one. That may provoke the mayor displacement and abandonment of the area (Huber).

The bear can also change its activity during the day. These changes in behaviour generally affect the total food intake (Rode *et al.* 2006 quoted by Katajisto) and distribution of bear individuals (Katajisto). For example it has been documented this kind of reaction after a bear has had a close meeting with a person. As stated above, it then moves less during the daytime resting periods. This short term reaction seems to last for 48 hours (Pedersen 2007 quoted by Swenson), although recent studies show an even shorter time, equal to 12 hours (Swenson).

Walther (1969) has concluded that wildlife species perceive human disturbance as similar to a predation risk, with human presence being perceived as the presence of a potential predator (Mertzanis). Many animal species are sensitive to human activities (as a disturbance cause) (Frid and Dill, 2002 quoted by Mertzanis). Human presence and related disturbance in natural areas disturb wildlife species forcing them to energy consuming movements into less suitable parts of their habitat. In the case of bears, this effect may have a negative impact upon critical phases of their year cycle: reproduction, denning, nutritional condition. The reaction of wildlife species to a disturbance stimulus is related to the perception of a potential imminent threat and therefore results into an escaping strategy. The distance of a triggered escape reaction depends upon the nature and intensity of the disturbance factor but also relies upon other components of the ecosystem (Frid and Dill, 2002 quoted by Mertzanis).

3. Attacking disturbance source (defence) (McLellan).

Females with cubs of the year may feel that the cubs are not able to run away to safety and this may provoke the active defence (Huber).

As long term reactions we have:

4. long term avoidance (McLellan; Servheen) of areas and times where disturbance is common (displacement) (McLellan).

Bears have been documented to avoid habitats near people in long term (Nellemann *et al.* 2007, Katajisto 2006, Elfström *et al.* 2007 quoted by Swenson). Studies conducted in Scandinavia suggest that instead of having a strict threshold, bears avoid humans with relation to the level of surrounding human influence (Katajisto 2006, quoted by Swenson).

Bears may avoid areas of disturbance completely or may change diel activity patterns to avoid the times of day the disturbance occurs at (Gunther).

Cases of presence of a continuous and close distance disturbance factor induce to wildlife species the necessity of prolonged vigilance for a longer period than in



the case of an ad-hoc or non repetitive disturbance, which is detrimental to foraging and resting time (Frid and Dill, 2002 quoted by Mertzanis). In such cases bears will change their habitat use patterns to avoid disturbance (Servheen 1984 quoted by Mertzanis).

5. Habituation (Knight and Temple 1995 quoted by Gunther; Servheen).

In the Canadian National Parks some bears actually gravitate towards areas of human activity because there are no other bears there. These bears 'habituate' to humans and can do quite well, but there the risk of mortality is greater (Gibeau).

Bears may habituate to human activities, especially if human-caused bear mortality is low and the potential rewards (high quality food resources) are high (Gunther *et al.* 2004b, Herrero *et al.* 2005 quoted by Gunther).

6. Attraction (Knight and Temple 1995 quoted by Gunther) by the disturbance.

Bears may be attracted to human activities or developments if they obtain a food reward (garbage, livestock, beehives, gardens, orchards, etc.) from them (Herrero 2002, Gunther *et al.* 2004a quoted by Gunther).

It has to be noted that different individuals react differently and many bears do have some ability to either alter their use patterns or actually accommodate to human activity (Gibeau). Bears may also react differently towards a human related disturbance factor (i.e. road infrastructure) depending on the sex and age of the individual (Mueller 2001, Wielgus *et al.* 2002 quoted by Mertzanis). Definitely females with cubs are more vulnerable and exposed to disturbance factors compared to other individuals of the population (adult and sub-adult males) (IGBC 1987, Linnell *et al.* 2000, Gibeau *et al.* 2002 quoted by Mertzanis). The bears using more open habitats could also be more vulnerable to disturbance in comparison to bears using more forested habitat types (McLellan 1990 quoted by Mertzanis).

For the bears in North America, and in relation to a disturbance factor such as mining and oil extraction activities, Reynolds *et al.* (1986) report displacement but also a physiological level increase of heart rate for denning bears at a relatively close distance from the disturbance source (Reynolds *et al.* 1986 quoted by Mertzanis).

1.8 Can displacement be a reaction?

<u>Experts opinion summary</u>
Displacement can be a reaction to disturbance: 8 out of 8 authors.

Human-caused displacement of bears from habitat adjacent to developments (Mattson *et al.* 1987 quoted by Gunther), roads (Mattson *et al.* 1987 quoted by Gunther), backcountry trails (Kasworm and Manley 1990 quoted by Gunther), occupied backcountry campsites (Gunther 1990, 1991 quoted by Gunther) and spawning streams (Gunther 1984, Olsen *et al.* 1989 quoted by Gunther) has been documented (Mattson 1990 quoted by Gunther) in USA and Canada even if



examples of situations of documented bear displacement (due to disturbance) are not very common in European bear literature (Mertzanis). Displacement seems to be an expected reaction of bears versus the effect of a disturbing factor. It has been stated by several researchers that consequent displacement of bears from critical foraging areas will invariably affect individual fitness if alternative food resources are unavailable (Archibald *et al.* 1987, Gilbert 1989, McCutchen 1990, Gilbert & Lanner 1992 in Chi & Gilbert 1999 quoted by Mertzanis).

For example, displacement of black bears in the Anan Creek (Alaska) related to disturbance caused by wildlife viewers-visitors was studied by Chi & Gilbert (1999). In this case researchers documented that in 19 instances, 10 bears were displaced from the foraging site (stream) by people at the (bear viewing) observatory (Chi & Gilbert 1999 quoted by Mertzanis).

According to Andrés Ordiz, working with the Cantabrian Brown Bear Research Project (Spain), some wardens that observed females with cubs have inadvertently caused them to move to new areas, with infanticide as a result. This has not been documented in the studies in Sweden (Swenson).

Displacement especially occurs in the case of strong and/or repeated stimuli, as described above (Huber).

Bears are certainly smart enough to know where and when disturbances are common and avoid these areas. Considerable research has documented displacement from various types of human activity centres (McLellan).

Since in general bears tend to avoid human activities, displacement could be either temporary or permanent. In the study areas in Sweden often when bears have temporarily shifted their range, there has been some human activity involved, especially in females with cubs that otherwise are not as mobile (the other reason for displacement of females with cubs is unknown male bears, but that also may be caused by humans) (Katajisto).

In all cases displacement as a reaction to disturbance will also depend on (Weaver *et al.* 1985 quoted by Mertzanis):

- the type of disturbance,
- the nature of activity,
- the intensity of use,
- the duration of the activity.

1.9 Can disturbance modify the distribution of a bear population?

<u>Experts opinion summary</u>
Disturbance can modify the distribution of a bear population: 8 out of 8 authors.

The distribution of bears is mostly affected by high quality habitats, but intense disturbance will modify behaviour and ultimately use of the habitat by some portion of the overall population (Gibeau).

Functionally, this can take 2 forms:



- 1) reduction in numbers due to mortality in disturbed habitats (Servheen). Bear distribution is also modified by long term mortality distribution that is often associated with humans and human disturbance (McLellan). It is anyway often difficult to separate behavioural displacement from apparent displacement caused by a history of excessive mortality (McLellan);
- 2) reduction in use in disturbed habitats by bears that avoid human activity (Servheen). For example, in the lower 48 states of the USA, loss and alteration of habitat and human activities that result in bear mortality have eliminated grizzly bears from 98% of their historic range (Schwartz *et al.* 2003 quoted by Gunther). Most species of bears throughout the world have had their ranges significantly reduced by human activities and disturbance (Servheen 1990 quoted by Gunther). Also, bears can be displaced by disturbance so the distribution will be changed (McLellan).

Again we have a long term modification of the distribution and a short term one. Many studies have found that in general bears occur in less disturbed habitats (Apps *et al.* 2004, Katajisto 2006, Nellemann *et al.* 2007, Nielsen *et al.* 2006 quoted by Katajisto) - i.e. they avoid human habitation - which means that disturbance may affect the bear distribution through habitat selection in long term (Katajisto). The area of repeated disturbance may be abandoned. Also the movement corridors, when frequently disturbed may become less used or even lost for connectivity (Huber). For example, Scandinavian brown bear home ranges are not distributed randomly over the landscape, but seem to occur mainly in forested areas with a low level of human influence (Katajisto 2006 quoted by Swenson). In short term, disturbance may cause displacements and through that affect the distribution of individuals in a small spatial scale (Katajisto).

Disturbance may also affect dispersal, e.g. by forming dispersal barriers. It may also have additive effects through competition among species (Apps *et al.* 2006 quoted by Katajisto), but this is probably not relevant for bears of Trentino (Katajisto).

Certain categories of disturbance factors have the greatest impact in areas and during seasons when bears are present. Their continuous impact could have a more generalized displacement effect which, under certain circumstances, could result into a modification of the distribution pattern of a sub-population unit in a given area at a local scale. Of course this depends again on the main characteristics of the disturbance factor: duration, intensity, magnitude/amplitude. For example in the case of a high level disturbance factor such as the construction of a new highway in an undisturbed area of primary bear habitat (like in the case of Via Egnatia, in NE Pindos, Greece) the expected effect of a local modification of the sub-population distribution is likely to occur. A case study on this aspect of disturbance influence is presently ongoing in a sector of NE Pindos range (Greece) in order to evaluate the effect of an underway highway construction (Mertzanis).

Moreover the distribution of bears in relation to disturbance appears to be a function of variation in bears sensitivity influenced by sex, age and social organisation (Nellemann *et al.* 2007 quoted by Swenson).



1.10 Can disturbance modify bear behaviour? If so, in which way does it modify bear behaviour? With which consequences?

Experts opinion summary

Disturbance can modify bear behaviour: 8 out of 8 authors.

Disturbance modifies bear behaviour in the following ways:

- changing diel activity pattern, food habits and/or habitat use: 6 out of 8 authors;
- displacing bears in time or space: 4 out of 8 authors;
- making bears flee: 2 out of 8 authors;
- habituating bears to humans: 2 out of 8 authors;
- making bears more careful: 2 out of 8 authors;
- making bears aggressive: 1 out of 8 authors.

The consequences of disturbance on bear behaviour are the following:

- decrease of individual fitness (reproduction and survival): 4 out of 6 authors;
- modification of distribution patterns: 3 out of 6 authors;
- increase of human caused mortality: 3 out of 6 authors;
- limitation in population size: 1 out of 6 authors;
- increase of survival of certain cohorts: 1 out of 6 authors.

Disturbance can modify bear behaviour in many ways (Gunther) and these may lead to population consequences (McLellan) or may decrease bear fitness:

1. displacement (avoidance of habitats near disturbance) (Mattson 1990 quoted by Gunther).

Disturbance may displace bears from preferred habitats. If they are displaced from a habitat and that limits the population size, then disturbance can have population consequences. It is probable that disturbance that causes an immediate reaction to bears may also influence the population: if people are acting in a way that causes many bears to flee (for example: people begin hiking off trails everywhere), this could have a population effect because bears:

- 1) do not forage efficiently,
- 2) have elevated stress hormones which may effect immune system,
- 3) may go to more dangerous places and be at risk from other bears or people (McLellan).

All this means that disturbance could affect bears to move to less favourable areas, which would lower their reproduction and survival. It could also cause changes in the distribution of individuals which could e.g. cause females with their cubs coming across unfamiliar males that would benefit killing the cubs (Swenson *et al.* 1997b quoted by Katajisto);

2. changes in diel activity patterns (from diurnal to nocturnal) (Matthews *et al.* 2006 quoted by Gunther).

Bears may react adjusting their activity by being more active e.g. during the night when there is little disturbance (Nevin and Gilbert 2005a, 2005b, Rode *et al.* 2006 quoted by Katajisto). In this sense, it has been noticed that



tourist actions seems to cause displacement in time rather than in space (Nevin and Gilbert 2005b quoted by Katajisto).

Disturbance may make bears more nocturnal so they will avoid periods of the day when people are most active and they will use darkness as “cover”. Changing the time of the day when bears are active, while they are using a habitat that limits the bear population, will likely make them less efficient foragers in the limiting habitat. Bears are fundamentally diurnal and probably forage more efficiently in daylight when they can see what they are doing better - they do rely on eyesight for foraging. Forcing them to be nocturnal, and thus reducing their efficiency of foraging, may have population consequences if the foods they are foraging on limit the population size (McLellan).

The total amount of activity versus resting time may increase. It may lead to all the consequences described in previous answers. In relation to man it may result in increased shyness, which seems to be the only possible positive effect (Huber);

3. changes in food habits and habitat use (for example, the introduction of exotic disease and competing exotic species has led to drastic reductions in whitebark pine and cutthroat trout in some ecosystems (Reinhart *et al.* 2001 quoted by Gunther)).

Disturbance can cause bears to flee. In doing so they are reducing their foraging efficiency (again, this may only have population consequences if the habitat/ food is limiting). Perhaps, more importantly, while fleeing they may encounter greater risks such as traffic on roads, hunters or other bears (McLellan). As stated earlier, it has been documented that a meeting between a person and a bear (at 50 m or so) can influence the bear’s behaviour for about 12 hours. The documented effect is that the bear is more careful during its daylight resting periods (i.e. it moves around much less than an undisturbed bear) (Swenson);

4. disturbance, if innocuous and predictable, can lead to habituation. The bears that become habituated to human activities are often more vulnerable to be killed because people sometimes find their close presence threatening to themselves, their property and livestock. Habituated bears are more likely to become food conditioned and learn to associate food with people. They then become management problem bears. This “double-edged-sword” of habituation is a key issue in bear management (McLellan).

Some bears can modify their behaviour. In fact they may not perceive human use as disturbance at all. The consequence though is a higher mortality risk because most humans can not tolerate bears (Gibeau)!

It is very unlikely, but not impossible, that a certain bear reacts to repeated disturbance with an aggression. Aggressive response may occur when a bear feels cornered, i.e. feels that has no escape from the situation (Huber).



1.11 Can bear accept, tolerate disturbance? If so, which kind of disturbance? When and under which circumstances?

Experts opinion summary

Bears can accept and tolerate some kind of disturbance: 8 out of 8 authors.

Disturbance can be tolerated as far as it is:

- predictable disturbance and restricted to a certain areas: 4 out of 6 authors;
- a kind of disturbance that poses no harm to bears: 2 out of 6 authors;
- almost any kind of disturbance can be tolerated: 1 out of 6 authors.

Disturbance can be tolerated under the following circumstances:

- if disturbance allows bears to access high quality food sources: 2 out of 4 authors;
- when it does not lead to death: 2 out of 4 authors;
- if there are not undisturbed areas for bears to move to: 1 out of 4 authors;
- when disturbance is gradually introduced: 1 out of 4 authors;
- when the population is at or near the carrying capacity: 1 out of 4 authors.

Some forms of disturbance may become tolerated (Huber): some bears will readily habituate to disturbance (Gunther). If the disturbance is predictable and has no harm to the bear (McLellan), individuals can habituate to almost any disturbance (McLellan; Servheen). The best example is the noise of traffic on roads and railroads. That is only because such noise is predictable and restricted to certain area. The frequent noise of humans walking and talking along hiking roads is easier to tolerate than sporadic individuals venturing away from trails (Huber). Most animals show the ability to acclimate to human presence, as do bears at feeding sites (photography blinds in Finland) or salmon streams (watching sites in Alaska) (Swenson).

Habituation is most likely to occur in populations that are at or near ecological carrying capacity (Mattson 1990 quoted by Gunther), where the disturbance is predictable enough to be expected and non-threatening (Knight and Cole 1995 quoted by Gunther), and human-caused bear mortality in the population is low (Gunther *et al.* 2006 quoted by Gunther). Bears are probably capable of habituating to most types of disturbance as long as humans habituate to bears as well (Smith *et al.* 2005 quoted by Gunther). Without human habituation to bears, humans would likely not tolerate bears that were habituated to people. Bears are most likely to habituate to disturbance if habituation allows bears to access high quality, high calorie foods and habituation does not lead to the bears death (Gunther). However, we find that habituated bears are at higher risk of mortality because they will use areas close to humans (Servheen).

As long as there is space to move to undisturbed area, bears very often tolerate disturbance. Moreover, it can be assumed that if the disturbance is introduced gradually, bears would have more time to adjust their behaviour. But, in any case, measuring tolerance would be very difficult (Katajisto).



There appears to be great individual variation among bears on their tendency to habituate (McLellan). In many ways bears are very much like people. There seems to be a complete range of behaviours, from grumpy old men right through to Mary Poppins. For reasons we can not understand some bears do not have to adapt or alter their behaviour: they can accept the circumstances they find themselves in and survive. It has to be remembered though, that there is a whole segment of the population that do not do well around humans and actively seek to avoid humans (Gibeau).

There is relatively limited information on the tolerance of wildlife to human disturbance. There is however general consensus among researchers about the fact that the response of species to a particular disturbance depends largely on disturbance history (Paquet *et al.* 1994 quoted by Mertzanis). We do not have much data on this, because "problem bears" are often shot (Swenson).

The use of the terms "acceptance" and "tolerance" in this question, leads to the necessity of using the "thresholds" concept. This means that in order to define bear acceptance/tolerance to a disturbance factor/situation it is needful to establish and validate threshold levels dealing with both ecological and behavioural disturbance. These thresholds could vary by season and by bear management unit area but also from the combination of the disturbing factors. As far as habitat disturbance thresholds are concerned: ideally thresholds for habitat effectiveness should provide for the energetic and spatial needs of a given bear population during worst – case situations. One possible approach would be to compare worst-case home range versus lifetime home range (seasonal and annual) of a representative set of adult female bears with multiyear histories of telemetry monitoring (Weaver 1985 quoted by Mertzanis).

As far as bear tolerance to behavioural disturbance is concerned: here one has to take into account the individualized behavioural patterns of bears as a specific attribute to the species. Given this fact, a logical assumption would be to say that bears could expose higher tolerance levels to the less (spatially and temporally) unpredictable human activities related to disturbance (Mertzanis).

In all cases, establishing and validating thresholds levels based on bears' response to varying environmental conditions and human activity will require habitat mapping and intensive analysis of all the existing data (Mertzanis).

As mentioned above, bears will not always show an overt response to disturbance. Internal responses such as stress and elevated heart rates may also negatively impact bears but may not be readily visible in habituated bears (Herrero *et al.* 2005 quoted by Gunther).



1.12 Can bear diminish the effects of disturbance? In which way?

Experts opinion summary

Bears can diminish the effects of disturbance: 6 out of 6 authors.

The effects of disturbance can be diminished in the following ways:

- habituating to disturbance: 3 out of 6 authors;
- changing period of habitat use: 3 out of 6 authors;
- avoiding area where disturbance is common: 2 out of 6 authors.

Bear can adjust its behaviour if possible (Katajisto), changing the period of habitat use to times when humans are not present, such as becoming nocturnal in areas of high human activity (Servheen), moving during nights if the disturbance happens during the day (Katajisto), selecting areas and habitats in order to avoid human presence (Swenson).

Due to individual differences, certain bears may habituate to disturbance and may start to tolerate frequent stimuli of similar kind. That will be related to the loss of fear towards humans and may result in a problem bear. Hence, the individual bear (never the whole population) may "conclude" that disturbance from humans is not dangerous, and that may even be rewarded with supplementary food source (Huber). But bears that do it are often more likely to be killed by citizens or managers (McLellan).

Bears also avoid areas and times where disturbance is common. They use cover and darkness to exploit areas where disturbance is more common (McLellan).

In general, predictability, even of disturbance, will influence how bears or other wildlife respond to the disturbance (Knight and Cole 1995 quoted by Gunther). When bears or other wildlife perceive a disturbance as frequent enough to be expected and without risk of injury or human-caused mortality, they may habituate and show little overt response to the disturbance (Knight and Cole 1995, Gunther *et al.* 2004b, Herrero *et al.* 2005, Smith *et al.* 2005 quoted by Gunther).

1.13 Under different circumstances or in different contexts, can bears reactions to disturbance be different? If so, why, when and in which way?

Experts opinion summary

Under different circumstances and in different contexts, bears reactions to disturbance are different: 8 out of 8 authors.

Bears reactions to disturbance are different for the following reasons:

- because bears are individually different: 3 out of 6 authors;
- because some bears use disturbed locations to avoid other bears: 1 out of 6 authors;
- because they depend on the level of disturbance: 1 out of 6 authors.

Bears reactions to disturbance are different in the following circumstances:

- when disturbance occurs in areas where not expected: 3 out of 6 authors;
- as bears of different age, sex and reproductive status react differently: 2 out of 6 authors;
- when bears have something to defend: 1 out of 6 authors;
- when the level of human caused mortality varies: 1 out of 6 authors;
- when the level of disturbance varies: 1 out of 6 authors.

Bears reactions to disturbance are different in the following ways:

- bears can show habituation or not: 1 out of 6 authors;
- bears can show a more or less intense reaction: 1 out of 6 authors;
- bears use areas with human disturbance as refuge: 1 out of 6 authors;
- bears can avoid disturbance or not: 1 out of 6 authors.

Bears are highly intelligent, very adaptable, omnivore generalists, that readily learn from past experiences. Some bears are aggressive or bold, others shy and reclusive. Aggressive bears generally don't live long in areas with high densities of people, but are very successful in rugged, remote terrain, with low densities of people. Some bears will completely avoid areas of disturbance, others will change diel activity patterns to avoid disturbance. Some bears will habituate to the disturbance (Gunther). So the reactions of bears are almost always individually different, even in the same circumstances (Huber).

The biggest factor that influences bears ability to cope with disturbance is human-caused mortality. If human-caused mortality is very low, bears can adapt to a high level of disturbance. If human-caused mortality is high, it is unlikely that bears will be able to adapt to human disturbances because they will die before they can habituate (Gunther).

In conclusion, bears are characterized by a highly individualized behaviour and "character" and therefore by a "behavioural plasticity" (Mertzanis).

Again the same individual will react differently in a different context. The notion of predictability is central here. Habituation is the term we use to describe a bear flexible behaviour in different circumstances. If we as humans can make our behaviour predictable, then bears can use the landscape (Gibeau). Bears become knowledgeable about where to expect human activity and can become habituated to this activity if they are not subject to negative impacts or mortality. It seems they also get to know areas where they do not expect human activity and if such areas become disturbed or used by humans, the disturbance reaction can be intense. Bears know the habitat they live in very well and "expect" certain levels of security and human activity in different areas. When this expectation is changed, the bears can react strongly and be "surprised". This is why long term security needs to be built into habitat management (Servheen).

Even bear individuals with different experience may react differently (Katajisto) and again besides factors already discussed (habituation, cover, time of day, food and season), sex, age and reproductive status of females may affect their reaction to disturbance (McLellan).

Young bears are likely to behave differently from older, more experienced, bears. Females that normally occupy much smaller home ranges than males could have shorter displacements than males. Sexes may also tolerate humans differently in different situations (Nevin and Gilbert 2005b quoted by Katajisto).



Also if the bear has something to defend, such as food source or cubs, it may behave differently, especially when confronted by humans (Katajisto).

In some instances, some female bears with cubs and subadult bears appear to use human disturbance locations as a refuge from potential dangerous male bears that avoid these locations. This is not to say that the females and subadults are not disturbed by people, but less disturbed by people than adult male bears (McLellan).

It is possible that in certain situations where new disturbance factors appear, in conjunction with "established" background, disturbance may surpass the level of "habituation" or innate behavioural plasticity that allows bears to cope with disruption (Paquet *et al.* 1994 quoted by Mertzanis). Under such a context which induces increased stress, bears may select suboptimal travel routes in more difficult terrain, but not without consequences. Depleted energy budgets and reduced fitness are possible outcomes of using secondary routes (Paquet *et al.* 1994 quoted by Mertzanis).

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Chapter 2: Ideal and disturbed bear habitat: loss and fragmentation

2.1 High quality habitat for bears: characteristics, importance and maintenance

Experts opinion summary

High quality habitat for bears has the following characteristic:

- good seasonal food sources, good vegetation cover, enough diversity, denning sites, secure area with low human access: 5 out of 8 authors;
- high quality food sources: 2 out of 8 authors;
- low human density: 1 out of 8 authors.

High quality habitat for bears has the following importance:

- it is the key to maintenance of any bear population: 2 out of 2 authors.

High quality habitat for bears can be maintained in the following ways:

- understanding the natural disturbance regime and trying to mimic it: 1 out of 4 authors;
- controlling human caused mortality: 1 out of 4 authors;
- monitoring certain ecological disturbance factors that may potentially or effectively affect habitat quality: 1 out of 4 authors;
- maintaining the habitat factors that maintained a viable population in the past: 1 out of 4 authors.

Brown bears have the most widespread distribution of any bear species and live in the widest range of habitats of any bear species including deserts, boreal forests, arctic tundra, coniferous forests, deciduous forests, alpine areas and coastal rainforests (U.S. Fish and Wildlife Service 2007 quoted by Servheen). More specifically, we can find bears in treeless tundra and barren grounds in the northern arctic, tall shrub habitats, old-growth forests, coastal sedge meadows, alpine and subalpine meadows, avalanche slopes, coastal salmon spawning streams, riparian areas, valley bottoms, wet forests and arid regions (Gunther). Nevertheless, the key to the maintenance of any bear population is habitat (Mertzanis). A global definition of the "bear habitat value" (habitat quality) is when it incorporates food resources, cover, habitat diversity and equity of seasonal feeding opportunity and where increased continuity of feeding opportunity for bears across seasons is considered to increase the habitat value in a given area unit (Weaver *et al.* 1985 quoted by Mertzanis).

Given sufficient habitat and access to that habitat, a bear population will survive and prosper if sufficient animals exist in the area. The habitat is continually being impacted by human activities and thus, careful monitoring of the available habitat is necessary. Knowledge of the habitat requirements of a bear species provides the information on what is required for survival and how much is necessary. Without knowledge of a species' habitat requirements, conservation cannot proceed. Basically, habitat research is necessary to determine what bears need, in order to meet their seasonal needs for food, space, and security, and to determine how human activities influence: 1) the existence of these habitat needs; and 2) the availability of these needs to bears. Habitat monitoring is



necessary to understand: 1) if these needs are present in sufficient quantity and quality in an area of interest; and 2) how human activities influence the accessibility of these habitat needs to bears (Servheen 1994 quoted by Mertzanis).

It is very important to understand the concepts of habitat availability and habitat accessibility. Habitat can be available in an area, yet inaccessible to bears because of human activity or development (Mertzanis). The available habitat for bears is largely determined by human activities. Human activities are the primary factor impacting habitat security. Human activity, social structure and relationship among resident bears are the three major influences on accessibility of available foods for bears (U.S. Fish and Wildlife Service 2007 quoted by Servheen). An example could be the existence and therefore availability of spring range in low elevation areas on south aspect slopes. Such an area could be extensive yet inaccessible to bears in spring due to extensive roads and vehicle use causing bears to avoid the area. Another example could be important summer habitat in high elevation areas where concentrations of roots and insects occur, but where intensive grazing by domestic animals makes these areas inaccessible to bears (Mertzanis). Both availability and accessibility are necessary if habitat requirements are to be met (Servheen 1994 quoted by Mertzanis).

Thus, in order to maintain habitat quality (suitability) levels it is necessary to establish and to monitor (on a long term basis) certain ecological disturbance factors that may potentially or effectively affect habitat quality (Mertzanis).

Brown bears are very demanding towards the habitat they live in and they need complex inherited and acquired skills to survive. Bears need, in fact, large unfragmented areas with good vegetation cover, enough diversity and low disturbance. It has also to be considered the depending on geographical latitude and general habitat quality, an individual bear may roam over some 100 km² up to 100.000 km². Bear walks in search for food, daily and winter shelter, sexual partners and to avoid other bears of the same sex (Huber).

At the same time, bears are highly intelligent, omnivore generalists, very adaptable and capable of using a broad array of environments, habitat types and cover types (Schwartz *et al.* 2003 quoted by Gunther): a huge variety of habitats that vary greatly in quality (McLellan). Generally, habitats that provide an abundance of high quality foods that are accessible to bears are the best (McLellan), because bears "live and die by their stomachs" (Gibeau). Food quality varies, with animal matter high in fats such as fish and some insects being the best, followed in approximate order by lower fat meats, fruits and nuts, tubers and corms, young green – high protein vegetation (i.e. legumes), roots, lower protein green vegetation (grasses and sedges), older vegetation (McLellan). Usually availability for bear is in the reverse order compared with quality, with green vegetation being most abundant and high fat meats very rare (except coastal areas with salmon). Bears continually decide on the optimal trade-off between food quality and quantity and this trade-off likely varies over the day as they become satiated with lower quality foods (McLellan).

Bears tend to concentrate their activity on a seasonal basis in the most productive habitats available within their home ranges (Schwartz *et al.* 2003 quoted by Gunther). Therefore there are probably several common features which characterise high quality habitat, such as: forested cover and rough terrain (which are more important when there is human presence in the



landscape), presence of seasonally important foods and lack of human presence (Swenson). About this last feature, bear populations tend to do best in areas with low densities of humans where habitat has not been significantly altered by people. However, if human-caused mortality of bears can be strictly controlled, bears are capable of surviving in areas dominated by humans (Gunther).

Anyway, these habitat characteristics will vary throughout the species' range, so there will be many local differences (Swenson). Habitat characteristics will also highly differ depending on geographical area (Katajisto). For example, forested cover is probably most important in areas with humans that threaten bears (Swenson). In Scandinavia, high quality habitat would be rugged forested habitat with little human activity (Katajisto 2006, Nellemann *et al.* 2007 quoted by Katajisto).

In conclusion, most high-quality habitats are dynamic, or they change due to succession or disturbance (McLellan).

Unfortunately very seldom habitat quality is actually measured in studies in terms of cub production; comparative studies of bear occurrence are done, instead, and they only say where bears are, not what would be optimal (Katajisto). Relatively high elevation, steep slopes, rugged terrain and low human access are often related to good quality bear habitat (Apps *et al.* 2004, Gibeau *et al.* 2002, Nams *et al.* 2006, Nielsen *et al.* 2006 quoted by Katajisto). At minimum, bears need food, seasonal foraging habitat, denning habitat and security in an area of sufficient size of survival. Bears overlap in home ranges and change densities based on a variety of social and environmental factors. However, the precise mixture of these diverse elements and the precise size of the area necessary to support a population of bears are impossible to specify. The key to establish habitat criteria that will maintain a healthy population is to look to the habitat factors in the past that maintained a viable population (U.S. Fish and Wildlife Service 2007 quoted by Servheen). Moreover, it is very difficult to maintain an area in optimal condition for bears. Once again it is usually more practical to understand the "natural disturbance regime" of the ecosystem and, if possible, try to mimic this – under the philosophy of "whatever worked for bears in the past, should continue to work in the future". Of course in Italy, the natural regime may have been highly altered for centuries so the factors that influenced the landscape may be more difficult to document (McLellan).



2.2 Which are the most detrimental human activities for bear habitat? Why (i.e. in which way can they affect bear habitat)?

Experts opinion summary

The most detrimental human activities for bear habitat are:

- permanent habitat disruption followed by human developments: 5 out of 7 authors;
- those that cause behavioural disturbance: 2 out of 7 authors;
- they vary depending on human tolerance: 1 out of 7 authors.

These human activities affect bear habitat because:

- they determine loss of habitat, permanently displace bears from portions of their potential habitat and create new sources of mortality: 6 out of 7 authors;
- they lead to human-bears conflicts: 5 out of 7 authors;
- they produce unfavourable energetic balance to bears: 1 out of 7 authors.

The most detrimental human activities are those that cause permanent and/or irreversible ecological disturbance (Mertzanis): habitat disruption (Mertzanis), large scale and long term loss of habitat (Gunther) caused by all permanent structures that fragment and diminish the habitat (Huber) such as (ranked):

1. fenced highways,
2. other fast roads,
3. railroads,
4. skiing slopes and lifts,
5. dispersed settlements and related infrastructure (Huber).

Likewise, those human activities that significantly alter habitat resulting in long term loss of important high quality concentrated high calorie bear foods or the ones that directly or indirectly cause mortality (Gunther).

Permanent habitat destructions are the most detrimental; human habitations (either cities/towns or tourist developments) (Swenson) and large roads (Katajisto) are the second most detrimental, because they permanently displace bears from portions of their potential habitat (Swenson). That is because bears normally choose their habitat away from humans and roads, they may be a new source of mortality (Mace *et al.* 1996 quoted by Katajisto) and/or increase accessibility of the area for humans (Nielsen *et al.* 2002 quoted by Katajisto). Also intentional or unintentional introduction of exotic species (Gunther) is included among the most detrimental human activities. Agriculture, livestock grazing, timber harvest, mining and oil and gas development can also be detrimental, depending on how these activities are conducted and managed (Gunther). For example, a factor to look at is the amount of land that is altered, which varies among human activities. Often forest harvesting and management, as well as grazing, are activities in bear habitat that are done over extensive areas and thus can be more detrimental to the bear population than a parking lot. Forestry is generally harmful for bear habitat because over most of the forest rotation, trees compete with smaller plants for sun, water and nutrients and are clearly the winners – small plants are rare under most forest



plantations. It's only during the first few years after harvest that competition is reduced and smaller plants, those fed on by bears, can grow. So, a landscape dominated by plantation forestry is often poor habitat for bears (McLellan).

Grazing animals compete with bears for forage and, because bears occasionally kill livestock, owners sometimes kill bears. Conflict between livestock owners and bears has a long history and bear numbers are usually greatly reduced when both occur in the same area (McLellan).

There are many detrimental activities for bear habitat that co-vary with human tolerance of bears. For example, making a parking lot is obviously very detrimental to bear habitat as it removes all bear foods and bears are no longer attracted to the area. Turning bear habitat into an orchard, however, would greatly increase the amount of bear food, but bears that used this food would likely be removed from the population. Thus, the net effect would likely be worse for the area to be turned into an orchard than a parking lot (McLellan).

Apart from what reported above, there are also detrimental activities that impact directly bears and not their habitat. Among them, harvest and poaching are the most detrimental activities because they affect survival directly, as well as anything that increases harvest (Katajisto). Since bears will find ways to use high quality habitat despite the activities that can make it difficult, very detrimental human activities are also those that are lethal to bears while they are attracted to high quality habitat (Gibeau). Besides, we have motorized use (Servheen) or those human activities that cause behavioural disturbance (Mertzanis), that is uses that may attract bears and change their behaviour (Huber), which subsequently induces human-bear conflict situations and/or unfavourable energetic balance to the bears (Mertzanis) such as:

1. poor sanitation (Servheen): any garbage in reach of bears (open baskets, garbage on ground) (Huber) or method of storing human foods and garbage that leads to bear-human conflicts (Gunther); here included garbage dumps that are accessible to bears (Huber);
2. other food sources provided by humans (Huber);
3. noises, smells, visual disturbances which change the current activity of bear and may harm it as described above (Huber).

Activities such as humans walking, picking berries or mushrooms, fishing, etc. in bear habitat probably have a less detrimental and short term effect (Swenson).

2.3 Can you identify causes and effects of bear habitat fragmentation and loss?

Experts opinion summary

Causes of habitat fragmentation and/or loss are:

- human settlements, major transportation corridors and naturally poor bear habitat: 7 out of 7 authors;
- agriculture and deforestation: 3 out of 7 authors;
- resource extractions: 1 out of 7 authors.

Effects of habitat fragmentation and/or loss are:

- decrease of population size, isolation (low gene flow) and local extirpation: 4 out of 4 authors;



- disruption of individuals movements, reduction of bears "efficiency": 2 out of 4 authors;
- change of the landscape ability to meet the needs of the species: 1 out of 4 authors.

Fragmentation occurs when habitats or wildlife are functionally separated by any kind of barrier that blocks every movement across it; namely, the habitat is broken into pieces that are separated from one other by unsuitable habitat (Servheen *et al.* 2003). Habitat fragmentation is usually accompanied by habitat loss (Servheen *et al.* 2003).

Fragmentation is the impact of human actions on the connectivity and continuity of the habitat (Mertzanis). Habitat fragmentation is the transformation of large continuous bear habitat into small habitat patches by human development activities and resource extraction. For example, large multi-lane, high use roads, especially those that are fenced and contain centre barriers, can split or fragment habitat into smaller units (Gunther).

So human activities are the main cause of bear habitat fragmentation (Mertzanis): in particular human habitation and very wide roads or the combination of these with very open habitats such as fields or lakes (Chruszcz *et al.* 2003, Kaczensky *et al.* 2003 quoted by Katajisto).

The effect of wide roads can vary in different contexts. Some authors has noticed that roads alone don't necessarily form a dispersal barrier (Chruszcz *et al.* 2003, Kaczensky *et al.* 2003 quoted by Katajisto). Others that the most serious fragmentation issues are linked to major transportation corridors (e.g. busy highways) (Gibeau). Others have seen that, in addition to roads and residential development, causes of habitat fragmentation include logging, mining, oil and gas development and agriculture (Gunther).

For example, one of the most serious habitat loss issues in western North America has recently been residential development expanding into wild land areas. This may have happened also in northern Italy some time ago (Gibeau). In Scandinavia, instead, the most important causes of habitat loss are removal of forest cover and the presence of cities/towns and tourist developments. Roads might be a lesser factor (Swenson).

Human activities are usually concentrated in lower elevation areas and are along transportation corridors (Servheen *et al.* 1998 unpubl. quoted by Mertzanis). In mountainous areas low elevation areas are valley bottoms. Valley bottoms are a linear feature, therefore when human activities are concentrated in mountain areas they usually become concentrated in a linear fashion. This linear distribution of human activities readily creates fractures between habitat units (Servheen *et al.* 1998 quoted by Mertzanis). The impacts on bears and other wildlife of habitat fragmentation include population decline, reduction in range and local extirpation (Hilty *et al.* 2006 quoted by Gunther). When human activities such as road building, clearing and development of lands, human settlements, water impoundments and extermination of species from certain areas occur in a linear area or a wide area, they have the potential to (Mertzanis):

- 1) inhibit the movement of bears and other animals across the landscape;
- 2) increase the mortality potential for bears and other animals that venture into such areas (Mertzanis).



The characteristics of the landscape, combined with the ecological requirements of animals of interest, determine the ability of the landscape to support the requirements of animals for food, security, reproduction and natural movements. It is a fact that as human activities change the landscape, they also change the ability of the landscape to meet the needs of resident wildlife. That is why it is so important that human activities are carefully managed if wildlife is to be conserved (Mertzanis).

Bear habitat fragmentation can occur at a variety of spatial scales including population scale fragmentation and within home range scale fragmentation. Population scale fragmentation is usually caused by human settlement, often in combination to transportation corridors (highways and railways), agriculture and naturally poor bear habitat (areas too dry, lakes/ocean) (McLellan). Human developments and activities such as roads, towns and agriculture can block animal movements and fragment the landscape (Mertzanis). One effect of habitat fragmentation can be low gene flow, which have been documented between southernmost bear subpopulation in Sweden and the other subpopulations (Tallmon *et al.* 2004 quoted by Swenson).

Habitat fragmentation is an insidious problem that results in small isolated "island populations". As large populations become fragmented by human activities the probability of their survival is diminished (Mertzanis): populations become isolated and, if small enough, isolated populations are likely to be extirpated with little or no chance of natural recolonization (McLellan).

Brown bear populations may be particularly easily fragmented (McLellan 1998 quoted by Mertzanis).

According to Servheen (1994) fragmentation of habitats is one of the major causes of the decline in global bear populations (Mertzanis).

Within home range scale, fragmentation disrupts the movement of individual bears and thus may reduce their efficiency. A great variety of habitat changes can cause this scale of fragmentation (McLellan). In an increasingly fragmented landscape bears are forced to use smaller and smaller patches of quality habitat. It is essential that bears maintain the ability to move between these habitat patches in order to fulfil daily and seasonal needs (Mertzanis). Bears are very large and mobile animals, so they are not that much affected by habitat fragmentation on a small scale (Katajisto). In areas with poor and fragmented habitat they may adjust their behaviour by having larger home ranges (Dahle and Swenson 2003 quoted by Katajisto).

Therefore this "habitat connectivity" is critical for ensuring the long term persistence of bears in given impacted area (Mertzanis).



2.4 In the context of possible habitat fragmentation and loss, what is the importance of dispersal for bears?

Experts opinion summary

In the context of possible loss and fragmentation of habitat, dispersal can play an important role:

- as, in theory, it gives the possibility of creation of a viable meta-population through immigration and emigration: 8 out of 8 authors;
- for re-establishing bears population where they have become locally extinct: 1 out of 8 authors.

Dispersal can here be defined as moving away from natal home range, distinguished from movements inside home range and displacement (which is seen as shift of home range) (Katajisto). Dispersal is the mechanism that maintains connectivity (Gibeau). It is important because it can preserve individuals, demes, populations and genetic diversity (Hilty *et al.* 2006 quoted by Gunther), that is gene flow (Huber). The connectivity among populations is essential for long term survival: the general rule requests one migrant among neighbouring populations per generation (Huber).

Dispersal into the population is particularly critical for long term persistence of small, fragmented populations (McLellan). That is, at a very large scale, such as Europe, difficulties that disturbance brings to dispersal could affect the gene pool of small populations. On the other hand, bears have gone through genetic bottle necks and there is no documentation about inbreeding depression in small isolated bear populations – except for captive brown bears (Laikre *et al.* 1996 quoted by Katajisto). In these small populations, dispersal (as well as restocking and reintroductions) may also cause continuous male turnover which may affect cub survival (Swenson *et al.* 2001, Swenson *et al.* 1997 quoted by Katajisto).³ Dispersal is a natural process and should not be hindered but it is important also to understand that in small populations it might be problematic before the population has grown to a more stable state (Katajisto).

Dispersal is also important for re-establishing bear or other wildlife populations in habitat fragments where they have become locally extinct (Hilty *et al.* 2006 quoted by Gunther). In this process, maintenance of dispersal corridors that will enhance female dispersal is especially critical for reducing the impacts of habitat fragmentation on small populations (Proctor *et al.* 2004 quoted by Gunther): demographic connectivity is mediated by females' movement (Herrero *et al.* 2005). On the other hand, dispersal of males is the primary mechanism of gene flow (Swenson): genetic connectivity is, in fact, mediated by males' movement (Herrero 2005).

Although brown bear dispersal behaviour remains poorly understood (Doak 1995 in McLellan 1998 quoted by Mertzanis), it is known that brown bears do not disperse long distance over a short period of time like many other carnivores such as wolves (McLellan) and there is evidence that it is sometimes a gradual

³ That because when bears are transferred to a location also without any previous bear population, transferring a set of bears that are not familiar with each other could in the beginning cause extra infanticide (Katajisto).



process for both sexes and it often takes several years for new ranges to bud-off from maternal ranges (McLellan & Hovey unpubl. data quoted by Mertzanis).

Other available data on black and grizzly bears agree that dispersal is sex-based with males usually dispersing far and females establishing their home range in or near their mothers' home range (Interagency Grizzly bear Comp. 1987, Rogers 1987, Blanchard and Knight 1991, Schwartz & Franzmann 1992 in Swenson *et al.* 1998 quoted by Mertzanis).

Data on dispersal from the expanding Scandinavian brown bear population show the same patterns with 85% of male individuals (sub-adult and young adults) dominating on the wave front of the expanding population (Swenson *et al.* 1998 quoted by Mertzanis).

Data on the southwards expansion of the brown bear range in Pindos mountain range (Greece) show a slow process of few dispersing individuals from both sexes (reproductive females have also been evidenced) over a period of approximately 25 years (Mertzanis *et al.* 2006 quoted by Mertzanis). In fact, bears by their very nature are not particularly good long distance dispersers compared to other carnivores such as wolves (Gibeau). Thus natural dispersal appears to be unable to recover most isolated populations. Artificial dispersal in the form of augmentation is often required (McLellan). Given this, corridors, linkages and overall connectivity are a huge issue for bears (Gibeau).

As negative effect of dispersal, the dispersing animal may venture out of desirable bear range. It may cause problems there, but it may also help identify possible corridors. If the general corridor direction is promising one can apply some mitigation measures (like a green bridge) to improve such a corridor (Huber). Dispersing brown bears may not only have to pass through a corridor between sub-populations, but may have to live in a corridor for months or years (McLellan 1998 quoted by Mertzanis). Because bears are attracted to a variety of human products, it may be difficult for bears to disperse across even a thin strip of settlement and survive to breeding age (McLellan 1998 quoted by Mertzanis).

Presence of humans is likely to be the largest barrier for dispersal. However, factors affecting bear dispersal are currently quite poorly known (Katajisto). For example, it has not been studied enough how habitat fragmentation and loss affects dispersal (Swenson).

Therefore, in conclusion, in a European landscape context where fragmentation is an established fact in many areas, the importance of dispersal can be theoretically high with the possibility of creation of a viable meta-population through recolonization of former (historical) or new range. In reality (and within the European context), dispersion seems rather difficult to become a functional mechanism and has to be investigated in relation to the existence and quality of corridors and linkage areas (Mertzanis).



2.5 Bear ecological corridors: characteristics, importance and maintenance

Experts opinion summary

Bear ecological corridors have the following characteristics:

- large areas that provide good bear habitat with cover, food resources and without humans to allow day to day or year long survival: 5 out of 6 authors;
- lack of attractants that will draw bears toward humans: 1 out of 6 authors.

The importance of ecological corridors for bears derives from:

- the maintenance of the gene flow (reducing the possibility of inbreeding and the chance of environmental catastrophes): 4 out of 4 authors;
- permission for individual bears to meet requirements for feeding, denning, mating and dispersal: 1 out of 4 authors.

Bear ecological corridors can be maintained through:

- the regulation of resources development in order to allow only those with minimal negative impact on bears: 2 out of 5 authors;
- simultaneous efforts addressed at public lands, private lands and transportation network (highways): 2 out of 5 authors;
- additional crossing structures (green bridges) on the critical points: 1 out of 5 authors.

Wildlife movement corridors are defined as linear landscape features that facilitate the biologically effective transport of animals between larger patches of habitat (Paquet *et al.* 1994 quoted by Mertzanis).

Ecological factors that determine the availability and quality of wildlife corridors are dynamic and they are expected to change within time. Furthermore, corridors may function as transitional habitats that provide only those ecological services and resources used when individuals move between patches. In other cases corridors may comprise habitats that are critical for a species day to day survival. Corridors provide travel lanes to accommodate daily, seasonal and dispersal movements from one large habitat block to another (Paquet *et al.* 1994 quoted by Mertzanis). The main **characteristics** of bear ecological corridors, or "linkage areas", encompass a set of physical and human related attributes that make them more or less functional. Of these components the most important are: vegetation cover and structure, topography, degree of interference with human infrastructure (i.e. transportation infrastructure which is one of the major problems in the European landscape), settlements and activities (land use: i.e. agricultural lands etc) (Mertzanis).

The corridors that connect populations should be as natural as possible. Forested stretches will serve the best, while long transversal structures are the worst obstacles; compact human settlements are usually impenetrable as well (Huber). Ecological corridors for bears are important when populations are becoming small and are threatened with isolation (McLellan). However, because most brown bears that do disperse, do so gradually (particularly females) expanding by small steps or shifting their home ranges sometimes over a period of several



years, corridors must be wide enough (a home range diameter wide) for bears to live in for extended periods (McLellan). In other words, it can happen that bears also establish themselves in such corridors (Katajisto).

Considering that, an important feature of corridors is a lack of attractants that can draw bears towards people (garbage, fruit trees, bee hives, etc.) and result in the bear being removed. Another feature of good corridors is good bear habitat (McLellan). Therefore large areas without humans and with enough food resources and cover for bears are the best corridors for bears (Dixon *et al.* 2006 quoted by Katajisto). That is especially important for female bears because they generally do not disperse far from their mothers home ranges. Therefore, it is important for bear linkage corridors to be large enough to incorporate inter-connected home ranges containing enough spring, summer and fall habitat to support adult female bears. Subadult male bears instead disperse long distances and therefore are more likely to make long movements through marginal habitat to inhabit new areas (Gunther). In this sense, there are some studies about small road passages that could be seen as corridors (Clevenger and Waltho 2005 quoted by Katajisto). In any case, such passages may lead to increase in conflicts with humans, since narrow areas have large edge-to-habitat ratio, and therefore some authors are not convinced about the use of human maintained artificial narrow corridors (Katajisto).

Using a different approach to the issue, it is also possible to exploit movement characteristics, rather than vegetation and landscape structure, to identify linkage areas and determine landscape functionality as corridors for a subpopulation of brown bears. In this sense, an area is acknowledged as a corridor when species behaviour is limited to travel rather than feeding or resting (Graves *et al.* 2007 quoted by Gibeau).

Corridors appear to follow "paths of least resistance" (e.g. topography and habitat) that have maximum visibility and minimum obstructions. Corridors seem to be established along routes characterized by low disturbance and escape terrain rather than forage (Paquet *et al.* 1994 quoted by Mertzanis).

Observed travel routes may include: human trails, game trails, open edges, riparian valley bottoms, open forest. In mountainous terrain, major river and creek valleys and interconnecting passages appear to function as local and regional travel corridors (Paquet *et al.* 1994 quoted by Mertzanis).

Servheen (1998) has attempted an identification/classification of fragmentation/linkage areas at the level of global bear populations in two study areas: the Rocky Mountains in North America and the Balkans and Carpathians in Europe. Existing brown bear range in the two areas was delineated and elevation ranges, as well as cover/non-cover data for each area within each known bear population unit, were used as main criteria and thus compared (Mertzanis).

Molinari and Molinari-Jobin (2001) ranked potential corridors in the south-eastern Italian Alps in order to better identify the re-colonisation routes of the expanding Slovenian brown bear into North-eastern Italy. Habitat physical features were characterized as of very good quality and therefore corridors identification was based on the presence of artificial barriers related to human activities (settlements) and especially transportation infrastructures (one railway line and two highways). In this case, sites with absence of true barriers (including steep terrain $>75^\circ$) were defined as corridors. Corridors suitability classification comprised 3 categories (Mertzanis):



- corridors of high quality: if bears could cross the valley without intersecting any traffic line (e.g. using tunnels or viaducts);
- corridors of poor quality: if no barrier was reported on any of the traffic lines but bears ran the risk of getting hit by a car or a train;
- potential corridors: in the case that a potential barrier (fences, human settlements, open landscapes) was reported on one of the several traffic lines (Molinari 2001, Molinari-Jobin, 2001 quoted by Mertzanis).

For the region of the eastern Alps, Boitani *et al.* (1999) have made an overall assessment on potential range and corridors for brown bears by building a 7 variables model using random bear locations, a moving window of 30 km² and the Mahalanobis ecological distance calculation for area classification. Here corridors were identified as part of a mosaic including optimal, sub-optimal and potential bear zones with an ecological distance (D) threshold of $D \leq 35$ (Mertzanis).

Spasov (1999) attempted the same categorization at a sub-regional level for the brown bear population in Bulgaria (Mertzanis).

Bear ecological corridors or better "linkage areas" ensure the connectivity function between larger bear habitat units or sub-population nuclei (Mertzanis). In theory, corridors greatly reduce the possibilities of inbreeding and the effect of chance environmental catastrophes by providing opportunity for the introgression of new genetic materials and the exchange of individuals from source populations (Paquet *et al.* 1994 quoted by Mertzanis).

The subsequent connectivity is **important** at two levels (Mertzanis):

- individual level (and since we are referring to the Western European context, individuals are of equal conservation importance as populations): connectivity allows individual bears to meet requirements for feeding, mating, denning and dispersal;
- population level: in order to maintain the bio-geographic continuity within a given bear population unit at a regional level (Mertzanis).

At a global level, and as summarized by Noss (1992 a, b) in Paquet *et al.* (1994), linkage areas role consist of:

- protecting key habitats;
- providing safe travel opportunities between critical habitats;
- facilitating dispersal and population exchanges, which can potentially counteract the effects of isolation and fragmentation;
- providing for latitudinal or elevational movements in response to seasonal and long-term climate changes (Noss 1992; Paquet 1994 quoted by Mertzanis).

For ecological corridors **maintenance**, the development of an adapted land-use strategy could be a useful tool (Mertzanis).

Such strategy has already been elaborated in the case of north american bears and generally consists of two major guidelines (Mertzanis):

- creation of strictly protected areas and linkage zones between them. Hunting and resource development would not be allowed in core areas and recreational activities would be managed with the needs of sensitive wildlife species in mind (Herrero 1994, Mattson *et al.* 1996 quoted by Mertzanis). That simply means no more development (construction) in the



- area. Mitigation measures may be additional crossing structures (like green bridges) on the critical points (Huber);
- surrounding regions should be carefully managed to allow regulated resource development with minimal impacts on bears (Herrero 1994, Mattson *et al.* 1996).

Linkage zones cross multiple ownerships including public lands, state lands and private lands. As such, successful implementation of linkage zones will require simultaneous efforts addressed at public lands, private lands and transportation networks such as highways within each linkage zones. Efforts must be simultaneous because a lack of consideration for linkage zone needs, on one land ownership area or on highways, will negate efforts undertaken on adjacent ownership or highways. Implementation of linkage zone management requires different approaches for each land ownership. It will require some new considerations in the way public lands are managed and consideration of highway improvement designs to facilitate wildlife crossing of highways at key areas within linkage zones. It will also require cooperative efforts with private landowners that can only be accomplished at the local level. This requires time, effort and careful listening to landowners who have concerns about this issue; their concerns must be addressed with good information and sensitivity. Linkage zone management must have biological data, an organizational structure and people to implement the action, political support, and public support (adapted from Kellet and Clark 1991 in Servheen *et al.* 2003 quoted by Gibeau and Servheen).

The best way to implement linkage zone management is to develop task forces of specialists to address each of the key issue areas for linkages zones – public land management, private lands and coordination with state and federal highway issues. These task forces will produce a set of recommendations on best management practices for linkage implementation and for cooperation with highway departments. A protocol to work with private landowners will also be developed (Servheen *et al.* 2003 quoted by Gibeau and Servheen).

2.6 Which are the effects of the loss of linkage areas on a bear population?

Experts opinion summary

- The effects of the loss of linkage areas on a bear population are:
- decrease of the viability of a population till the extinction: 8 out of 8 authors;
 - reduction of the ability of exploiting resources within the home range: 1 out of 8 authors.

Loss of bear habitat, and/or range connectivity, which is largely maintained by the linkage areas (in a potentially or effectively fragmented landscape), can significantly affect bears by reducing their ability to efficiently exploit resources within their home range. Smaller habitat units mean smaller populations and the



combined demographic and genetic effects deriving from small population size (Servheen 1998 quoted by Mertzanis).

At population level, reduced habitat connectivity after loss of linkage areas can have significant implications for long term bear conservation if it results in regional populations becoming cut-off, or isolated, one from another (Mertzanis). Anyway, the current problem in Europe appears not much the loss of linkage but bear population being so small that they are vulnerable to any random demographic and environmental effects (Katajisto).

Other effects of loss of linkage areas can be summarized as follows:

- preventing emigration (Gunther): isolated bear populations experience little/no emigration (Mertzanis). That causes potential inbreeding depression (Katajisto) and results in a decreased ability to respond to short and long term changes in the habitat (Mertzanis);
- preventing immigration (Gunther): isolated bear populations experience little/no immigration (Mertzanis). Relatively small, isolated populations eventually show reduced genetic variability which is generally regarded as important in maintaining high levels of fitness and allows for adaptation to a changing environment (Mertzanis). Genetically isolated population will instead become homogenous (homozygote), factor which decreases the viability (Huber) and leads to loss of genetic diversity (Gunther) because of a very low gene flow (Swenson), as documented between two subpopulations that seem to have lost linkage (Tallmon *et al.* 2004 quoted by Swenson).

In synthesis, main consequence of loss of linkage is the loss of gene flow (Huber);

- increasing the chances of local extirpation of small bear populations (Gunther). If isolated population are small, the loss of linkage to larger populations means that the small population has a higher probability of being extirpated and not naturally recovered (McLellan). Augmentation or reintroduction may have to become ongoing management tools (McLellan), as it may happen in Italy (Gibeau). However, in the case of total absence of linkage to the closest population, artificial transplantations may be occasionally done: as told before, one per generation (each 3 years) should satisfy the minimum (Huber).

In Italy for example, genetic studies conducted by Randi (1993) indicated that fragmentation and isolation of west European bear populations had led to the fixation of different genotypes in different populations. These different mt DNA genomes showed that genetic variability is conserved mainly between and not within populations (Mertzanis). In such a situation two major negative outcomes related to loss of linkage areas are evident (Mertzanis):

- gene flow between populations becomes unlikely because of loss of linkage areas at a regional level;
- fitness and adaptability of a given bear (sub)population is subsequently reduced (Mertzanis).

Nevertheless, it has to be considered that at a continental scale (Europe) other concurrent factors may have resulted in genetic isolation of brown bear subpopulations (Mertzanis).

More recent studies on bear phylogeography (through analysis of excremental DNA) showed that gene pool of bears in Europe is divided into 2 clades of related



mitochondrial genotypes (Kohn & Knauer 1998 quoted by Mertzanis). The authors stress out that the dramatic decline of Western and of some Eastern European brown bear populations (due to human activities) cannot explain the dichotomy in the gene pool of the European brown bear (Mertzanis). Random extinction of genotypes due to human activity would, in fact, not result (as it is now) in a congruent pattern of phylogenetic relationships of genotypes and their geographic distributions. The formation of these clades (and the subsequent genetic differentiation) can thus be best explained by geographic separation of brown bear populations by ice sheets or unsuitable habitat during the quaternary ice ages (Kohn & Knauer 1998 quoted by Mertzanis).

2.7 Bear recovery areas: characteristics, importance and maintenance

Experts opinion summary

Bear recovery areas can be described as follows:

- areas with all seasonal habitats and features, as well as security required by bears (little humans and no harvest): 5 out of 7 authors;
- areas more than 500 meters from an open or gated motorized access route or recurring helicopter flight line, greater than or equal to 10 acres⁴ in size: 1 out of 7 authors (referring to the Great Yellowstone Ecosystem);
- areas that have the characteristics of general bear habitat: 1 out of 7 authors.

Bear recovery areas are important as they:

- permit long term maintenance of bear populations, sustain genetic diversity and provide dispersers: 2 out of 2 authors.

Bear recovery areas can be maintained through:

- the reduction of human caused mortality: 3 out of 3 authors.

It is possible to give different meaning to recovery areas, maybe also because a rather large local variation is evident (Swenson).

Bear recovery areas are seen as:

- areas where a small bear population subsists in very low numbers and with very low survival probability (population in need of restocking or augmentation) (Mertzanis);
- areas of potential or effective re-colonization (Mertzanis).

In both these cases main features/characteristics of these areas should be related to key population and habitat suitability components (Mertzanis).

- areas that have the general characteristics of bear habitat (Huber);
- core areas (McLellan; Gunther) that are essentially secure (Gibeau).

This last definition, however, shares some features with the previous meanings. Core recovery areas are, in fact, crucial for long term maintenance or re-establishment of bear populations. Critical habitat must meet the nutritional and spatial needs of bears and provide for specific physical, seasonal and behavioural requirements, as well as assure sites for breeding, reproduction, and shelter

⁴ Measure of surface, equal to 4047 m².



(Craighead 1980 quoted by Gunther). Ideally, recovery areas should be large, remote, contain good bear habitat and a high density of bear foods during spring, summer and fall, be capable of supporting a large bear population and be relatively un-influenced by human activities. Core areas are important for maintaining genetic diversity and for providing dispersers that emigrate to other areas. (sink areas), if parts of the population operate under a source-sink dynamic (Gunther). These areas should be located by making a trade-off between bear habitat quality and the social costs of making them secure (reducing human use). Unless strong laws protecting the habitat of the species are available, developing recovery areas may require multi-stakeholder land use planning (McLellan). For example, in the Great Yellowstone Ecosystem, secure habitat is defined as areas more than 500 meters from an open or gated motorized access route or recurring helicopter flight line, greater than or equal to 10 acres in size.

In the Great Yellowstone Ecosystem (USA), secure habitat is divided into long and short term secure habitat based on the management area category. Long term secure habitat is secure habitat within management area categories that typically include wilderness, backcountry lands, research natural areas, national recreation areas, designated wild and scenic rivers, special interest areas and other areas where some management activities may occur but natural ecological process and resulting patterns will normally predominate. Generally new motorized access routes will not be constructed in these areas. In some of these areas oil and gas surface occupancy may be allowed. Short term secure habitat is secure habitat within management area categories that typically include areas that are managed to provide recreational use; forested ecosystems that are managed to meet a variety of uses, timber harvesting emphasis areas, areas of intensive grazing and areas likely to be permanently altered by human activities (U.S. Department of Agriculture Forest Service, 2005 quoted by Servheen).

Reducing human caused mortality is the key of maintenance of recovery areas. Therefore recovery areas should be natural areas with little humans and overall no harvest (Merrill *et al.* 1999 quoted by Katajisto). Mortality, especially that of reproductive females, is often found to be the key factor in bear population dynamics (Knight and Eberhardt 1985, Sæther *et al.* 1998, Wiegand *et al.* 1998 quoted by Katajisto). If bear populations are small and threatened, then having core areas that are relatively secure will be very important (McLellan).

In the case of the grizzly bear recovery plan in the Cabinet/Yaak ecosystem (Montana, USA), recovery areas criteria require that 18 of the 22 bear management units are occupied by females with young (Kasworm *et al.* 1998 quoted by Mertzanis), which means that permanent presence of this important cohort of the population is a decisive criterion (Mertzanis). An additional criterion is bear habitat availability and suitability: these bear recovery areas (Bear Management Units) are, in fact, also delineated as to contain all seasonal habitats required for a grizzly bear. The maintenance of such areas is indispensable but, in the European densely populated context, this is not an easy task (Mertzanis).



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Chapter 3: Human activities and impacts on bears

The present section of the document (each question of the chapter) refers to the following list of human activities and conflict situations:

1. *forestry*
2. *agriculture*
3. *animal farming/grazing, zootechnical activities*
4. *apiarian activities*
5. *mining*
6. *hunting*
7. *tourism/recreation activities (playgrounds, golf-courses, riding-schools, boating, flying, trekking, climbing, etc.)*
8. *winter recreation activities*
9. *skiing areas*
10. *roads (main and secondary) and railways*
11. *forestry roads*
12. *human structures and development (resorts, villages, towns, dams, factories, etc.)*
13. *garbage/feeding sites (for bears and/or for other wildlife)*

Authors were invited to modify the list, adding other activities/situations which they think can disturb bear or not considering those which they think do not affect bears (justifying their opinions).

3.1 In which way does the activity/situation affect bears and/or bear habitat?

The single largest impact to bears is leaving human food and garbage available for them to eat. This is the problem to be addressed first and to whatever extent possible all human food and garbage have to be removed. Sanitation is the single biggest step which can be done in protecting bear populations (Gibeau). Anyway, it is possible to group disturbances into broad categories instead of viewing them as individual human activities. First of all, it can be considered if the activity leads to direct mortality or not. In the reported list, hunting is the only human activity that leads to direct mortality. This is not just bear hunting, but ungulate hunters as well that may encounter and kill a bear. Also we must consider illegal 'hunters', that are to be viewed as criminals with a gun more than as hunters (Gibeau).

We can also divide indirect disturbances into 2 main categories: 1) motorized use, and 2) non-motorized use. Motorized human use is much more detrimental to bears than those non-motorized. Bear habituation to non-motorized human use certainly helps them access food resources that might otherwise not be available (Gibeau).

Changing approach, it is also possible to group the types of disturbance on the base of their effects (Katajisto):

- forestry, agriculture, animal farming/grazing, zootechnical activities, apiarian activities, mining, roads (main and secondary) and railways,



- human structures and developments reduce the amount of suitable habitat (Katajisto);
- forestry on the other hand may also increase habitat quality, if it increases food sources (Nielsen *et al.* 2004 quoted by Katajisto)
 - roads and railways also increase mortality, either through road mortality or by increasing the access of humans into the area (Mace *et al.* 1996, Nielsen *et al.* 2002 quoted by Katajisto). Bears may also just avoid the noise from roads (Gibeau *et al.* 2002 quoted by Katajisto);
 - agriculture, animal farming/grazing, zootechnical activities, apiarian activities, garbage, feeding sites (for bears and/or for other wildlife) can also attract bears providing potential food sources (Beckmann and Berger 2003, Blanchard and Knight 1991, Wilson *et al.* 2005, Wilson *et al.* 2006 quoted by Katajisto), which would increase the likelihood of conflicts with humans and thus the probability of bears being named as problem bears and removed legally or illegally (Katajisto);
 - hunting would directly affect bears survival, as well as indirectly increase infanticide (Katajisto);
 - tourism, recreation activities (playgrounds, golf-courses, riding-schools, boating, flying, trekking, climbing, etc.), winter recreation activities, skiing areas, forestry roads could bring occasional disturbance, but if they do not require destruction of habitat (such as turning forest into a golf course), they normally form such small disturbance that bears can probably avoid it. Of course, anyway, it depends on various factors: e.g. skiing resorts in Finland are very small compared to those of the Alps, so it's difficult to say something general (Katajisto);
 - forestry roads, garbage/feeding sites (for bears and/or for other wildlife) could also increase the probability of bear-human confrontations and create potentially dangerous situations (Katajisto);
 - winter recreation activities and skiing areas could cause disturbance for over wintering (Petram *et al.* 2004, Swenson *et al.* 1997 quoted by Katajisto) which may lower survival, especially in case of cubs (Katajisto).

Again it can be estimated that forestry, agriculture, mining, partly tourism/recreation activities (playgrounds, golf-courses, riding-schools, boating, flying, trekking, climbing, etc.), skiing areas, roads (main and secondary) and railways, forestry roads, human structures and development (resorts, villages, towns, dams, factories, etc.) have the most detrimental effect in terms of bear habitat quality, availability and maintenance and are mostly related to ecological disturbance (habitat loss, habitat degradation and habitat disruption) (Mertzanis).

In case of forestry, we are mainly referring to clear-cuts as a logging practice occurring mainly in oak forests. Selective logging has a less serious direct impact upon habitat condition but has detrimental secondary effects related to forest roads. Forest roads in Greece have a total length of 40.000 km and their density has increased 700% within a period of 20 years (1971-1991) (Mertzanis).

In case of agriculture activity, depending on the scale, configuration (located within bear habitat in a mosaic form) and type (i.e. small scale cultures with foraging value and interest for bears) may have the opposite effect (Mertzanis). Animal farming/grazing, zootechnical activities, apiarian activities and garbage/feeding sites (for bears and/or for other wildlife) appear to be mostly related to



bear–human conflict situations that might have a direct negative effect upon bears in terms of human-caused mortality or (in certain contexts) induce a “habituation” procedure through “easy food (but not always accessible)” conditioning (Mertzanis).

Hunting, tourism/recreation activities (playgrounds, golf-courses, riding-schools, boating, flying, trekking, climbing, etc.) and winter recreation activities appear to be mostly related to behavioural disturbance causing mainly displacement (Mertzanis).

In the following section, the different types of disturbance are treated separately.

1. Forestry

<u>Experts opinion summary</u>
Effects of forestry on bear habitat are: <ul style="list-style-type: none">- reduction of the amount of suitable habitat: 5 out of 6 authors;- increase of access to bear habitat: 3 out of 6 authors;- increase of habitat quality, through creation of food sources: 2 out of 6 authors. Effects of forestry on bears are: <ul style="list-style-type: none">- displacement or habituation: 2 out of 6 authors;- disturbance during work: 2 out of 6 authors.

Forestry is a very diverse activity with many different implications.

Implications of forestry on bears include: access, habitat change and the forestry activity itself (McLellan).

Forestry normally also means construction of forestry roads (Huber): improving access can be a major issue if many people may use the improved access and particularly if any of these people are apt to kill bears or do activities that lead to the death of bears (apiaries, poaching, hunting camps) (McLellan).

Habitat change due to forestry is a complex issue that varies among areas and practices. As previously mentioned, over the rotation of a commercial plantation, forestry usually results in poor bear habitat. After a forest is cut, there may be a few years during which bear foods are produced, but foresters usually encourage trees to grow soon after cutting by site preparation, planting and then clearing competing vegetation around the seedlings. With this type of forestry, crop tree usually becomes dominant in a few years and the vegetation that may be of greater value to bears is out-competed and declines. From then until the forest is cut again, there is little foraging habitat value for bears. This process can be improved by increasing the period that the site is not forested, or by clump planting of crop trees to leave space for some smaller bear food plants to persist through the rotation (McLellan).

Therefore forestry and timber harvest can be either negative or positive for bears (Gunther).

Some studies documented reduced grizzly bear use of logged areas (Zager *et al.* 1983 quoted by Gunther); however, logging can in some cases actually enhance



grizzly bear habitat (Ruediger and Mealey 1978 quoted by Gunther). Size, location, timing, age structure, seral stage, species and type of cuts, as well as use of buffer zones, leave strips, security areas and post harvest treatment can reduce impacts of timber harvest on bears or even enhance bear habitat after timber harvest (Gunther). For example in Scandinavia, forestry probably improves the habitat because stumps, which are left after cutting the trees, are an important habitat for *Camponotus ants*, which in turn are an important summer food for bears. Also, moose habitat is created (young forest) and moose calves are an important spring food (Swenson). On the other hand forestry cutting can affect bears by eventual creation of open areas with poor hiding locations (Huber).

So, not harvesting in or adjacent to naturally occurring high quality feeding habitat to maintain cover is also an important forestry practice (McLellan).

Again forestry activities themselves can create disturbance during the work (Huber). Forestry activity such as harvesting, site-preparation, planting, thinning and pruning can cause displacement or habituation of bears. If the forest is on public land that all people can access, the effect of forestry may be minor compared to access and habitat change. If the forest is on private land and if very intensively managed with people working the forest every day, then access is unlikely a great issue but the forestry activity itself may be more significant, at least during the day time when forest workers are active. Similarly, the implication of forestry activity is most prevalent during the time of year when bears are active but perhaps can be an issue in winter if foresters work near hibernating bears (McLellan), which can disturb bears in their dens (Swenson) and certainly if they remove den structures (in trees, under roots, under blown down trees) (McLellan).

2. Agriculture

Experts opinion summary

Effects of agriculture on **bear habitat** are:

- reduction of the amount of suitable habitat: 6 out of 6 authors;
- increase of access to bear habitat: 1 out of 6 authors.

Effects of agriculture on **bears** are:

- attraction to new food sources: 5 out of 6 authors;
- increase of conflicts and human caused mortality: 2 out of 6 authors;
- limited disturbance during the work: 1 out of 6 authors.

Agricultural practices can impact bears in several ways (Gunther). They alter large areas of habitat and, depending on the crops planted, may eliminate important bear foods and replace them with crops not consumed by bears (Gunther). But even if agricultural crops could be eaten by bears (Mattson 1990 quoted by Gunther) - and in this case bears are often attracted to them (fruit, grains, vegetables, compost) (McLellan) - they are usually prohibited from feeding on agricultural crops by human intolerance (Mattson 1990 quoted by Gunther). Bears that persist in attempting to feed in agricultural fields are usually killed (Gunther) by the farmers or authorities (McLellan).



In some areas, such as in Finland, bears sometimes cause problems by eating oats in fields (Swenson). Agricultural lands, therefore, often become population sinks that reduce the abundance of bears over larger areas (McLellan).

Large areas used for agriculture can fragment habitat (Hilty *et al.* 2006 quoted by Gunther), create open areas with no hiding locations, increase the access to the habitat by construction of roads (Huber).

Anyway, on the other hand, agriculture causes limited disturbance during the work (Huber).

The negative effect of agriculture on bear populations can be reduced by reducing attractants, using electric fences and guardian dogs to keep bears away from livestock and crops, as well as by having farmers accept loss to bears as a cost of doing business (McLellan).

However, even with very good practices, the effect of agriculture will always exist as habitat, that was often good for bears (deeper richer soils), is removed from being usable by bears (McLellan), all today agriculture is, in fact, on former bear habitat (Huber).

3. Animal farming/grazing, zootechnical activities

Experts opinion summary

Effects of animal farming, etc. on **bear habitat** are:

- reduction of the amount of suitable habitat: 2 out of 5 authors.

Effects of animal farming, etc. on **bears** are:

- increase of conflicts and human caused mortality: 5 out of 5 authors;
- attraction to feed on livestock: 3 out of 5 authors;
- competition with livestock for food: 1 out of 5 authors;
- habituation: 1 out of 5 authors.

Animal farming and grazing and zootechnical activities affect bears in multiple ways.

Grazing animals, especially cattle and sheep (Gunther), compete with bears for forage (McLellan; Gunther) but, more importantly, bears that persistently prey on domestic livestock (cattle, sheep, horses, ducks, chickens and turkeys) are usually killed in control actions (Reinhart *et al.* 2001, Gunther *et al.* 2004 quoted by Gunther). Bears are often removed even if they are suspected of killing livestock (McLellan). This is a major problem for bears in areas where animals, especially sheep, are allowed to graze in bear habitats without being guarded. The result is high levels of loss, even in small bears populations, and great political pressure to kill the bears (Swenson).

Otherwise, animal fat is an excellent food for bears that are building up stores of lipids in autumn (Swenson).

In addition, livestock grazing has modified vegetation composition and structure in many areas: livestock browsing has reduced or eliminated many desirable tree species (especially mast producing oaks) in some areas (Mattson 1990 quoted by Gunther).



4. Apiarian activities

Experts opinion summary

Effects of apiarian activities on **bear habitat** are:

- reduction of the amount of suitable habitat: 1 out of 6 authors.

Effects of apiarian activities on **bears** are:

- increase of conflicts and human caused mortality: 5 out of 6 authors;
- attraction: 3 out of 6 authors;
- limited disturbance during the work: 1 out of 6 authors.

Apiarian activities cause limited disturbance during the work (Huber) but they can attract bears to rural farms and areas of human activity (Gunther *et al.* 2004 quoted by Gunther). This can lead to conflicts with bears that destroy beehives (Swenson).

Although apiaries provide food for bears, bears are in fact usually prohibited from using them due to human intolerance (Gunther *et al.* 2004 quoted by Gunther): bears often damage apiaries in their attempts to get honey and apiary owners usually won't tolerate the economic loss from bear consumption of commercial honey and damage to the hives (Gunther). As a result, those bears are sometimes removed from the population (McLellan).

The problem is anyway easily solved by fencing the hives with electric fence (Swenson).

5. Mining

Experts opinion summary

Effects of mining on **bear habitat** are:

- reduction of the amount of suitable habitat: 4 out of 4 authors;
- enhancement of bear habitat: 1 out of 4 authors;
- increase of access to bear habitat: 1 out of 4 authors.

Effects of mining on **bears** are:

- bear displacement: 1 out of 4 authors.

Like forestry, mining is a hugely diverse activity on which many pages could be written (McLellan).

Mining and exploration for minerals often increases access (McLellan), causes loss of habitat from large open pit mines and disturbance (causing avoidance and bear displacement) from seismic activity, blasting and helicopter flights (Gunther). For these reasons, it may be a serious problem if done extensively in the bear habitat (Huber).

However, some large mining tailings areas are seeded with high quality bear foods, are not open to hunting or people with guns and closely patrolled and bears may even find refuge near them (McLellan).



6. Hunting

Experts opinion summary

Effects of hunting are:

- increase of human caused mortality and conflicts: 6 out of 7 authors;
- bear displacement: 2 out of 7 authors;
- increase of survival of some cohort: 1 out of 7 authors;
- increase of bear wariness: 1 out of 7 authors;
- attraction to game meat: 1 out of 7 authors;
- competition with hunters for prey: 1 out of 7 authors;
- limited disturbance during the hunt: 1 out of 7 authors.

Bears hunting can only be justified if populations are large enough and there is a clear surplus of bears. Because the status of bears is difficult to assess and there is at least short term economic gains to be made, over-harvesting bears is possible and can have serious implications. Hunting appears to have complex effects on bear behaviour, likely due to the removal of unwary or bold individuals. Bears in many hunted populations appear more wary of people than unhunted populations, likely because habituated bears live longer in unhunted areas than hunted areas (McLellan). Hunted populations do not have habituated bears (Jalkotzy *et al.* 1997 quoted by Gibeau). It appears that the removal of adult males and shifting the sex ratio towards females may increase cub survival because the few adult males remaining will have ample breeding opportunity without killing cubs and waiting for the mother to become receptive (McLellan). Anyway hunting mortality can generally be regulated through permit numbers, season dates, season length, and other restrictions (Gunther).

In Croatia harvesting is conducted from elevated shooting platforms, attracting bears with baits. The most questionable issue is thus the use of bait for bears, which attracts other animal species as well (wild boar for example) (Huber). Talking about harvest of other preys, like ungulates, some authors believe that it causes limited disturbance during the event and it may result in an accidental kill of a bear, which anyway happens very rarely (Huber). But other think that the greatest impact from big game hunting activities is from mortality associated with defence-of-life kills when hunters have surprise encounters with bears (Gunther *et al.* 2004 quoted by Gunther). Hunting camps can also lead to bear mortality when game meat or garbage is not stored in a bear-proof manner and bears enter camps to consume these food sources and are then shot and killed in self defence or removed by bear managers due to concern for human safety. Hunters also compete with bears for available preys (Gunther).

On the other hand, hunting also has some positive effects deriving from the food made available by hunting in the form of gut piles and carrion of animals killed during the hunting season (Ruth *et al.* 2003, Haroldson *et al.* 2004 quoted by Gunther).

Late hunting, especially with dogs, can force bears to leave their dens soon after denning (Swenson *et al.* 1997 quoted by Swenson). They might be most susceptible to this type of disturbance at this time. Of course, hunters might kill bears even if they do not have the right or permission to do it (Swenson).



7. Tourism/recreation activities (playgrounds, golf-courses, riding-schools, boating, flying, trekking, climbing, etc.)

Experts opinion summary

Effects of tourism activities on **bear habitat** are:

- reduction of the amount of suitable habitat: 2 out of 6 authors.

Effects of tourism activities on **bears** are:

- displacement: 3 out of 6 authors;
- increase of conflicts and human caused mortality: 2 out of 6 authors;
- attraction: 1 out of 6 authors;
- habituation: 1 out of 6 authors;
- short term effects: 1 out of 6 authors;
- positive voice of bears from tourists viewing the animals: 1 out of 6 authors.

The topic regarding tourism and recreation activities (included playgrounds, golf-courses, riding-schools, boating, flying, trekking, climbing, etc.), is a diverse and complex one (McLellan). These activities, in fact, affect the habitat both through infrastructures constructed and through their use (Huber).

The activities that require permanent changes in habitat are definitely worse (Huber).

In general, outdoor recreation can displace bears from quality feeding area (McLellan): in particular, high levels of recreation can cause displacement of bears from prime food sources (Gunther) and/or they can habituate bears to the presence of people (McLellan). Thus outdoor recreationists may also condition bears to their food, if a bear learns to associate food with tourists. These habituated bears may, depending on the situation and type of recreationists, end up becoming problem bears and be sometimes removed from the population (McLellan).

Therefore it can be said that these activities most often impact bear populations through mortality associated with management removal and defence of life kills of bears attracted to improperly stored anthropogenic food and garbage (Gunther).

On the other hand, human activities themselves, especially if they are dispersed, probably only have short-term effects, such as the 12-hour effects (Swenson).

Anyway the very activities are less critical if restricted to daytime (Huber).

On the positive side, outdoor enthusiasts are often a positive voice for bears and result in positive actions (McLellan).



8. Winter recreation activities

Experts opinion summary

Effects of winter recreation activities on **bear habitat** are:

- reduction of the amount of suitable habitat: 1 out of 4 authors.

Effects of winter recreation activities on **bears** are:

- bear displacement: 3 out of 4 authors;
- increase of conflicts and human caused mortality: 2 out of 4 authors;
- little disturbance: 1 out of 4 authors.

Winter recreation activities affect the habitat through infrastructures constructed - most of these activities do require permanent changes in habitat - and through their use (Huber).

Because bears hibernate, winter recreation is likely a relatively minor disturbance (McLellan). However, if winter recreation occurs near den sites - and especially if it is noisy (using of snow machines) (McLellan) or it happens during the period of den entrance or emergence (Gunther) - it can have a dramatic effect on denning bears, causing them to switch dens (Swenson *et al.* 1997, Linnell *et al.* 2000 quoted by Swenson). This switching can cause an elevated loss of young among pregnant females (Swenson *et al.* 1997, Linnell *et al.* 2000 quoted by Swenson).

However due to the steep and rugged, extremely remote locations of most bear dens and the inaccessibility of denning areas due to deep snow depths, most winter recreation has little or no potential to impact on bears (Podruzny *et al.* 2002 quoted by Gunther).

9. Skiing areas

Experts opinion summary

Effects of skiing areas on **bear habitat** are:

- reduction of the amount of suitable habitat: 2 out of 4 authors;
- production of good bear habitat: 1 out of 4 authors.

Effects of skiing areas on **bears** are:

- little disturbance: 2 out of 4 authors;
- decrease of survival: 1 out of 4 authors;
- attraction: 1 out of 4 authors;
- displacement: 1 out of 4 authors;
- positive voice of bears from tourists viewing the animals: 1 out of 4 authors.

The impacts of skiing areas on bears are similar to those of other winter recreational activities (Gunther). This activity affects the habitat through infrastructures constructed and their use: the effect of permanent structures is year long, though lower in summer (Huber).

Unless skiing activities occur near dens and during den entrance or emergence, they generally have little or no impact on bears (Gunther). The very activities,



such as skiing, are less critical if restricted to daytime. Night skiing is an additional problem (Huber).

On the other hand, in particular contexts ski areas may artificially produce good bear habitat. Ski runs are maintained at an early seral stage (often grasses and shrubs) by removing trees and planting grasses and legumes (i.e. clover). Additionally, snowmaking puts an unnatural amount of snow on these open areas. The combination of extra moisture, no trees and sometimes seeding, to grasses and legumes can lead to rich plant growth and heavy use of ski runs by bears for foraging. Bears can also be safely viewed from ski lifts and the experience can give extra value to bears. The downside of ski areas is, once again, attractant management (garbage, restraint waste) and bears becoming habituated to the presence of people, eventually becoming food conditioned (McLellan).

10. Roads (main and secondary) and railways

Experts opinion summary

Effects of roads and railways on **bear habitat** are:

- reduction of the amount of suitable habitat: 2 out of 5 authors;
- increase of access to bear habitat: 1 out of 5 authors;
- creation of barriers: 1 out of 5 authors.

Effects of roads and railways on **bears** are:

- displacement: 3 out of 5 authors;
- attraction: 1 out of 5 authors;
- increase of conflicts and human caused mortality: 1 out of 5 authors.

Road itself typically does not cause a disturbance response; it is the human presence on the road that causes disturbance (Lyon *et al.* 1985, Beall 1974, Horejsi 1981, Behrend and Lubeck 1968 in Jalkotzy *et al.* 1997 quoted by Gibeau). Closed roads are generally not avoided by wildlife. On roads open to traffic, vehicles that never stop may be ignored in some cases. However, stopped vehicles and people leaving their vehicles cause increased levels of disruption. Typically, hunted wildlife populations exhibit stronger disturbance reactions to people along roads than does wildlife in protected areas (Jalkotzy *et al.* 1997 quoted by Gibeau).

Regarding railways, human disturbance is predictable and generally does not involve humans outside the train, further reducing the likelihood of significant disturbances. For example, a grizzly bear foraging along a railroad right-of-way yields to train traffic at the last possible moment and returns soon after the train has passed (M.G. Jalkotzy, pers. observation in Jalkotzy *et al.* 1997 quoted by Gibeau).

Moreover, major roadways and railways may (McLellan):

1. remove bear habitat (McLellan): there is loss of habitat that has been paved over (Gunther). To quantify the importance of habitat loss, the amount of each habitat type should be determined. Loss of habitats that are both rare and important to wildlife are more important than habitats with extensive distribution (Jalkotzy *et al.* 1997 quoted by Gibeau). In addition, roads can



disrupt habitat indirectly through introduction of exotic plants and pollution dust (Cameron and Whitten 1977 in Jalkotzy *et al.* 1997 quoted by Gibeau), salt (Fraser and Thomas 1982 in Jalkotzy *et al.* 1997 quoted by Gibeau) and vehicle emissions (Harrison and Dyer 1984 in Jalkotzy *et al.* 1997 quoted by Gibeau). Efficient foraging strategies of bears may be disrupted by roads (Mattson *et al.* 1987 in Jalkotzy *et al.* 1997 quoted by Gibeau).

2. Bears are sometimes attracted to roads and railways because:
 - a. grasses and clover are sometimes seeded on "right-of-ways",
 - b. train cars carrying grain leak or derail spilling large volumes of grain,
 - c. other animals are killed and bears are attracted to the carcasses.

Bears attracted to highways and railways can also be killed by these vehicles (McLellan). Thus roads and railways impact bears through direct and indirect mortality associated with them (Schwartz *et al.* 2003 quoted by Gunther).

3. Bears can be displaced from habitat near roads (McLellan). Grizzly bears are known to avoid open roads in general, yet in protected populations some bears become habituated to the point that they use roadside verges with apparent disregard for human traffic on it (McLellan *et al.* 1985, McLellan and Shackleton 1989, Tracy 1977 in Jalkotzy *et al.* 1997 quoted by Gibeau). Bears avoid some categories of roads during the summer season and for denning (Yri 2006, Elfström *et al.* in press quoted by Swenson). If traffic volume decreases at night, then bears will make use of adjacent habitat. The use of this habitat, however, may increase the chance of being hit by a vehicle (McLellan). However, in the Greater Yellowstone Ecosystem, vehicle strike mortality of bears is relatively insignificant and likely does not have a population level effect on bears (Gunther *et al.* 2004 quoted by Gunther).
4. Roads may also act as filter or complete barriers for wildlife (Jalkotzy *et al.* 1997 quoted by Gibeau). Bears can sometimes find it difficult to cross large, multi-lane highways and multi-track railways resulting in population scale or home range scale fragmentation (McLellan). For example, only a few adult female grizzly bears have been documented crossing the TransCanada Highway in the Bow Valley of Banff National Park (Gibeau and Heuer 1996, Woods and Munro 1996, Hustin and Herrero 1995, Stevens *et al.* 1996 in Jalkotzy *et al.* 1997 quoted by Gibeau). Width, curvilinearity and traffic volumes probably affect wildlife crossing rate (Jalkotzy *et al.* 1997 quoted by Gibeau).
5. The greatest impact from roads on bears derives from the increase of human access to bear habitat for big game hunting and other forms of recreation which directly or indirectly lead to bear mortality. The greater the number of people recreating in bear habitat, the greater the chances of bears being killed in defence of life during encounters and confrontations with humans (Gunther). In the Greater Yellowstone Ecosystem, defence of life kills by hunters is one of the leading causes of bear mortality; moreover, in the GYE, some bears are also killed in malicious acts (Gunther *et al.* 2004 quoted by Gunther). Many hunters and poachers, in fact, access bear habitat from roads (Gunther). For what concerns railways, the importance of train-caused mortality for local wildlife population is unknown (Jalkotzy *et al.* 1997 quoted by Gibeau).

Habitat enhancement may be associated with roads and railways corridors (Jalkotzy *et al.* 1997 quoted by Gibeau). Closed roads or roads with little traffic



(like unpaved secondary roads) are frequently used as travel routes, probably because such use is beneficial from an energetic point of view (Smith 1978, Zager 1980 in Jalkotzy *et al.* 1997 quoted by Gibeau). When roads and railways create openings in forested habitats, vegetation recolonizing the disturbed right-of-way and reseeded vegetation may provide food resources not available in the surrounding matrix (Jalkotzy *et al.* 1997 quoted by Gibeau). Bears are attracted to these areas because of the high concentrations of food (Nagy and Russel 1978, Manville 1983 in Jalkotzy *et al.* 1997 quoted by Gibeau). However, the advantages gained by using this habitat may not benefit wildlife in the long term, since mortality risks, direct and indirect, are also greater along road rights-of-way (Jalkotzy *et al.* 1997 quoted by Gibeau).

11. Forestry roads

Experts opinion summary

Effects of forestry roads on **bear habitat** are:

- reduction of the amount of suitable habitat: 3 out of 6 authors;
- increase of access to bear habitat: 3 out of 6 authors.

Effects of forestry roads on **bears** are:

- displacement: 3 out of 6 authors;
- increase of conflicts and human caused mortality: 1 out of 6 authors;
- disturbance during the work of construction and forest work: 1 out of 6 authors;
- little disturbance: 1 out of 6 authors.

Forestry roads have the same types of impact as primary and secondary roads, although disturbance through displacement is generally less due to the lower densities of traffic (Gunther *et al.* 2004 quoted by Gunther). Forestry roads greatest impact is due to the human access they provide (Gunther *et al.* 2004 quoted by Gunther): in fact, they increase access for people that may habituate bears, may food condition bears, or may shoot bears for a variety of reasons (McLellan).

Forestry roads open the habitat to various users (Huber), fact that can lead to human-caused bear mortality through self defence kills and poaching (Gunther *et al.* 2004 quoted by Gunther). Self defence kill of grizzly bears by hunters and other recreationists is one of the leading causes of mortality in the Greater Yellowstone Ecosystem (Gunther *et al.* 2004 quoted by Gunther), but it true that usually bears do use roads and areas near roads at night, when people rarely utilize forestry roads (McLellan).

Planting areas next to roads with clover/grass mixes often attracts bears. The added food may be good for bears but having them near roads increases the chance that they will be shot, hit by a vehicle, or start the process of habituation, that may lead to conditioning and then to "problem bears". For this reason it can be better not to seed roadsides or do so with plants that bears do not like (McLellan). Forestry roads can also remove good habitat or cause displacement from preferred habitat (McLellan) because bears avoid some categories of roads during the summer season and for denning (Yri 2006,



Elfström *et al.* in press quoted by Swenson). Moreover, it must be considered that building and using them in forestry operations can cause disturbance (Huber).

12. Human structures and development (resorts, villages, towns, dams, factories, etc.)

<u>Experts opinion summary</u>
Effects of human structures and development on bear habitat are: <ul style="list-style-type: none">- reduction of the amount of suitable habitat: 5 out of 6 authors. Effects of human structures and development on bears are: <ul style="list-style-type: none">- displacement: 3 out of 6 authors;- fragmentation of populations: 1 out of 6 authors;- increase of conflicts and human caused mortality: 1 out of 6 authors.

Towns and human developments impact bears first of all through the habitat that is lost or built over (Gunther) or permanently changed (Huber): developing a number of human structures, typically in valleys, can for example fragment bear populations (McLellan). But human structures impact bears also through displacement from habitat adjacent to towns and through the bear mortality associated with these developments (Gunther), because they attract bears due to garbage or other attractants and thus create problem bears (McLellan). This is mainly caused to the human use of these structures and developments (Huber). Resorts and villages have a major negative effect on the distribution of bears (Nellemann *et al.* 2007 quoted by Swenson). In most cases the mortality associated with towns and villages has a greater impact on bear populations than the loss of habitat or displacement from habitat. Bear mortality associated with towns and villages usually comes from management removal of bears entering towns to feed on garbage or other anthropogenic food attractants and to a lesser extent from bears damaging gardens and orchards. In the Great Yellowstone Ecosystem, management removal of bears from towns and developments is one of the leading causes of bear mortality. In addition, there are usually some bears killed by private land owners in defence of life and property associated with towns and villages (Gunther *et al.* 2004 quoted by Gunther).

13. Garbage/feeding sites (for bears and/or for other wildlife)

<u>Experts opinion summary</u>
Effects of garbage/feeding sites are: <ul style="list-style-type: none">- increase of conflicts and human caused mortality: 4 out of 5 authors;- attraction: 3 out of 5 authors;- habituation: 1 out of 5 authors.



Garbage is a major attractant for bears and draws bears from wilder habitats to areas close to people (McLellan), since garbage is typically disposed close to human settlements (Huber).

Garbage feeding sites can provide bears with a stable, high calorie food source that can dampen the effects of natural fluctuations in native bear foods (Craighead *et al.* 1995 quoted by Gunther). Bears who have access to garbage can associate garbage with homes, becoming very bold in search of garbage (McLellan). Such human food conditioned bears often cause significant damages to personal property and occasionally injure or kill people (Herrero 2002 quoted by Gunther). Therefore due to human safety concerns and human intolerance, bears are not tolerated by people at most sites where bears can obtain garbage (town sites, developed areas, open-pit dumps and campgrounds) (Gunther). For these reasons, bears that learn to seek out garbage usually are killed as problem animals (McLellan).

Regarding feeding sites, they may be placed away from human settlements and, at least temporarily, keep the bears further away (Huber).

3.2 In which period of the year does the activity/situation affect bears and/or bear habitat?

Activities can be grouped by similar effecting period: forestry, agriculture, zootechnical activities, hunting, tourism/recreation activities, winter recreational activities, skiing areas are characterized by a complementary seasonality and especially hunting, winter recreational activities and skiing areas are overlapping in fall and winter, thus increasing the detrimental effect of behavioural disturbance during a critical phase of the bears life cycle (pre-denning and denning periods) (Mertzanis).

Concerning roads (main and secondary) and railways use, forestry roads use, human structures and development, what is most important above the temporal dimension is especially the density and intensity of use (as far as roads are concerned) as well as spatial amplitude (as far as human settlements are concerned) (Mertzanis).

Concerning especially roads (main and secondary) and railways use and forestry roads use, the road density is a key predictive variable that can be used to estimate the effects of disturbance and habitat fragmentation (Diamondback 1990, Mattson *et al.* 1987 in Paquet *et al.* 1994 quoted by Mertzanis).

There is irrefutable evidence that roads and the associated disturbance reduce habitat effectiveness resulting in reduced fitness and increased risk of mortality (Diamondback 1990 in Paquet *et al.* 1994 quoted by Mertzanis).

Summarily we can consider that most activities affect bears throughout all the year, although "special" tourist actions have their low and high seasons, unless they lead to habitat loss. During the wintering period the effect of most actions is usually the lowest, unless the action directly disturbs denning (Katajisto).



1. Forestry

Experts opinion summary

Forestry affects bears and/or bear habitat mostly in the following period of the year:

- year long: 3 out of 3 authors.

Forestry activities impact is year long (Huber). They impact bears primarily during spring, summer and fall, although there is some chance that timber harvest during winter could also disturb hibernating bears in their dens (Gunther). In this case, the worst effect is in the denning period (Huber). The impacts on bears can be reduced by timing timber harvests to avoid seasonally important bear habitat or sites with concentrations of high quality bear foods (Gunther).

2. Agriculture

Experts opinion summary

Agriculture affects bears and/or bear habitat mostly in the following period of the year:

- year long: 3 out of 3 authors.

The habitat is affected by agriculture year long (Huber). Depending on which crops are planted, agricultural activities could impact bears during spring, summer and fall. In most instances, crops that attract bears as a food source are ripe and become most attractive to bears during the late summer or fall. Although generally unlikely, agriculture can lead to disturbance in winter as well. In Montana (USA) there have been a few instances where bears denned and hibernated in haystacks and were disturbed when hay was removed for winter livestock feeding (Gunther).

3. Animal farming/grazing, zootechnical activities

Experts opinion summary

Animal farming affects bears and/or bear habitat mostly in the following period of the year:

- year long: 1 out of 2 authors;
- spring, summer and fall: 1 out of 2 authors.

Bears are opportunistic predators and will prey on sheep, ducks, chickens and turkeys throughout spring, summer and fall, whereas most depredation on cattle occurs on calves (Murie 1948 quoted by Gunther): adult cows and steers are less frequently preyed on than calves. In the Greater Yellowstone Ecosystem,



most livestock depredations occur during early hyperphagia (16 July-31 August) and late-hyperphagia (1 September – denning).

The killing of multiple farm animals during a single episode occurs more often when bears prey on sheep than when they prey on cattle (Gunther *et al.* 2004 quoted by Gunther).

4. Apiarian activities

Experts opinion summary

Apiarian activities affect bears and/or bear habitat mostly in the following period of the year:

- spring, summer and fall: 2 out of 3 authors;
- year long: 1 out of 3 authors.

Bear damage to apiaries can occur during all the seasons when bears are active (Gunther *et al.* 2004 quoted by Gunther), especially during the flowering season (Huber). In the Greater Yellowstone Ecosystem, most damage to beehives occurred during early hyperphagia (16 July-31 August) and late hyperphagia (1 September – Denning). Bear damage to beehives has been successfully prevented in the Greater Yellowstone Ecosystem through the use of electric fences (Gunther *et al.* 2004 quoted by Gunther).

5. Mining

Experts opinion summary

Mining affects bears and/or bear habitat mostly in the following period of the year:

- year long: 2 out of 2 authors.

Disturbance deriving from mining activities can occur during spring, summer and fall, and to a lesser extent during winter as well. Seismic and blasting activities could disturb bears in their winter dens (Gunther).

6. Hunting

Experts opinion summary

Hunting affects bears and/or bear habitat mostly in the following period of the year:

- year long: 2 out of 3 authors;
- fall and winter: 1 out of 3 authors.



Bear habitat is affected by each hunt (Huber). The season of disturbance corresponds with the hunting season (Gunther). In North America, most big game hunting seasons occur during the fall. Hunting generally impacts brown bears through defence of life kills by hunters that have surprise encounters with bears, through defence of life and property kills of bears entering hunter camps in attempts to get human food, garbage, horse feed, or game meat, and through kills of brown bears that are mistakenly identified as black bears (and thus killed) during the black bear hunting season (Gunther *et al.* 2004 quoted by Gunther). Winter hunting seasons generally have little impact on bears (Gunther) but it may disturb the den, with possible loss of litter (Huber).

7. Tourism/recreation activities (playgrounds, golf-courses, riding-schools, boating, flying, trekking, climbing, etc.)

<u>Experts opinion summary</u>
Tourism affects bears and/or bear habitat mostly in the following period of the year: <ul style="list-style-type: none">- year long (if it causes permanent changes of the habitat): 3 out of 3 authors;- low and high season: 1 out of 3 authors.

Disturbance deriving from tourism and recreation activities can occur during spring, summer, fall and, to a lesser extent, winter. The impacts of these activities will vary by season depending on the habitat that they occur in (Gunther). Again in winter they may disturb denning bears, with possible loss of litter (Huber).

8. Winter recreation activities

<u>Experts opinion summary</u>
Winter recreation activities affect bears and/or bear habitat mostly in the following period of the year: <ul style="list-style-type: none">- winter: 2 out of 3 authors;- low and high season: 1 out of 3 authors;- year long (if they cause permanent changes of the habitat): 1 out of 3 authors.

Winter recreation activities generally have very little impact on bears because bears are hibernating in dens during the winter season. Most brown bear dens are located in relatively remote, steep terrain where disturbance from recreational activities is unlikely (Gunther). But such activities may disturb denning bears, with possible loss of litter (Huber). In fact it has been seen in a study in south central Sweden and south-eastern Norway that human disturbance was the major cause of den abandonment. Most of the



abandonment occurred early in the denning period, before mid-winter, and bears moved up to 30 km before denning again (Swenson 1997).

9. Skiing areas

Experts opinion summary

Skiing areas affect bears and/or bear habitat mostly in the following period of the year:

- year long (if they cause permanent changes of the habitat): 2 out of 3 authors;
- fall and winter. 1 out of 3 authors.

Since skiing is a winter activity, it generally does not have direct impacts on bears because they are hibernating in winter dens during the ski season (Gunther), but it may disturb the denning bears, with possible loss of litter (Huber). In North America, the human developments that are built around ski areas probably have more impact on bears than the ski areas themselves. Although the ski slopes may only impact bears during the winter, the surrounding developments may impact bears during spring, summer and fall (Gunther). Thus the habitat is affected by each facility all year (Huber).

10. Roads (main and secondary) and railways

Experts opinion summary

Roads and railways affect bears and/or bear habitat mostly in the following period of the year:

- spring, summer and fall: 1 out of 2 authors;
- year long: 1 out of 2 authors.

Main and secondary roads and railways can disturb bears and lead to mortality, primarily during spring, summer and fall (Gunther). It has also been seen that successful dens are significantly farther from paved national highways, smaller highways and gravel roads (Elfström *et al.*, in press). Grizzly bears appear to avoid road less in spring than in fall (Aune *et al.* 1986, Kasworm and Manley 1990, Aune 1985 in Jalkotzy 1997 quoted by Gibeau). This avoidance may be associate with either seasonal increases in traffic volume related to hunting or it may result from the distribution of seasonal foods if other variables like traffic volume are constant (Jalkotzy 1997 quoted by Gibeau).



11. Forestry roads

Experts opinion summary

Forestry roads affect bears and/or bear habitat mostly in the following period of the year:

- year long: 2 out of 3 authors;
- spring, summer and fall: 1 out of 3 authors.

Forestry roads can disturb bears during spring, summer and fall (Gunther), but if there is no snow in winter (i.e. bear denning period), especially at lower elevations and in the recent years, forestry operations do go on and the disturbance becomes year-long and is worse in the denning period (Huber).

12. Human structures and development (resorts, villages, towns, dams, factories, etc.)

Experts opinion summary

Human structures affect bears and/or bear habitat mostly in the following period of the year:

- year long: 2 out of 3 authors;
- spring, summer and fall: 1 out of 3 authors.

Human structures and developments impact bears primarily during spring, summer and fall seasons (Gunther). But the habitat is affected all year long (Huber).

13. Garbage/feeding sites (for bears and/or for other wildlife)

Experts opinion summary

Garbage affects bears and/or bear habitat mostly in the following period of the year:

- year long: 2 out of 3 authors;
- spring, summer and fall: 1 out of 3 authors.

Garbage and feeding sites may be used by bears during the spring, summer, and fall seasons (Gunther).

But the effect is the worst in spring and fall. Spring because of sparse natural food and fall because the bears need to get ready for winter (Huber).



3.3 In which period of the day does the activity/situation affect bears and/or bear habitat?

Those activities that cause loss of habitat (activities 1/2/3/4/5/10/12), cause it permanently independent of the time of the day or year (Katajisto). But forestry, agriculture, animal farming/grazing, zootechnical activities, apiarian activities, mining, hunting, tourism/recreation activities, winter recreation activities, skiing areas, roads and railways, forestry roads, human structures and development, garbage/feeding sites (for bears and/or for other wildlife) impact bears during the period in which they are practiced (Gunther). That is, the majority of the activities and related disturbance occurs during daylight hours (Mertzanis), when humans are active (Katajisto). Since bears have behavioural plasticity, they may change activity patterns to avoid human activities (Gunther). Activities that avoid crepuscular time periods minimize the impact on most bears because bears are generally most active during crepuscular time periods. Activities that lead to human-caused mortality have greater impacts on bear populations than those that displace or disturb bears but don't lead to mortality (Gunther).

1. Forestry

Experts opinion summary

Forestry affects bears and/or bear habitat mostly in the following period of the day:

- daylight hours, morning and evening dusk: 3 out of 4 authors;
- the period that it is practiced: 1 out of 4 authors.

Forestry is usually done during daytime but its effect worsens when extended into morning or evening dusk (Huber).

2. Agriculture

Experts opinion summary

Agriculture affects bears and/or bear habitat mostly in the following period of the day:

- daylight hours: 2 out of 3 authors;
- the period that it is practiced: 1 out of 3 authors;
- all day long: 1 out of 3 authors.

Agriculture is usually done in the daytime: this decreases the negative effect (Huber).



3. Animal farming/grazing, zootechnical activities

Experts opinion summary

Animal farming affects bears and/or bear habitat mostly in the following period of the day:

- daylight hours: 1 out of 3 authors;
- the period that it is practiced: 1 out of 3 authors;
- all day long: 1 out of 3 authors.

4. Apiarian activities

Experts opinion summary

Apiarian activities affect bears and/or bear habitat mostly in the following period of the day:

- daylight hours: 2 out of 4 authors;
- the period that they are practiced: 1 out of 4 authors;
- all day long: 1 out of 4 authors.

Apiarian activities are usually done in the daytime: this decreases the negative effect (Huber).

5. Mining

Experts opinion summary

Mining affects bears and/or bear habitat mostly in the following period of the day:

- daylight hours: 1 out of 3 authors;
- the period that it is practiced: 1 out of 3 authors;
- all day long: 1 out of 3 authors.

6. Hunting

Experts opinion summary

Hunting affects bears and/or bear habitat mostly in the following period of the day:

- daylight hours, morning and evening dusk: 3 out of 4 authors;
- the period that it is practiced: 1 out of 4 authors.

Hunting is usually done in the daytime, but also in early morning and evening when the effect is worse (Huber).



7. Tourism/recreation activities (playgrounds, golf-courses, riding-schools, boating, flying, trekking, climbing, etc.)

Experts opinion summary

Tourism affects bears and/or bear habitat mostly in the following period of the day:

- daylight hours, morning and evening dusk: 3 out of 4 authors;
- the period that they are practiced: 1 out of 4 authors.

Tourism and recreation activities (playgrounds, golf-courses, riding-schools, boating, flying, trekking, climbing, etc.) are usually done in the daytime, but also in early morning and evening when the effect is worse (Huber).

8. Winter recreation activities

Experts opinion summary

Winter recreation activities affect bears and/or bear habitat mostly in the following period of the day:

- daylight hours, morning and evening dusk: 3 out of 4 authors;
- the period that they are practiced: 1 out of 4 authors.

Winter recreation activities are usually done in the daytime, but also in early morning and evening when the effect is worse (Huber).

9. Skiing areas

Experts opinion summary

Skiing areas affect bears and/or bear habitat mostly in the following period of the day:

- daylight hours, morning and evening dusk: 3 out of 4 authors;
- the period that they are practiced: 1 out of 4 authors.

Skiing areas are usually used in the daytime, but also evening and even night when the effect is worse (Huber).

10. Roads (main and secondary) and railways

Experts opinion summary

Roads and railways affect bears and/or bear habitat mostly in the following period of the day:



- the period they are used: 1 out of 3 authors;
- all day long: 1 out of 3 authors;
- daylight hours, morning and evening dusk: 1 out of 3 authors.

Roads (main and secondary) and railways are usually used in the daytime but the effect of their use worsens when extended into morning or evening dusk, or night (Huber). Bears are seen to use areas near roads during the period when human are inactive, if within high quality habitat (Gibeau *et al.* 2002 in Yri 2006).

11. Forestry roads

Experts opinion summary

Forestry roads affect bears and/or bear habitat mostly in the following period of the day:

- daylight hours, morning and evening dusk: 3 out of 4 authors;
- the period they are used: 1 out of 4 authors.

Forestry roads are usually used in the daytime but the effect of their use worsens when extended into morning or evening dusk, or night (Huber).

12. Human structures and development (resorts, villages, towns, dams, factories, etc.)

Experts opinion summary

Human structures affect bears and/or bear habitat mostly in the following period of the day:

- all day long: 2 out of 4 authors.
- daylight hours, morning and evening dusk: 1 out of 4 authors;
- the period they are used: 1 out of 4 authors.

13. Garbage/feeding sites (for bears and/or for other wildlife)

Experts opinion summary

Garbage and feeding sites affect bears and/or bear habitat mostly in the following period of the day:

- all day long: 1 out of 2 authors;
- the period they are present: 1 out of 2 authors.

Garbage/feeding sites (for bears and/or for other wildlife) can effect bears daylong: they are usually visited by bears at night but eventually some bears do become habituated to such a degree that those individuals do show up even in



the daytime. Especially vulnerable are young (sub-adult) bears who also fear adult bears and try to avoid them in space (forest) and time (day) (Huber).



3.4 In which habitat is the activity/situation more detrimental for bears?

Generally it seems that human effects are most detrimental in open habitats (agricultural areas, alpine areas, large bogs) and, when in forested habitats, human effects seem to be most detrimental in flatter areas (Swenson).

It appears also that the disturbance factors with the most irreversible effect upon bear primary habitat (such as roading and other permanent heavy infrastructure i.e. highways, railways, water dams, etc.) have the most detrimental and long - term effect (Mertzanis). Therefore any human activities is detrimental in any primary bear habitat such as forests (Katajisto).

Thus forestry, agriculture, animal farming/grazing, zootechnical activities, apiarian activities, mining, hunting, tourism/recreation activities, winter recreation activities, skiing areas, roads and railways, forestry roads, human structures and development, garbage/feeding sites have the greatest impact when they occur in high quality habitats that contain seasonally important, concentrated high calorie foods. However, these activities can also be detrimental in low quality habitats if they attract bears (garbage/feeding sites, apiaries, livestock, agriculture) and lead to high levels of human-caused mortalities (Gunther).

The short, medium and long term consequences of a detrimental activity/disturbance upon critical bear habitat could be: destruction and degradation with immediate effects of:

- loss of food resources and cover
- loss of diversity
- loss of seasonal equity (Mertzanis).

All this considered, currently untouched habitats should be preserved (Katajisto).

1. Forestry

Experts opinion summary

Forestry is more detrimental in the following habitat:

- primary and/or critical bear habitat (such as forest): 3 out of 5 authors;
- both high and low quality bear habitat: 1 out of 5 authors;
- in open habitat and when in forested habitats, in flatter areas: 1 out of 5 authors.

Forestry is always realized in the forest, i.e. in the critical bear habitat (Huber).

2. Agriculture

Experts opinion summary

Agriculture is more detrimental in the following habitat:

- primary and/or critical bear habitat: 3 out of 5 authors;



- | |
|--|
| <ul style="list-style-type: none">- both high and low quality bear habitat: 1 out of 5 authors;- in open habitat and when in forested habitats, in flatter areas: 1 out of 5 authors. |
|--|

Agriculture is more detrimental when the agricultural fields are away from villages, i.e. in the critical habitat (Huber).

3. Animal farming/grazing, zootechnical activities

<u>Experts opinion summary</u>

- | |
|--|
| <p>Animal farming is more detrimental in the following habitat:</p> <ul style="list-style-type: none">- primary and/or critical bear habitat: 2 out of 4 authors;- both high and low quality bear habitat: 1 out of 4 authors;- in open habitat and when in forested habitats, in flatter areas: 1 out of 4 authors. |
|--|

4. Apiarian activities

<u>Experts opinion summary</u>

- | |
|--|
| <p>Apiarian activities are more detrimental in the following habitat:</p> <ul style="list-style-type: none">- primary and/or critical bear habitat: 2 out of 4 authors;- both high and low quality bear habitat: 1 out of 4 authors;- in open habitat and when in forested habitats, in flatter areas: 1 out of 4 authors. |
|--|

Apiarian activities are of almost no direct problem for bears (Huber).

5. Mining

<u>Experts opinion summary</u>

- | |
|--|
| <p>Mining is more detrimental in the following habitat:</p> <ul style="list-style-type: none">- primary and/or critical bear habitat: 2 out of 5 authors;- both high and low quality bear habitat: 2 out of 5 authors;- in open habitat and when in forested habitats, in flatter areas: 1 out of 5 authors. |
|--|

6. Hunting

<u>Experts opinion summary</u>

Hunting is more detrimental in the following habitat:



- primary and/or critical bear habitat: 2 out of 5 authors;
- both high and low quality bear habitat: 1 out of 5 authors;
- in deep forest: 1 out of 5 authors;
- in open habitat and when in forested habitats, in flatter areas: 1 out of 5 authors.

The deeper in forest hunting is, the worse is (Huber).

7. Tourism/recreation activities (playgrounds, golf-courses, riding-schools, boating, flying, trekking, climbing, etc.)

Experts opinion summary

- Tourism is more detrimental in the following habitat:
- primary and/or critical bear habitat: 2 out of 5 authors;
 - both high and low quality bear habitat: 1 out of 5 authors;
 - in deep forest: 1 out of 5 authors;
 - in open habitat and when in forested habitats, in flatter areas: 1 out of 5 authors.

The deeper in forest tourism/recreation activities occur, the worst is (Huber).

8. Winter recreation activities

Experts opinion summary

- Winter recreation activities is more detrimental in the following habitat:
- primary and/or critical bear habitat: 2 out of 6 authors;
 - both high and low quality bear habitat: 1 out of 6 authors;
 - in deep forest: 1 out of 6 authors;
 - in denning areas: 1 out of 6 authors;
 - in open habitat and when in forested habitats, in flatter areas: 1 out of 6 authors.

The deeper in forest winter recreation activities occur, the worst is (Huber).

9. Skiing areas

Experts opinion summary

- Skiing areas are more detrimental in the following habitat:
- primary and/or critical bear habitat: 2 out of 5 authors;
 - both high and low quality bear habitat: 1 out of 5 authors;
 - in deep forest: 1 out of 5 authors;



- in open habitat and when in forested habitats, in flatter areas: 1 out of 5 authors.

The deeper in forest and close to potential denning areas skiing areas are, the worse it is (Huber).

10. Roads (main and secondary) and railways

Experts opinion summary

- Roads and railways are more detrimental in the following habitat:
- primary and/or critical bear habitat: 2 out of 4 authors;
 - both high and low quality bear habitat: 1 out of 4 authors;
 - in open habitat and when in forested habitats, in flatter areas: 1 out of 4 authors.

11. Forestry roads

Experts opinion summary

- Forestry roads are more detrimental in the following habitat:
- primary and/or critical bear habitat: 3 out of 5 authors;
 - both high and low quality bear habitat: 1 out of 5 authors;
 - in open habitat and when in forested habitats, in flatter areas: 1 out of 5 authors.

Forestry roads are always in the forest, i.e. in the critical habitat (Huber).

12. Human structures and development (resorts, villages, towns, dams, factories, etc.)

Experts opinion summary

- Human structures are more detrimental in the following habitat:
- primary and/or critical bear habitat: 2 out of 5 authors;
 - both high and low quality bear habitat: 1 out of 5 authors;
 - in small habitats, in densely populated areas: 1 out of 5 authors;
 - in open habitat and when in forested habitats, in flatter areas: 1 out of 5 authors.

The smaller the total available area for bears the bigger the effect of each single human structure. The cumulative effect wipes out the bears at a certain point. The remaining parts of unchanged habitat are the most critical (Huber).



13. Garbage/feeding sites (for bears and/or for other wildlife)

Experts opinion summary

Human structures are more detrimental in the following habitat:

- primary and/or critical bear habitat: 2 out of 5 authors;
- both high and low quality bear habitat: 1 out of 5 authors;
- in deep forest: 1 out of 5 authors;
- in open habitat and when in forested habitats, in flatter areas: 1 out of 5 authors.

Garbage/feeding sites are more detrimental in smaller habitats, in densely populated areas and to small bear populations (Huber).

3.5 Does the activity/situation have an influence area? If so, can it be quantified?

Primary rule of thumb is that the more people the more and wider disturbance, but the influence area also depends on the surrounding habitat and surrounding human activities (Katajisto). Therefore the influence area of forestry, agriculture, animal farming/grazing, zootechnical activities, apiarian activities, mining, hunting, tourism/recreation activities, winter recreation activities, skiing areas, roads and railways, forestry roads, human structures and development, garbage/feeding sites vary depending on the season, habitat quality, amount of cover available, availability of natural bear foods, density of bears in the area and level of bear habituation to people (Gunther).

Bears are likely to avoid human activities in relation to the relative human activity in the area, i.e. small source of human activity in an area otherwise undisturbed could be more avoided than that in an area with lots of human activities (Katajisto 2006 quoted by Katajisto).

The direct mortality effect of roads is restricted to their immediate proximity, but their effect of potentially increasing human activity in bear habitats has a larger influence area, that is mostly related to the amount of traffic or type of road (Gibeau *et al.* 2002, Mace *et al.* 1996, Wielgus *et al.* 2002 quoted by Katajisto).

From the most to the least detrimental influence it is possible to order the activities in the following way: hunting (n.6), human structures (12), agriculture (2 and zootechnical, 3), main roads (10), forestry (1, depending on how intensive it is), apiarian activities (4) and garbage (13), mining (5, depending on how intensive it is), skiing areas (9) and forestry roads (11, if harvest is controlled, otherwise they may e.g. increase poaching), tourism (7), winter recreation activities (8) (Katajisto).

Weaver *et al.* (1985) have constructed a "displacement sub-model" in the frame of a CEM (Cumulative Effect Model) in which they have incorporated the components:

- disturbance coefficient;
- zones of influence.



The zone of influence identifies the distance in which brown bears (grizzlies in the case of this study) would be affected by the disturbing activity after having identified 13 human activity groups classified according to the dominant disturbance effect (Mertzanis).

For each group they have assigned high and low level degrees related also to duration within 24 h. These activity groups have been described as follows (Weaver *et al.* 1985 quoted by Mertzanis):

1. Motorized linear: restricted to roads, trails, or linear corridor of travel.
 - High use: for vehicle traffic: 1veh/daylight hour, including recurring low-elevation aircraft use (less than 500 m above-ground) or seismic exploration (without explosives);
 - low use: for vehicle traffic: ≤ 1 veh/daylight hour;
2. motorized point: motorized activities restricted to a specific spot or area such as: drilling operation, timber harvest activities, generator site or resort complex. Here again they have assigned levels of intensity according to timing during a 24h day as follows:
 - diurnal: activities that produce loud equipment noises and occur only during the daylight hours:
 - high intensity: i.e. timber harvest activities, day-use-only resort complex;
 - low intensity: i.e. firewood cutting;
 - 24 hour: activities that produce loud equipment noises during a 24 h operation period: i.e. oil and gas drilling, mine site, resort complex;
3. motorized dispersed: concentrated off-road vehicle activities that are not restricted to roads or trails, but that occur over broad areas. (i.e. overland motorcycle, or over-snow (snow mobiles) etc.);
4. non-motorized linear: non-vehicle use associated with roads or trails, including roads closed to vehicle traffic. High use: > than 3 parties/day. Low use: < than 3 parties/day;
5. non-motorized point: human activities restricted to a certain point or area.
 - Diurnal: i.e. picnic ground or trailhead;
 - 24 Hour: i.e. campground or summer home;
6. non-motorized dispersed: human activities not restricted to a linear corridor or a specific point.
 - High use: > than 1 person/habitat component/day (i.e. concentrated hunting use area);
 - low use: < than 1person/hab comp/day (i.e. area without easy access or without recreation attractions);
7. explosives: activities in which very loud explosions are associated: i.e. road/highway construction.

Then for each activity category they have assigned a zone of influence (ZI) in a radius around the activity/disturbance source for cover and non-cover situations as follows (Mertzanis):

1. motorized linear (high use):
 - ZI (cover/ridge line)=0.8 km,
 - ZI (non-cover/ridge line)=3.2km;
2. motorized linear (low use):
 - ZI (cover/ridge line)=0.8 km,



- ZI (non-cover/ridge line)=3.2km;
- 3. motorized point (diurnal/high intensity):
 - ZI (cover/ridge line)=1.6 km,
 - ZI (non-cover/ridge line)=3.2km;
- 4. motorized point (diurnal/low intensity):
 - ZI (cover/ridge line)=1.6 km,
 - ZI (non-cover/ridge line)=3.2km;
- 5. motorized point (24 hour):
 - ZI (cover/ridge line)=1.6 km,
 - ZI (non-cover/ridge line)=3.2km;
- 6. non motorized linear (high use):
 - ZI (cover)=0.2km,
 - ZI (line of sight)=0.8 km;
- 7. non motorized linear (low use):
 - ZI (cover)=none,
 - ZI (non cover/line of sight)=0.8 km;
- 8. non motorized point (diurnal):
 - ZI(cover)=0.5km,
 - ZI (non cover/line of sight)=0.8 km;
- 9. non motorized point (24h):
 - ZI(cover)=0.5km,
 - ZI (non cover/line of sight)=0.8 km;
- 10. explosives:
 - ZI(cover/ridge line)=1.6km,
 - ZI(non cover/ridge line)=3.2 km.

In this example "cover" was defined as that vegetation structure capable of hiding 90% of a standing adult bear from human sight at a distance ≤ 60 m. (Weaver et al. 1985 quoted by Mertzanis).

1. Forestry

<u>Experts opinion summary</u>
Forestry has an influence area which is: <ul style="list-style-type: none">- variable: 2 out of 3 authors;- 300-500 m circle: 1 out of 3 authors.

Forestry has an influence deriving from: the chain saw, which may be heard in some 500 m circle; the extraction of logs, which disturbs the longitudinal tract in width of some 300 m; the transport on trucks, which disturbs along forest roads (Huber).

2. Agriculture

<u>Experts opinion summary</u>
Agriculture has an influence area which is:



- | |
|--|
| <ul style="list-style-type: none">- variable: 2 out of 3 authors;- minimal: 1 out of 3 authors. |
|--|

Disturbance deriving from agriculture occurs only during the active work, which is always in the daytime, so the direct disturbance is minimal (Huber).

3. Animal farming/grazing, zootechnical activities

<u>Experts opinion summary</u>

Animal farming has an influence area which is:
--

- | |
|---|
| <ul style="list-style-type: none">- variable: 2 out of 2 authors. |
|---|

4. Apiarian activities

<u>Experts opinion summary</u>

Apiarian activities have an influence area which is:
--

- | |
|--|
| <ul style="list-style-type: none">- variable: 2 out of 3 authors;- minimal: 1 out of 3 authors. |
|--|

5. Mining

<u>Experts opinion summary</u>

Mining has an influence area which is:
--

- | |
|---|
| <ul style="list-style-type: none">- variable: 2 out of 2 authors. |
|---|

6. Hunting

<u>Experts opinion summary</u>

Hunting has an influence area which is:

- | |
|---|
| <ul style="list-style-type: none">- variable: 2 out of 3 authors;- as wide as the whole mountain slope and adjacent valleys: 1 out of 3 authors. |
|---|

Hunting influence area depends on the method used. The chase hunt may disturb the whole mountain slope and adjacent valleys (Huber).



7. Tourism/recreation activities (playgrounds, golf-courses, riding-schools, boating, flying, trekking, climbing, etc.)

Experts opinion summary

Tourism has an influence area which is:

- variable: 3 out of 3 authors.

Tourism/recreation activities disturbance area depends on the activity realized. The noise accompanied may increase the area, like engines, loud music, or human voices (Huber).

8. Winter recreation activities

Experts opinion summary

Winter recreation activities have an influence area which is:

- variable: 3 out of 3 authors.

Winter recreation activities disturbance area varies: the noise accompanied may increase the area, like engines, loud music, or human voices (Huber).

9. Skiing areas

Experts opinion summary

Skiing areas have an influence area which is:

- variable: 3 out of 3 authors.

Skiing areas disturbance depends on the activity realized. The noise accompanied may increase the area, like engines, loud music, or human voices (Huber).

10. Roads (main and secondary) and railways

Experts opinion summary

Roads and railways have an influence area which is:

- variable: 2 out of 3 authors;
- 2 km wide (of avoidance): 1 out of 3 authors.

The paved national highways that are high speed (90-110 km/h) and high volume clearly affect the animals more than the other road category, with a 2 km wide area of avoidance (Yri 2006).



11. Forestry roads

Experts opinion summary

Forestry roads have an influence area which is:

- variable: 2 out of 3 authors;
- 500 m circle: 1 out of 3 authors.

The vehicles on the road do make various noise that may be heard up to 500 m (Huber).

12. Human structures and development (resorts, villages, towns, dams, factories, etc.)

Experts opinion summary

Human structures have an influence area which is:

- variable: 3 out of 4 authors;
- > 10 km (of avoidance) for old males and females: 1 out of 4 authors.

Human structures and development disturbance area depends on the facility, but each has an effect beyond the structure itself. The noise and smells accompanied may increase the area, like engines, loud music, or human voices (Huber).

It has been observed that the distance at which bears are potentially disturbed by tourist resorts and villages (which have the same effect) is likely dependent upon age and sex and possibly the previous experience of the individual bear with human (Nellemann *et al.* 2007 quoted by Swenson): areas within 10 km from resorts and settlements have a relatively higher proportion of sub-adults, with an average age of 4.4 years; these areas contain only 8% of the old males (> 7 years) and 26% of all females. The remaining 92% of the old males and 74% of all females are located beyond 10 km from resorts and settlements (Schwartz and Franzmann, 1992; Muller *et al.*, 2004 in Nellemann *et al.* quoted by Swenson). Older male bears appear to be more, or at least just as, sensitive to disturbance than reproductive females (Nellemann *et al.* 2007 quoted by Swenson).

13. Garbage/feeding sites (for bears and/or for other wildlife)

Experts opinion summary

Garbage has an influence area which is:

- variable: 2 out of 3 authors;
- wide as the total range of a bear population: 1 out of 3 authors.



Bears learn quickly where food sources of human origin are and thus garbage and feeding sites may influence the total range of a bear population (Huber).



3.6 Does the activity/situation influence bear behaviour? If so, in which way? With which consequences (long term/short term consequences)?

The influences of the listed activities on bear behaviour can be grouped into the following broad categories (Gunther):

- A. avoidance (Gunther): bears normally avoid human activities, so all human activities affect the space use of bears (dispersal and home range) (Katajisto). Literature review shows that the main influence upon bears behaviour deals with the loss of bears ability to use a certain habitat area where the disturbance factor is present. Disturbance can influence bears habitat use in two ways (Weaver at al 1985 quoted by Mertzanis):
- actual displacement;
 - change in use patterns that reduces the time available for a bear to use an area (Weaver at al 1985 quoted by Mertzanis);
- B. habituation (Gunther);
- C. attraction (Gunther).

1. Forestry

Experts opinion summary

Forestry does influence bear behaviour: 4 out of 4;

causing:

- avoidance: 2 out of 4 authors;
- habituation: 2 out of 4 authors;
- change in habitat use pattern: 2 out of 4 authors;
- displacement of bears: 1 out of 4 authors;

with the following consequences:

- no answer: 8 out of 8 authors.

Forestry can cause avoidance or habituation (Gunther): to some degree bears may get used to such disturbance, but it always causes local temporal displacement (Huber). The consequences can be either long-term or short-term, depending on the habitat type in which forestry occurs (Gunther). Another problem is if it occurs at a wide range simultaneously (Huber).

2. Agriculture

Experts opinion summary

Agriculture does influence bear behaviour: 5 out of 5;

causing:

- attraction: 3 out of 5 authors;
- change in habitat use pattern: 1 out of 5 authors;
- displacement of bears: 1 out of 5 authors;



- avoidance: 1 out of 5 authors;
with the following consequences:
- reduction of abundance of bears: 1 out of 2 authors;
- cost of compensation: 1 out of 2 authors;
- creation of negative image of bears: 1 out of 2 authors.

Agriculture can cause attraction to some crops (Gunther; Huber); these may provide additional food to bears, but they probably have minor importance in their total diet (Huber). The consequences of agriculture are generally long-term due to the severe alteration of the native habitat (Gunther), that causes loss of habitat (Huber). Important is also the damage done to farmers, resulting in costs of compensations and creating the negative image of bears (Huber).

3. Animal farming/grazing, zootechnical activities

Experts opinion summary

- Animal farming does influence bear behaviour: 4 out of 4 authors;
causing:
- attraction for depredation: 2 out of 4 authors;
 - avoidance: 1 out of 4 authors;
 - loss of bear ability to use certain habitats: 1 out of 4 authors;
- with the following consequences:
- removal of the bears that feed on livestock: 2 out of 4 authors;
 - change in habitat use pattern: 2 out of 4 authors;
 - displacement of bears: 1 out of 4 authors.

Animal farming/grazing, zootechnical activities can cause attraction (Gunther; Katajisto) for depredation (Gunther). The consequences can be long-term if bears that prey on livestock are removed in management actions (Gunther).

4. Apiarian activities

Experts opinion summary

- Apiarian activities do influence bear behaviour: 4 out of 4 authors;
causing:
- attraction: 4 out of 4 authors;
- with the following consequences:
- removal of the bears that feed on beehives: 2 out of 3 authors;
 - creation of negative image of bears: 1 out of 3 authors.

Apiarian activities can cause attraction (Gunther; Huber; Katajisto), but honey is of no help in bear total diet (Huber). Most important is the damage done to farmers, thus resulting in costs of compensations and creating the negative image of bears (Huber). Consequences can be long-term if bears that damage apiaries are removed in management actions (Gunther).



5. Mining

Experts opinion summary

- Mining does influence bear behaviour: 3 out of 3 authors;
causing:
- avoidance: 2 out of 3 authors;
 - habituation to disturbance: 1 out of 3 authors;
 - loss of bear ability to use certain habitats: 1 out of 3 authors;
 - use of tailing areas as refuge: 1 out of 3 authors;
- with the following consequences:
- change in habitat use pattern: 1 out of 2 authors;
 - displacement of bears: 1 out of 2 authors;
 - long term consequences: 1 out of 2 authors.

Mining can cause avoidance or habituation; the consequences can be long-term if the area of disturbance or water quality are not rehabilitated after the mining activity is terminated (Gunther); mining may be a serious problem if done extensively in the bear habitat (Huber).

6. Hunting

Experts opinion summary

- Hunting does influence bear behaviour: 4 out of 4 authors;
causing:
- effects on social rank: 2 out of 3 authors;
 - avoidance: 1 out of 3 authors;
 - attraction to carcasses: 1 out of 3 authors;
 - increasing of wariness: 1 out of 3 authors;
- with the following consequences:
- effects on survival of some cohorts: 2 out of 4 authors;
 - long term consequences if they lead to bear mortality: 2 out of 4 authors;
 - short term consequences: 1 out of 4 authors.

Hunting can cause avoidance or attraction (to gut piles, carcasses, or garbage in camps); the consequences are generally short term, but they can be long term if they lead to bear mortality (Gunther): hunt may result in an accidental killing or wounding of a bear (Huber). Some hunters may interpret the sudden encounter with a bear as an attack and may shoot it in what they feel as self defence (Huber). The chase hunt is a major disturbance. It may separate a mother from their cubs (Huber). Hunting may affect the social rank of bears and through that affect their behaviour e.g. the occurrence of infanticide (Swenson 2003 quoted by Katajisto). But the effects of hunting on behaviour are not unambiguous (Swenson 1999 quoted by Katajisto).



7. Tourism/recreation activities (playgrounds, golf-courses, riding-schools, boating, flying, trekking, climbing, etc.)

Experts opinion summary

Tourism activities do influence bear behaviour: 5 out of 5 authors;
causing:

- habituation to humans: 4 out of 5 authors;
- avoidance: 3 out of 5 authors;

with the following consequences:

- removal of habituated bears: 3 out of 4 authors;
- change in habitat use pattern: 1 out of 4 authors.

Tourism/recreation activities can cause avoidance or habituation (Gunther): bears do get used to activities that always take place in the same area (Huber). The activities away from fixed areas (trekking, climbing) may be a major disturbance. This may separate a mother from their cubs and some people may interpret a sudden encounter as an attack (Huber). The consequences can be either short term or long term (Gunther), because habituation could increase the human-bear conflicts (Katajisto). The loss of part of the habitat or its fragmentation is the problem in any case (Huber).

8. Winter recreation activities

Experts opinion summary

Winter recreation activities do influence bear behaviour: 3 out of 3 authors;
causing:

- loss of bear ability to use certain habitat: 1 out of 3 authors;
- avoidance: 1 out of 3 authors;
- habituation to disturbance: 1 out of 3 authors.

with the following consequences:

- displacement of bears: 1 out of 1 authors;
- change in habitat use patterns: 1 out of 1 authors.

Usually it is not possible to evaluate the way these activities influence bear behaviour, because bear hibernate during winter (Gunther). Anyway bears do get used to activities that always take place in the same area. The activities away from fixed areas (cross country) may be a special disturbance. The loss of part of the habitat or its fragmentation is the problem in any case (Huber).

9. Skiing areas

Experts opinion summary

Skiing areas do influence bear behaviour: 2 out of 2 authors;
causing:



- habituation to people: 2 out of 2 authors;
 - food conditioning: 2 out of 2 authors;
 - attraction: 1 out of 2 authors;
- with the following consequences:
- no answers: 8 out of 8 authors.

Usually it is not possible to evaluate the way these activities influence bear behaviour, because bear hibernate during winter (Gunther). The activities away from fixed areas (cross country) may be a special disturbance. It may also separate a mother from their cubs and some people may interpret a sudden encounter as an attack (Huber).

10. Roads (main and secondary) and railways

Experts opinion summary

- Roads and railways do influence bear behaviour: 2 out of 2 authors; causing:
- avoidance: 2 out of 2 authors;
 - attraction: 2 out of 2 authors;
 - habituation to roads: 1 out of 2 authors;
- with the following consequences:
- increase of bear mortality risk: 3 out of 3 authors;
 - displacement from high quality habitats: 1 out of 3 authors;
 - population or home range scale fragmentation: 1 out of 3 authors.

Roads (main and secondary) and railways can cause avoidance or habituation to heavy used roads, attraction as travel corridors to roads with low densities of use; railways may also attract bears if they contain grain spills (Gunther). Avoidance is generally short-term (Gunther), especially for railways. In fact, a grizzly bear foraging along a railroad right-of-way yields to train traffic at the last possible moment and returns soon after the train passed (Jalkotzy pers. observation in Jalkotzy *et al.* 1997 quoted by Gibeau). If roads lead to human-caused mortality the consequences are then long term (Gunther). Some categories of roads seem to have a long term effect: for example, as for the denning site selection, although bears den near the roads with little disturbance (large highways where parking is prohibited and very small roads where the snow is not ploughed in winter), they avoid the three intermediate sizes of roads which are associated with much more disturbance (Elfström *et al.* in press quoted by Swenson).

11. Forestry roads

Experts opinion summary

- Forestry roads do influence bear behaviour: 5 out of 5 authors; causing:



- habituation: 3 out of 5 authors;
 - attraction as travel corridors: 2 out of 5 authors;
 - avoidance: 1 out of 5 authors;
 - food conditioning: 1 out of 5 authors;
- with the following consequences:
- increase of bear mortality rate: 2 out of 4 authors;
 - temporal local displacement: 2 out of 4 authors.

Forestry roads can cause avoidance or habituation to heavy used roads (Gunther): to some degree bears can get used to disturbance on roads (Huber); on the other hand there can be attraction as travel corridors to roads with low densities of use (Gunther and Katajisto). Avoidance is generally short term (Gunther), but the problem is if disturbance occurs at a wide range simultaneously (Huber). If roads lead to human-caused mortality the consequences are long term (Gunther).

12. Human structures and development (resorts, villages, towns, dams, factories, etc.)

Experts opinion summary

- Human structures do influence bear behaviour: 4 out of 4 authors; causing:
- habituation: 3 out of 4 authors;
 - avoidance: 1 out of 4 authors;
 - attraction and food conditioning: 1 out of 4 authors;
- with the following consequences:
- increase of bear mortality rate: 2 out of 3 authors;
 - temporal local displacement: 2 out of 3 authors;
 - loss of ability to use disturbance areas: 1 out of 3 authors.

Human structures and development (resorts, villages, towns, dams, factories, etc.) can cause avoidance, habituation, or attraction (to unsecured human foods or garbage); the consequences of human structures and developments are generally long term (Gunther) and it seems that tourist resorts and villages too have a long term effect (Yri 2006, Nellemann *et al.* 2007, Elfström *et al.* in press quoted by Swenson). Human structures permanently displace bears to the remaining habitat as long as there is some left; in the long term, they may make the existence of bears impossible (Huber).

13. Garbage/feeding sites (for bears and/or for other wildlife)

Experts opinion summary

- Garbage does influence bear behaviour: 4 out of 4 authors; causing:
- attraction: 3 out of 4 authors;



- | |
|---|
| <ul style="list-style-type: none">- habituation to humans and human food sources: 2 out of 4 authors; with the following consequences:- increase of human-bears conflicts and bear mortality rate: 4 out of 4 authors. |
|---|

Garbage/feeding sites (for bears and/or for other wildlife) can cause attraction (Gunther): bears do get used to human sources of food (Huber). Any food that is clearly related to people results in habituation and even nuisance behaviour. In the next stage, such a bear may start doing repeated damages (problem bear). The garbage creates habituation much faster than feeding away from settlements (Huber). The consequences are generally long-term (Gunther).

3.7 How do bears react to the activity/situation?

The reaction of bears to the listed activities and situation can be summarized into the following broad categories (Gunther):

1. avoidance;
2. habituation;
3. attraction.

Following is a more detailed description of the reactions.

1. Forestry

<u>Experts opinion summary</u>

Bears reactions to forestry are:

- | |
|---|
| <ul style="list-style-type: none">- avoidance, even if just temporally: 4 out of 5 authors;- habituation to disturbance: 2 out of 5 authors;- attraction to remains of food of workers: 1 out of 5 authors. |
|---|

Forestry can cause avoidance or habituation (Gunther). Typically bears move away, but do come back as soon as disturbance is over, maybe even in the next night. Occasionally they may be even attracted by some remains of food of workers and/or the oil of chain saws (Huber).

2. Agriculture

<u>Experts opinion summary</u>

Bears reactions to agriculture are:

- | |
|---|
| <ul style="list-style-type: none">- attraction to some crops: 3 out of 4 authors;- avoidance, even if just temporally: 2 out of 4 authors. |
|---|



Agriculture can cause attraction to some crops (Gunther). Typically bears move away during daytime, but do come back in the night. Occasionally they may be attracted by food source (Huber).

3. Animal farming/grazing, zootechnical activities

Experts opinion summary

Bears reaction to animal farming is:

- attraction for depredation: 2 out of 2 authors.

Animal farming/grazing, zootechnical activities can cause attraction for depredation on sheep, cattle, chickens, ducks, and turkeys (Gunther).

4. Apiarian activities

Experts opinion summary

Bears reactions to apiarian activities are:

- attraction: 3 out of 3 authors;
- momentary avoidance: 1 out of 3 authors.

Apiarian activities can cause attraction due to food reward (Gunther). Typically bears move away during daytime, but do come back in the night attracted by food source. The protective measures are effective if applied properly (Huber).

5. Mining

Experts opinion summary

Bears reactions to mining are:

- avoidance: 4 out of 4 authors;
- habituation: 1 out of 4 authors.

Mining can cause avoidance or habituation (Gunther).

6. Hunting

Experts opinion summary

Bears reactions to hunting are:

- avoidance: 2 out of 3 authors;
- attraction to gut piles, carcasses or garbage in camp: 1 out of 3 authors;
- increase of bear wariness: 1 out of 3 authors.



Hunting can cause: avoidance (displacement) (Gunther), with bears typically moving away (Huber); or attraction (to gut piles, carcasses, or garbage in camps) (Gunther). The problem is when a large area is affected at the same time (Huber).

7. Tourism/recreation activities (playgrounds, golf-courses, riding-schools, boating, flying, trekking, climbing, etc.)

Experts opinion summary

Bears reactions to tourism are:

- avoidance: 4 out of 4 authors;
- habituation: 2 out of 4 authors;
- attraction: 1 out of 4 authors.

Tourism/recreation activities (playgrounds, golf-courses, riding-schools, boating, flying, trekking, climbing, etc.) can cause avoidance, habituation, or attraction (due to food reward from unsecured garbage) (Gunther). Typically bears move away. The problem is when a large area is affected at the same time (Huber).

8. Winter recreation activities

Experts opinion summary

Bears reaction to winter recreation activities is:

- avoidance: 1 out of 1 authors.

Winter recreation activities don't usually influence bear behaviour, because bear hibernate during winter (Gunther). But if the disturbance is heard in the den this may be abandoned. Typically bears do not feel safe in the den that was closely approached by people (Huber).

9. Skiing areas

Experts opinion summary

Bears reactions to skiing area are:

- avoidance during spring, summer and fall, switching the den during winter: 1 out of 2 authors;
- attraction to garbage: 1 out of 2 authors;
- habituation: 1 out of 2 authors.

Skiing developments can displace, cause habituation, or attract bears during spring, summer and fall (Gunther). As for winter, some authors haven't documented any disturbance as bears hibernate during winter (Gunther);



whereas others have seen that typically bears change the den if disturbed (Huber). The second den is never as good as the one prepared in fall. Moreover, the maternal disturbed den means the loss of litter (Huber).

10. Roads (main and secondary) and railways

Experts opinion summary

Bears reactions to roads and railways are:

- avoidance: 1 out of 1 author;
- attraction as travel corridors or food spills: 1 out of 1 author;
- habituation: 1 out of 1 author.

Roads (main and secondary) and railways can cause avoidance or habituation to heavy used roads, attraction as travel corridors to roads with low densities of use. Railways may also attract bears if they contain grain spills (Gunther).

11. Forestry roads

Experts opinion summary

Bears reactions to forestry roads are:

- avoidance: 2 out of 2 authors;
- attraction as travel corridors : 2 out of 2 authors;
- habituation: 1 out of 2 authors.

Forestry roads can cause avoidance or habituation to heavy used roads, attraction as travel corridors to roads with low densities of use (Gunther): typically bears move away, but do come back as soon as disturbance is over; occasionally they may use the forest roads for walking (Huber).

12. Human structures and development (resorts, villages, towns, dams, factories, etc.)

Experts opinion summary

Bears reactions to human structures are:

- avoidance: 2 out of 2 authors;
- attraction to garbage: 2 out of 2 authors;
- habituation: 1 out of 2 authors.

Human structures and development (resorts, villages, towns, dams, factories, etc.) can cause avoidance, habituation, or attraction (to unsecured human foods or garbage) (Gunther). Typically bears abandon the area, so the problem is when a large area is affected at the same time (Huber). Certain individuals may



start to look for some food sources in a developed area and that becomes a real problem, both for such a bear (which usually has to be removed) and for the local community (Huber).

13. Garbage/feeding sites (for bears and/or for other wildlife)

<u>Experts opinion summary</u>
Bears reaction to garbage is: - attraction: 2 out of 2 authors.

Garbage/feeding sites (for bears and/or for other wildlife) can cause attraction (Gunther): the bear typically visits such sites on a regular basis and it stops avoiding people (Huber).

3.8 Which management measure can be suggested for each one of the mentioned activities/situations?

1. Forestry

<u>Experts opinion summary</u>
Useful management measures to reduce the impact of forestry are: - planning carefully timing, location and type of cuts, concentrating forestry activities in secondary bear habitat, avoiding important denning areas and mating season: 3 out of 4 authors; - concentrating forestry activities to one area at a time, which must be as small as possible. No activity in the same area for a long time (i.e. 10 years or more): 1 out of 4 authors.

The timing of cuts, location of cuts, type of cuts (size, shape, interspersation of cover, degree of crown closure and age structure of timber cut), species cut, use of buffer zones and leave strips, post harvest treatment and regeneration can all be used not only to reduce the impacts of timber harvest on bears, but in some cases to increase the value of the habitat to bears (Moss and LeFranc 1987 quoted by Gunther). Forestry activities could be concentrated in secondary habitats for bears, avoiding them especially in the mating season (Katajisto) and in winter within important denning areas (Swenson). The forestry operations should be concentrated in one area at a time and they should be as small as possible. The best would be that the activity does not visit the same area for a long time (i.e. 10 years or more) (Huber).



2. Agriculture

Experts opinion summary

- Useful management measures to reduce the impact of agriculture are:
- keeping the fields close to villages and not to extend them further into the bear habitat: 1 out of 4 authors;
 - hazing or aversive conditioning: 1 out of 4 authors;
 - keeping it concentrated in clusters: 1 out of 4 authors;
 - implementation of preventive measures: electric fencing of productive units: 1 out of 4 authors;
 - amendment of the national damage compensation system: 1 out of 4 authors.

Agriculture may change the habitat from vegetal foods used by bears into crops that bears do not consume, or may attract bears if crops planted are consumed by bears. Due to human intolerance, bears that are attracted to agricultural crops are generally killed. Hazing or aversive conditioning may have some value in teaching bears to avoid agricultural areas. However, aversive conditioning is very expensive to do right and may not be a cost-effective method of teaching bears to avoid farming areas (Gunther). Again agriculture should be concentrated in clusters rather than spread all over (Katajisto). The fields should be kept close to villages and not be extended further into bear habitat (Huber). Best practices vary depending on terrain but could include keeping stock away from areas that bears frequently use and using electric fencing. Again, either paying farmers for loss or having them accept some loss may be needed (McLellan).

3. Animal farming/grazing, zootechnical activities

Experts opinion summary

- Useful management measures to reduce the impact of animal farming are:
- effecting protective measure for livestock (like electric fences or guardian dogs etc): 3 out of 5 authors;
 - amendment of the national damage compensation system: 1 out of 5 authors;
 - keeping it concentrated in clusters: 1 out of 5 authors;
 - moving the calves as late as possible to summer grazing allotments because the larger and older the calves are before being moved to summer grazing allotments, the lower the risks of predation by bears: 1 out of 5 authors.

In the Yellowstone Ecosystem, most livestock depredations involve cattle and most depredated cattle are calves (Gunther *et al.* 2004 quoted by Gunther). The timing of when cattle are moved to summer grazing allotments that overlap grizzly bear range has some potential to reduce cattle depredations. The larger and older the calves are before being moved to summer grazing allotments, the



lower the risks of predation by bears is. Sheep are very vulnerable to bear predation (Gunther). It is very important to use effective protective measure to protect livestock from bears in bear areas (Swenson). Electric fencing has the potential to protect sheep from bear predation at night on bed-grounds where most sheep depredations occur. Electric fence can also be used very successfully to reduce or eliminate bear predation on chickens and other poultry (Gunther). Again animal farming/grazing and zootechnical activities should be concentrated in clusters rather than spread all over (Katajisto).

Best practices vary depending on livestock species and terrain but could include the use of guardian dogs, keeping stock away from areas that bears frequently use, putting livestock in safe areas at night, using electric fencing and removing any animal carcass before it can be found by bears and thus teaching bears not to associate livestock with food. Again, either paying farmers for loss or having them accept some loss may be needed (McLellan).

4. Apiarian activities

Experts opinion summary

- Useful management measures to reduce the impact of apiarian activities are:
- effecting protections for beehives, like electric fences: 4 out of 5 authors;
 - keeping beehives close to villages: 1 out of 5 authors;
 - keeping beehives distributed/concentrated in clusters: 1 out of 5 authors;
 - amendment of the national damage compensation system: 1 out of 5 authors.

It is very important to use effect protective measure to protect bees from bears in bear areas (Swenson). Bear damage to beehives is relatively easy to prevent with electric fencing (Gunther *et al.* 2004 quoted by Gunther; Katajisto). In the Yellowstone Ecosystem electric fencing was used to successfully reduce and maintain a very low rate of incidents of bears damaging beehives (Gunther *et al.* 2004 quoted by Gunther). Cost-share programs and other incentives can be used to encourage land owners to install and maintain electric fences around apiaries (Gunther). Moreover these activities should be concentrated in clusters rather than all over (Katajisto) and the beehives should be kept close to villages (Huber).

5. Mining

Experts opinion summary

- Useful management measures to reduce the impact of mining are:
- keeping surface disturbance to an area as small as possible, preventing alteration of the water table, managing human foods and garbage associated with mines in a bear-proof manner and timing mining activities to avoid seasons of biological importance to bears: 1 out of 2 authors;



- avoiding primary bear habitat, maybe building overpasses: 1 out of 2 authors.

Impacts of mining activities can be reduced by avoiding primary habitats (Katajisto), keeping surface disturbance to an area as small as possible, preventing alteration of the water table, managing human foods and garbage associated with mines in a bear-proof manner and timing mining activities to avoid seasons of biological importance to bears (Moss and LeFranc 1987 quoted by Gunther). It may also be useful to build overpasses (Katajisto).

6. Hunting

Experts opinion summary

- Useful management measures to reduce the impact of hunting are:
- intensification of hunters awareness and information: 2 out of 4 authors;
 - creation of new game refuges in relation to important areas for brown bear: 1 out of 4 authors;
 - timing hunting season when bears are denning to reduce humans-bears conflicts: 1 out of 4 authors;
 - no chase hunting and no winter hunting in potential bear denning areas: 1 out of 4 authors.

Big game hunting often results in high levels of human-caused bear mortality, even if bears can not be legally hunted. In the Greater Yellowstone Ecosystem, defence of life kills during surprise encounters account for a significant proportion of total human-caused bear mortality (Gunther *et al.* 2004 quoted by Gunther).

Hunting must be eventually carefully planned because, in such small populations as Brenta, bears could be killed only in life threatening situations (Katajisto). Public education efforts can be used to reduce these types of mortalities by educating hunters about bear behaviour and methods to reduce encounters and defuse confrontations between hunters and bears when they occur (Gunther *et al.* 2004 quoted by Gunther). Use of bear repellent spray can also be promoted to repel aggressive bears in surprise encounter situations (Herrero and Higgins 1998 quoted by Gunther). Educating hunters on proper ways to store food, garbage and game meat can reduce bear-human conflicts at hunters camps. Timing big game hunting seasons to the period when bears are in winter dens will reduce overlap with the period that bears are active and can be very effective at reducing hunter-bear conflicts (Gunther). Anyway there shouldn't be chase hunting in bear habitat and winter hunting in potential bear denning area (Huber).

7. Tourism/recreation activities (playgrounds, golf-courses, riding-schools, boating, flying, trekking, climbing, etc.)

Experts opinion summary



Useful management measures to reduce the impact of tourism are:

- restriction of recreation activities to certain areas and time: 2 out of 4 authors;
- no more construction in bear habitat or new constructions only in low quality bear habitat: 2 out of 4 authors;
- development of recreation activities so that they are unattractive for bears, for example storing food in a bear-proofing manner: 1 out of 4 authors;
- implementation of mitigation measures: 1 out of 4 authors.

Regarding tourism and recreation activities, there shouldn't be any more construction of permanent recreation facilities in bear habitat (Huber). Tourism activities should be done in low quality bear habitat whenever possible (Gunther) and they should be concentrated in clusters rather than spread all over (Katajisto): the recreation activities that does not require permanent structures should be restricted to certain areas (Huber). Developments can be designed to make them unattractive to bears. Generally small dense developments that contain very little cover are less attractive to bears than large spread-out developments that contain a lot of natural vegetation cover. Garbage and human food are usually what attracts bears to tourism activities. Bear-proofing human food and garbage attractants associated with tourism significantly minimize the attraction of bears to these activities (Gunther). Tourism activities can also sometimes be scheduled avoiding important bear habitat on a seasonal basis (Gunther) and also the total number of users per day must be limited (Huber). In Yellowstone National Park recreational activity is seasonally restricted within large areas of important bear habitat (Gunther 1990 quoted by Gunther).

8. Winter recreation activities

Experts opinion summary

Useful management measures to reduce the impact of winter recreation activities are:

- keeping them away from denning areas or areas of early spring green-up or other bear foraging areas: 3 out of 4 authors;
- restriction of such activities to certain areas and time and number of users: 2 out of 4 authors.

Winter recreation activities generally don't have much impact on bears because they hibernate during the winter (Gunther) but it has to be considered that bears quite often choose certain areas as denning areas and dens can be concentrated in one landscape (Swenson). Therefore, it would be good for bears to steer human activity away from these areas (Swenson). Spring snowmobiling can be disruptive to bears if it takes place in denning areas or areas of early spring green-up or other bear foraging areas (Gunther). These activities should also be concentrated in clusters rather than spread all over (Katajisto): the recreation activity that does not require permanent structures should be restricted to certain areas (Huber). There shouldn't be any more construction of



permanent recreation facilities in bear habitat and the total number of users per day must be limited (Huber).

9. Skiing areas

Experts opinion summary

Useful management measure to reduce the impact of skiing areas is:

- restriction to certain areas and time and number of users: 4 out of 4 authors.

Regarding skiing areas, there shouldn't be any more construction of permanent skiing facilities in bear habitat (Huber) or development associated with ski areas should be kept as small and dense as possible (Gunther). These areas should be concentrated in clusters rather than spread all over (Katajisto): the skiing activity that does not require permanent structures should be restricted to certain areas (Huber), limited in extent, so that there are areas for bears to live in (Swenson). It is important to remember that these areas are usually tourist areas when there is no snow (Swenson): ski resorts often also become summer recreation areas (mountain biking, etc.) (Gunther). Summer activities at ski resorts are more likely to impact bears (Gunther). The effects of these activities are greater in flat landscapes (Swenson). The total number of users per day must be limited (Huber).

10. Roads (main and secondary) and railways

Experts opinion summary

Useful management measures to reduce the impact of roads and railways are:

- concentrating them in clusters: 1 out of 4 authors;
- building them at minimum specifications to discourage high use, minimizing clearing widths, lowering cuts and fills, keeping road cuts to the minimum necessary for construction, providing cover as close as possible on both road edges, not constructing road shoulders, allowing 100-500 m buffers between roads and important bear habitat: 1 out of 4 authors;
- jointing projects with neighbouring countries for the conservation of trans-border bear corridors and linkage areas: 1 out of 4 authors;
- closing them when appropriate: 1 out of 4 authors.

To minimize their impact, it can be useful to build roads at minimum specifications to discourage high use, to minimize clearing widths, to low cuts and fills, to keep road cuts at the minimum necessary for construction, to provide cover as close as possible on both road edges, not to construct road shoulders, to allow 100-500 m buffers between roads and important bear habitat (Harting 1987 quoted by Gunther). It may be useful also to build under-



/overpasses but with careful planning (Katajisto). It should also be considered to close roads when appropriate (Swenson).

11. Forestry roads

Experts opinion summary

Useful management measures to reduce the impact of forestry roads are:

- closing them to public, especially the ones in high quality habitat: 5 out of 5 authors;
- halting the construction of new roads in high quality habitat, eventually permitting the construction only in low quality habitat: 1 out of 5 authors.

No new roads should be constructed in the bear habitat (Huber): they should be built in low quality habitat whenever possible (Harting 1987 quoted by Gunther). Seasonal closures of forestry roads (Harting 1987 quoted by Gunther) or closure when appropriate (Swenson) can be used to reduce the impacts of roads that are built in high quality habitat (Harting 1987 quoted by Gunther). Other useful measures are the following: locating roads to avoid riparian areas, ridge tops, saddles and creek bottoms as these areas are important brown bear feeding areas and travel corridors; minimizing the number of miles of roads needed to achieve the objective (Harting 1987 quoted by Gunther). Moreover access to roads for other than forestry purposes should be restricted (Katajisto), that is the forestry roads should be close to public (Huber). Their use should be restricted to one area at a time (Huber): after the timber has been harvested forestry roads should be closed and restored to natural conditions using native plants (Gunther).

12. Human structures and development (resorts, villages, towns, dams, factories, etc.)

Experts opinion summary

Useful management measures to reduce the impact of human structures are:

- avoiding any more constructions in bear habitat and allow new constructions only in low quality habitat and limited in extent: 3 out of 4 authors;
- creating some movement corridors to mitigate the existing constructions: 1 out of 4 authors;
- jointing projects with neighbouring countries for the conservation of trans-border bear corridors and linkage areas: 1 out of 4 authors;
- developing them to make them unattractive for bears, for example storing food in a bear- proofing manner: 1 out of 4 authors.

Regarding human structures and development, there shouldn't be any more construction of permanent structures in bear habitat (Huber): human structures should be built in low quality bear habitat whenever possible (Gunther).



Developments can be designed to make them unattractive to bears. Generally small dense developments that contain very little cover will be less attractive to bears than large spread-out developments that contain a lot of natural vegetation cover. Garbage, human foods, gardens and orchards are usually what attracts bears to human developments. Bear-proofing these attractants will significantly minimize the attraction of human developments to bears (Gunther). These structures and developments should also be limited in extent, so that there are areas for bears to live in. It has to be kept in mind that the effects are greater in flat landscapes (Swenson). The existing structures may be mitigated by leaving or creating some movement corridors around them restricting the human use to limited area around. Namely, for example the forestry operation in aread close to town, villages etc.should be completely finished in one sector (and it should not be too large) before starting operations somewhere else in the same habitat. (Huber).

13. Garbage/feeding sites (for bears and/or for other wildlife)

<u>Experts opinion summary</u>
Useful management measures to reduce the impact of garbage are: <ul style="list-style-type: none">- bear-proof designing for dumpsters and baskets, using also electric fences: 4 out of 4 authors;- keeping garbage next to villages: 1 out of 4 authors.

Garbage dumps can be fenced with electric fence (Gunther; Huber) to prevent bears from obtaining garbage (Gunther). Individual garbage cans and dumpsters can be made of a bear-proof design (Gunther; Huber; Katajisto). No loose garbage in bear range should be tolerated and any feeding of bears should be discouraged (Huber).



Following are management measures suggestions related to what has been discussed and proposed in the frame of the Greek context and namely based on the guidelines included in the **Greek Bear Action Plan**. This Action Plan was the main output of the project **LIFE93NAT/GR/01080** (completed in 1996) (Mertzanis). Management measures suggestions here are related to most of the disturbing activities which are related to three major negative effects upon bears, that is (Mertzanis):

- illegal killing;
- habitat degradation and habitat loss;
- fragmentation of bear range (at local and trans-border level) (Mertzanis).

Table 1: Human activities related to human-caused bear mortality.

<i>Disturbance activities</i>	<i>Immediate measures and actions undertaken/present status</i>	<i>Involved competent authorities and bodies</i>
Agriculture, animal farming, apiarian activities	Implementation of preventive measures: electric fencing of productive units/ <u>done/expanding</u> . Inclusion of this measure for subvention under the new CAP (agro-environmental measures) and national policy / <u>to be adopted shortly</u> Management and installation to be also transferred to local communities and beekeepers co-operatives / <u>done partly</u> .	Ministry of Rural Development and Food (ex Ministry of Agriculture) Forestry services Beekeepers co-operatives NGO's
Agriculture, animal farming, apiarian activities	Amendment of the national damage compensation system/ <u>done</u> current regulations have included: bear damage on beehive boxes, on livestock below a certain quota and on crops/ <u>implemented (remaining quota for small livestock creates conflict problems)</u>	Ministry of Agriculture EL.GA (Organisation for farmer's insurance) NGO's
Animal farming	Intensification of livestock raisers' information through specific pamphlet on compensation measures system/ <u>done and renewed</u> . Breeding and provision of local pure breed of Greek guarding dogs to shepherds for better protection of livestock/ <u>done at pilot scale/ to be subsidized under the new CAP-agro-environmental measures</u>	Ministry of Agriculture Dog breeders and trainers NGO's
Hunting	Intensification of hunters awareness and information through seminars/ <u>done- needs renewal</u>	Regional and local Hunting Associations. NGO's
Hunting	Creation of new game refuges in relation to important areas for brown bear/ <u>done in certain areas</u>	Ministry of Agriculture Forestry Services. NGO's
	Intensification of wardening: Employment and special training of permanent wardening personnel/ <u>pending/dramatic lack of personnel</u>	Ministry of Agriculture Forestry Services.



<i>Disturbance activities</i>	<i>Immediate measures and actions undertaken/<u>present status</u></i>	<i>Involved competent authorities and bodies</i>
Hunting, forestry roads	Seasonal closure of secondary forest road network in periods of absence of forestry works/ <u>adopted at a national level with additional clause in national legislation/ yearly implemented in bear areas.</u>	Ministry of Agriculture Forestry Services
Garbage/feeding sites	Closure of garbage dumps next to villages with priority given to important bear areas / <u>done progressively but still pending and delaying in many municipalities within bear range</u>	Regional authorities Communities



Table 2: Human activities related to bear habitat degradation & habitat loss

<i>Disturbance activities</i>	<i>Immediate future actions undertaken/ present status.</i>	<i>Involved competent authorities and bodies</i>
All categories	Development and implementation, in application of national legislation (L.1650/86), of 3 Specific Environmental Studies in three bear sectors of outstanding importance (Pindos mt., Gramos mt., and Rodopi mts.)/ <u>done</u> For 2 of them (Pindos, Rodopi)/Issue of specific presidential decree in 2002/ <u>Proclamation of these two sectors as protected areas/ establishment of specific management regulations and status taking into account bear conservation needs</u>	Ministry of Environment, Planning and Public Works. Ministry of Agriculture NGO's
Forestry	Concrete proposals concerning specific measures for each important bear area category with reference and emphasis to actual forestry practices and norms of forest management plans/ <u>proposals submitted by scientific committee to Ministry of Agriculture/decision pending</u>	Ministry of Agriculture Forest Research Institute.
Tourism, winter recreation activities, skiing areas, roads and railways, forestry roads, human structures	Concrete guidelines for the incorporation of the environmental component in the initial stage of planning and designing of large scale infrastructure works – Implementation of monitoring programs – implementation of mitigation measures/ <u>done in certain cases and ongoing for the case of Egnatia and E65 highways construction</u>	Regional governments Prefectures Ministry of Environment Ministry of Finances NGO's

Table 3: Bear range fragmentation - shrinkage of linkage areas.

<i>Disturbance activities</i>	<i>Immediate actions undertaken/present status</i>	<i>Involved competent authorities and bodies</i>
Roads and railways, human structures	Joint projects with neighbouring countries for the conservation of trans-border bear corridors and linkage areas/ <u>done in the past with Albania, FYROM and Bulgaria/ ongoing with Bulgaria under PHARE-CBC project</u>	Public authorities Universities NGO's (in the three neighbouring countries: Bulgaria, FYROM, Albania)



Specific researches concerning the effects of human activities towards the species conducted by the authors: references, main objectives and goals of the studies

Gibeau:

Gibeau, M.L., A.P. Clevenger, S. Herrero and J. Wierchowski. 2002. Grizzly bear response to human development and activities in the Bow River watershed, Alberta. *Biological Conservation*. 103:227-236

Gunther:

Gunther, K.A., M.A. Haroldson, K. Frey, S.L. Cain, J. Copeland, and C.C. Schwartz. 2004. Grizzly bear-human conflicts in the Greater Yellowstone Ecosystem, 1992-2000. *Ursus* 15(1):10-22.

Gunther, K.A. 1994. Bear management in Yellowstone National Park, 1960-1993. *International Conference on Bear Research and Management* 9:549-560.

Gunther, K.A. 1994. Visitor impact on grizzly bear activity in Pelican Valley, Yellowstone National Park. *International Conference on Bear Research and Management* 8:73-78.

Gunther, K.A., and H.E. Hoekstra. 1996. Bear-inflicted human injuries in Yellowstone National Park, 1970-1994, a cautionary and instructive guide to who gets hurt and why. *Yellowstone Science* 4(1):2-9.

Gunther, K.A., K. Tonnessen, P. Dratch, and C. Servheen. 2004. Management of habituated grizzly bears in North America: report from a workshop. *Transactions of the 69th North American Wildlife and Natural Resources Conference*.

Gunther, K.A., M.A. Haroldson, K. Frey, S.L. Cain, J. Copeland, and C.C. Schwartz. 2004. Grizzly bear-human conflicts in the Greater Yellowstone ecosystem, 1992-2000. *Ursus* 15:10-22.

Gunther, K.A., M.J. Biel, K.A. Churchill, and R.L. Danforth. 1995. Changing problems in Yellowstone bear management, 23 years after the dumps. Pages 85-110 in A.P. Curlee, A.M. Gillsberg, and D. Casey, editors. *Greater Yellowstone predators: Ecology and conservation in a changing landscape*. Proceedings of the Third Biennial Conference on the Greater Yellowstone Ecosystem. Northern Rockies Conservation Cooperative, Jackson, Wyoming, USA.

Gunther, K.A., and M.J. Biel. 1999. Reducing human-caused black and grizzly bear mortality along roadside corridors in Yellowstone National Park. Pages 25-27 in: G.L. Evinck, P. Garret, and D. Zeigler, editors. *Proceedings of the International Conference on Wildlife Ecology and Transportation*. Florida Department of Transportation, Tallahassee, Florida, USA. FL-ER-73-99.

Schwartz, C.C. and K.A. Gunther. 2006. Grizzly bear management in Yellowstone National Park, the heart of recovery in the Yellowstone Ecosystem. Chapter 5, Pages 232-238 in: D.R. McCullough, K. Kaji, and M. Yamanaka, editors. *Wildlife in Shiretoko and Yellowstone National Parks*. Published by Shiretoko Nature Foundation and the Asahi Shimbun Company.

Gunther, K.A. 1990. Visitor impact on grizzly bear activity in Pelican Valley, Yellowstone National Park. *International Conference on Bear Research and Management* 8:73-78.

Gunther, K.A. 1991. Grizzly bear activity and human-induced modifications in Pelican Valley, Yellowstone National Park. M.S. Thesis, Montana State University, Bozeman, Montana, USA.

Huber:

Kusak, J., Huber, D. 1998. Brown bear habitat quality in Gorski kotar, Croatia. *Ursus* 10: 281-291.

Katajisto:



- Katajisto, J. K. 2006. Habitat use and population dynamics of brown bears (*Ursus arctos*) in Scandinavia. PhD Thesis. Department on biological and environmental sciences. - University of Helsinki, p. 89.
- Katajisto, J., Moilanen, A. and Swenson, J. E. 2007a. Landscape level habitat use by brown bears (*Ursus arctos*) in relation to human distribution in Scandinavia.
- Katajisto, J., Ovaskainen, O. and Swenson, J. E. 2007b. The role of sexually selected infanticide in the reproductive biology of the brown bear. - Submitted manuscript.

Mertzanis:

As a first step and in the frame of the Greek context the monitoring parameters (which also allow a spatial evaluation of their influence) of the disturbance factors have been identified and presented in the following table (after Servheen 1994)



Table 1. The major habitat conditions in relation to disturbance factors that can be monitored for conservation of a bear population (after Servheen 1994).

ECOLOGICAL DISTURB. FACTORS	MEASUR. UNIT	METHOD OF MEASUREMENT	IMPT⁵	INTERVAL	AREA	TARGET⁶
Timber Harvest	Cubic m /unit area ⁷ /year	Annual harvest cut	Mod	Annual	All	No
Road Density	1. Km road/sq. km 2. Km road/unit area	1. Moving window ⁸ or total sq. km divided by total road km's 2. Total km/unit area	High	Seasonal density in impt habitats ⁹	All	Yes, limit road density/unit area
Livestock Grazing	Number of livestock/season/unit area	Reports from shepherds	High	Seasonal	All	No
Human Development	People living/unit area	Village censuses, number of houses built/yr., agricultural production/unit area	High	Annual	All	No
Fire	Hectares burned/yr.	Forester reports	Mod	Annual	All	Low

⁵Importance of monitoring this factor.

⁶The target is the value in a "best case" desired future condition where habitat values would be best for bears. Some factors have no target levels, but some need a value because beyond a certain level of disturbance, bear survival and use of the habitats so disturbed is reduced. Specific target values will vary with habitat, species, topography and human activities. The listed target values are presumed to provide a reasonable level of habitat value for bears in lieu of specific data and are suggested to provide a conservative approach.

⁷Unit area is one of the smaller areas described for measurement of habitat values within the entire range. The size of these units usually has some relationship to the size of an adult female's home range, and it should ideally contain all season habitats for a bear (spring, summer, fall, and denning habitats). A reasonable unit area size may be 50-100 km² unless precise adult female home range size is known. The use of unit areas allows measurement of habitat values in smaller areas so habitat needs are well distributed throughout the range of the species.

⁸Moving window is the term for a computer-based system that calculates the spatial distribution of road density per unit area of habitat. It requires ERDAS software and digital road data. Since the moving window technique it is difficult to implement due to its high technological demands, road density can also be calculated in km of road per unit area by dividing the unit area size by the km of road within it.

⁹Seasonal density of roads is important as bears move between habitats by season. Thus, road density in spring habitats is most important to manage in the spring. Season dates for bears in temperate climates can be generalized as: Spring=March 15-June15; Summer=June 16-August 15; Fall=August 16-November 1. Specific seasonal time periods will vary by habitats and region, and can be specifically learned only through radio-tracking and foods habits data.



ECOLOGICAL DISTURB. FACTORS	MEASUR. UNIT	METHOD OF MEASUREMENT	IMPT⁵	INTERVAL	AREA	TARGET⁶
Water Impoundments	Hectares riparian zone flooded	National engineering offices	Mod	Summary total to date	All	Yes, 0% flooded
Percent Security ¹⁰	Hectares/unit area > 500 m from road	1. Moving window 2. Hand calculation	High	Annual	All	Yes, 40-50% secure/unit area

BEHAVIORAL DISTURB. FACTORS	MEASUR. UNIT	METHOD OF MEASUREMENT	IMPT¹¹	INTERVAL	AREA	TARGET
Vehicle Use	vehicles month, day, hour	Road vehicle counters, highway administration	Mod	Seasonal	All	Not set, limit
Hunting	Hunters unit area, hunting techniques, species hunted, season length, hunter distribution	Interviews with hunters; selected counts of hunters/day	High	Annual	All	Not set
Livestock Presence	Number of livestock/season/unit area	reports from shepherds	High	Seasonal	All	Not set

Furthermore research and studies on relevant topics in Greece are the following:

- During period 2000-2002 a monitoring operation was conducted in Rodopi mountain massif (NE Greece) in the frame of project LIFE99NAT/GR/6498. An instrumented female bear with her 2 cubs of the year was monitored for 2 years. The goal of the operation was to investigate movement patterns and home range of the bear family. Significant differences of the bear family's daily movements appeared in autumn 2000 and notably during weekends. This fact was related to the high hunting pressure occurring in the study area in weekends. Many hunters were present during the weekends, they were organized into groups, used diffuse base camps within the forest as headquarters and conducted drive-hunts as the main hunting practice for wild boars (*Sus scrofa*). This

¹⁰Secure areas are defined as those more than 500 m from areas with motorized vehicle access. Several research studies have shown the importance of security habitat to bear survival and reproduction. Security areas provide habitat free of constant disturbance. Survival of animals within such areas is higher and this is especially important for adult females. Each unit area of habitat within the entire habitat of the species should provide security habitat. The amount of security habitat per unit area may vary, but a reasonable percentage might be 30-40% of each unit area for optimum bear distribution and survival.

¹¹Importance of monitoring this factor.



seemed to be a major factor of disturbance probably causing the bear family to move continuously to avoid human presence. Drive-hunts have been also identified as a serious human caused mortality factor for bears in the study area (MERTZANIS, 1994).
(Full references of the study: MERTZANIS G, ISAAK I, MAVRIDIS Avr., NIKOLAOU Ol., RIEGLER S. , RIEGLER Ar., TRAGOS Ath. (2005): *Movements, activity patterns and home range of the brown bear (Ursus arctos L.) in Rodopi mountain range, Greece. Belg. J. of Zool.,135 (2):217-221*).

- In 2003, a research study was conducted on brown bear habitat selection patterns in the mountain massif of Gramos (Pindos range) using the Discrete Choice Model (DCM). Main goal of this study was to determine the factors (also related to human disturbance i.e. roading, settlements) that define the habitat selection patterns of the bears in the given study area. Bear telemetry data (from 6 instrumented bears) as well as a data set of bear signs of presence and activity were used in the analyses. One of the main conclusions of this study is that optimum bear habitat conditions were identified in habitat units located in lower elevations, with rugged topography and distant from roads and human settlements showing the negative influence of the related human disturbance.

(Full study references: Kylafis G.,2003. *Brown bear (Ursus arctos) habitat selection in the area of Gramos mountain. Bachelor degree thesis, University of Aegean, Faculty of Environmental Sciences, dept of Ecosystems Management, lab. of Biodiversity Management.59 pp*).

- During period 2003-2005 a 2-year monitoring project was implemented in NE Pindos mountain range in order to evaluate the impact upon bear habitat and populations from the construction of a 37km stretch of the via Egnatia highway.

Project structure comprises the following stages:

Stage A – Evaluation of status prior to construction (targeting key species and elements of the natural and human environment)

Stage B1 – adjustment and corroboration of the planned mitigation measures to the results of Stage A.

Stage B2 – Monitoring of key elements & species during highway construction.

Stage C – Monitoring of key elements & species during highway and mitigation measures operation. The main aim is to evaluate and sufficiently adjust (if necessary) construction works and mitigation measures in order to finally achieve:

- population and habitat connectivity for the targeted fauna species (*Ursus arctos*, *Canis lupus*, *Capreolus capreolus*).
- minimization of degradation on forest vegetation and habitat types
- minimization of the overall disturbance of the ecosystem.

The main **research topics were:**

the assessment of the status of the local brown bear and wolf populations, which includes:

- evaluation of habitat use, availability and suitability in relation to the ecological requirements of the aforementioned target species versus the highway alignment
- monitoring and identification of movement patterns of the target species within the study area and specifically versus the highway alignment.
- estimation of the local population sizes
- investigation of the genetic composition and gene flow of the local brown bear population versus the highway alignment.

The major objective of the aforementioned research topics is to identify prior to construction the adequacy and efficiency of the mitigation measures included in the highway alignment.



The final objective of phase (A) was a comparative evaluation of the foreseen effectiveness of the mitigations measures versus the present status and ecological requirements of the target species in the study area.

(The pluri-disciplinary nature of this project encompasses several bodies: 3 NGO's (Arcturos, Hellenic Ornithological Society, Callisto) and four Faculty Departments (Genetics, Ecology, Forestry, Wildlife Management) from two Universities: Aristotle University of Thessaloniki, University of Thessalia. It is co-financed by EGNATIA ODOS SA and the E.C (DG Regio).

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This project has now entered stage B2 (duration 2006-2008): for assessment of disturbance upon bears during construction. In this frame a PhD Thesis is conducted in parallel by student Alexios Giannakopoulos (forester, BSc – University of Aegean) aiming at evaluating more specifically the impact of noise disturbance upon bears during the highway construction phase.

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Chapter 4: Bears habituation

4.1 Can bear get habituated (i.e. become more tolerant) to any disturbance sources (including people)? If so, which are those disturbance sources?

Experts opinion summary

Bear can get habituated to some disturbance sources: 8 out of 8 authors.

Disturbance sources to which bear can get habituated are:

- long lasting, predictable, site related and innocuous disturbances: 7 out of 7 authors.

In order to answer the questions of this section of the study, it is useful to remind certain principles and definitions applied to animal and further on, to bear behaviour (Mertzanis).

In animal behaviour, "habituation" is the third of the three major concepts of learning behaviour theory, the other two being: "conditioning" and "extinction" which have been experimentally evidenced after (McCullough 1982 quoted by Mertzanis).

"Conditioning" is learning involved in receiving a reward or punishment for a given response (behavioural act) to a given stimulus. The animal responds to the stimulus in a trial-and-error fashion: when the behaviour of interest is shown the animal is immediately either rewarded (typically by food) or punished. Therefore conditioning can be either positive or negative. After several repetitions the animal associates a reward or punishment with its behavioural response to the given stimulus and learns to repeat this behaviour if rewarded or (in the opposite) to avoid it if punished. Therefore the behavioural response "learning" is reinforced (Mertzanis).

"Extinction" is the waning of a conditioned response once the reward or punishment process is stopped (Mertzanis).

"Habituation" (a concept similar to "extinction") is the waning of a response (Mertzanis) usually of an animal's flight response (Jope 1985, Herrero *et al.* 2005, Smith *et al.* 2005 quoted by Gunther), when a reward or punishment is discontinued (Mertzanis), that is when a bear is subject to repeated exposure to inconsequential stimulus (Jope 1985, Herrero *et al.* 2005, Smith *et al.* 2005 quoted by Gunther) . It is not the learning or the formation of a "habit" as it sometimes appears in the wildlife literature (Mertzanis).

Typically "habituation" is shown in loss of fear responses. If the stimulus (i.e. food for bears) occurs repeatedly without subsequent punishment the fear response declines (McCullough 1982 quoted by Mertzanis). Therefore in areas where bears and people come into frequent, benign contact and there are few human-caused bear mortalities, bears will habituate to people, many human activities, roads, vehicles, machinery and buildings (Gunther). Bears can habituate to any long lasting and regular source of disturbance (Nevin and Gilbert 2005 quoted by Katajisto), especially small disturbance (Katajisto). Namely, bear may become tolerant to disturbances that are site related like traffic on roads, hiking on certain trails, or skiing on certain slopes (Huber). And



it habituates most quickly to predictable stimuli that have no real effect on the bear (innocuous) (McLellan). Examples include people hiking along fixed trails where they often hike at the same times of days during the same season (McLellan), traffic on roads or skiing on certain slopes (Huber). This means that bear does not run away from such disturbances, but the presence of such source still means the loss and fragmentation of habitat (Huber).

Habituation is adaptive and reduces energy costs by reducing irrelevant behaviour (McCullough 1982, Smith *et al.* 2005 quoted by Gunther). It also allows bears to access and utilize habitat in areas with high levels of human activity (Gunther and Biel 1999, Herrero *et al.* 2005 quoted by Gunther). Habituation is most likely to occur in areas with concentrated, high quality food resources where exposure to humans does not result in painful stimulus or death for the bear (Gunther).

Some of the aforementioned behavioural patterns have been applied to bear behaviour relative to humans (McCullough 1982 quoted by Mertzanis). They can be summarised as follows (Mertzanis):

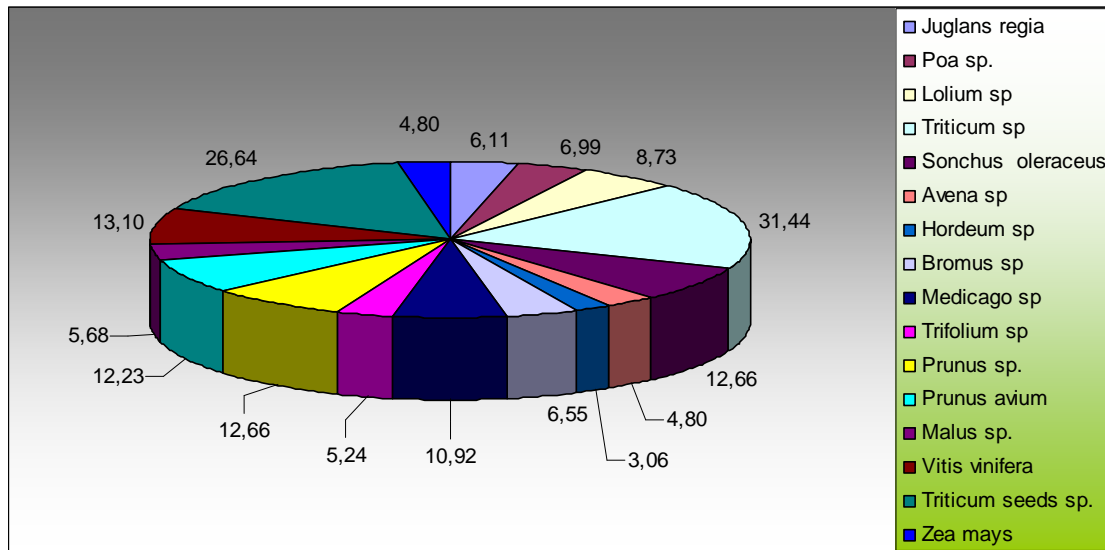
1. bears that detect human food resources and successfully obtain them will be positively conditioned by food reward (Mertzanis). Bears visiting garbage sites are an obvious example of bear habituation (Katajisto), but there are also other similar attractive food sources that bear can habituate to (Gibeau *et al.* 2002, Mattson *et al.* 1992, Wilson *et al.* 2006 quoted by Katajisto). In fact, bears are seen to lose their fear of humans at food sources (garbage sites, salmon streams) (Swenson).
2. Because the stimuli involved in human-related foods are broad (i.e. human scent, human presence, human structures and equipments, etc.) once bears are rewarded by obtaining food they may become conditioned to seek it in response to any of these stimuli even if food per se is not detected (Mertzanis).
3. Even if the reward is discontinued (i.e. the bears do not find food every time) extinction of conditioned behaviour will be slow and infrequent rewards (bear do have access to human related food resources) may perpetuate the behaviour (Mertzanis).
4. Frequent encounters between bears and humans without at least occasional reinforcement of fear in the bear by punishment will habituate bears to humans (Mertzanis).
5. Habituation may also occur in the absence of food if natural patterns of bears bring them into frequent contact with humans (Mertzanis).
6. Development of habituation fosters development of conditioning and vice versa. Commonly they are learned simultaneously (Mertzanis).

The aforementioned patterns must be connected to the ability of bears to learn (Mertzanis). Bears can learn and, as such, become 'habituated'. Some portion of the population can learn to adjust to humans, but not all individuals: some individuals are much more successful around humans than others (Gibeau). Again bears that are used to other bears around them may have different tendency to habituate (Smith *et al.* 2005 quoted by Katajisto).

Bears can make complex evaluations of benefits and risks (McCullough 1982 quoted by Mertzanis). Therefore persistence, a variety of strategies and the absence of "punishment" lead bears to become habituated to humans. Bears



learn also from the experiences of other bears. Young bears most often learn from any association among bears (McCullough 1982 quoted by Mertzanis). Bears are omnivorous and opportunistic and therefore very keen on locating natural and human-related food concentrations. In the European landscape context, natural and human-related food resources (mainly cultivations, livestock and beehives) are in lots of cases spatially interrelated into a complex mosaic. For example in the case of Greece, bear habitat features in the area of north eastern Pindos mountains present these characteristics leading the bears to exploit both (natural and human-related) possibilities. The graphic here below, on bears' feeding habits in the aforementioned area, clearly illustrates the importance of human-related food resources (in terms of cultivations) in the bears diet and thus the bears adaptive behaviour in valorising both sources. It is worth mentioning though that this type of situation and scenario differs from the cases of absolute bear food positive conditioning (i.e. situations of parks with visitors leaving food remains for bears or even trying to feed bears) and subsequent bear habituation with all the inherent risks (Mertzanis).



Bear diet composition in an area of north eastern Pindos mountain range (Greece) with high frequency of human related food resources (cultivations) within bear habitat (Giannakopoulos et al.2006 quoted by Mertzanis).

In the case of the Greek context we could assume that bear are used (and not "habituated") to this configuration of the landscape and to the food possibilities it offers. This leads to the assumption that bears in such areas with continuous and extensive human presence get also "used to" the disturbance caused by the agricultural practices related to this system. Therefore conflict situations (in terms of damage caused on crop or livestock) may occur periodically (seasonally) but they rarely or never take the form of a "habituation". There seems to be a balanced situation between "avoidance" and "opportunism" (Mertzanis). Indeed there is a very thin line (threshold) between opportunism and habituation and it is not always easy to define, keeping also in mind the individualized behaviour in bears: food opportunism can be basically seen as being part of an adaptive pattern/mechanism with purely self-sustaining/survival



functions for the animal(s). There are anyway also some “rules” dealing also with the “fear factor”. In the Greek context foraging on crops is more than a very well defined (spatially and temporally) feeding “habit”. In this very context awareness of human presence is perceived at a certain given level which is more or less invariable (something like part of the landscape). And here the rule in force is “tolerance” provided that safety distances are kept and time rotation (between humans and bears using the same spot) as well. So far field observations as well as telemetry data are supporting this interpretation of facts: bears are active in these fields mainly during night or very early morning hours. The fact that bears *get “used to” the disturbance caused by agricultural practices*, as stated above, implies more the concept of “tolerance” and opportunism” and less the concept of “habituation” sensus stricto.

According to McCullough (1982) a reasonable assumption of negative conditioning of bears towards such a behaviour (habituation) is the long lived impact of hunting (Mertzanis).

In Greece, although bears are totally protected, they still live in areas where hunting has been an ever lasting practice. Many bears have been injured, or poached (usually in a wild boar drive hunt) over time and presumably this negative experience is memorized and transmitted as a negative conditioning versus human presence (Mertzanis).

McCullough (1982) states that mothers and other bears that avoid humans or take alarm foster similar behaviour in young bears. Therefore the role of learning in producing “wildness” in bears and subsequent avoidance of humans should not be underestimated (Mertzanis).

According to the experience, in USA bear habituation seems to be most prevalent in parks and reserves where hunting has been restricted for a long time. In these cases negative (aversive) conditioning has its rules (McCullough 1982 quoted by Mertzanis): as with aversive conditioning, early learning seems to be more effective. Thus young bears or bears recently exhibiting a “habituation” behaviour are the most likely candidates for reversing this behaviour (Mertzanis).

4.2 Which are the consequences of habituation (positive and negative effects)?

Experts opinion summary

Positive consequences of habituation are the following:

- bears can use a greater portion of their range: 7 out of 8 authors;
- it promotes appreciation for bears and eco-tourism, which may in turn favour bear conservation by local people: 2 out of 8 authors;
- it causes an increased survival of some cohorts: 1 out of 8 authors.

Negative consequences of habituation are the following:

- increased mortality risk for bears: 7 out of 7 authors;
- attraction and food conditioning for bears: 1 out of 7 authors.



Habituation has both costs and benefits for both bears and people (Herrero *et al.* 2005 quoted by Gunther).

Benefits to bears:

1. a more balanced situation where long established disturbance factors in the immediate environment do not cause any more the expected negative effects upon bears in terms of displacement, ability to use habitat and subsequent energetic costs of using lower quality habitat. In other words some bears (due to their innate behavioural plasticity) might be or become able with time to live along with a certain level of disturbance provided that this remains constant in all its parameters (intensity, magnitude, spatial occurrence, etc.) and therefore not undergo the negative effects of disturbance as described further above (Mertzanis). Particularly, habituation allows bears to use a greater portion of their habitat (Swenson) so that they can use important habitats in relative close proximity to humans (Gibeau), accessing natural food resources near areas with high levels of human activity (Gunther and Biel, Herrero *et al.* 2005 quoted by Gunther). Habituated bears no longer are displaced from quality habitats near sources of human activity and, in some instances, sub-dominant animals can find foraging opportunities that they may not otherwise (McLellan). In the end, habituation and use of roadside habitat could increase the carrying capacity for bears (Herrero *et al.* 2005 quoted by Gunther).
2. Some bears may habituate to people to avoid encounters with other bears or predators (subordinate cohorts such as subadults and females with cubs are the most likely segment of bear populations to habituate and use areas near human activity centres to avoid interactions with large male bears or other predators) (Herrero *et al.* 2005 quoted by Gunther).
3. Habituation allows bear viewing which in turn may promote appreciation for bears and eco-tourism, which may promote bear conservation by local people (because bears provide financial returns) (Herrero *et al.* 2005 quoted by Gunther and Katajisto). Some authors see this as the only positive effects of habituation of such a large and potentially dangerous animal (Katajisto).

It is positive that bears may accept some types of disturbance as it is a way to cope with possible negative situations. However, people should not understand that this fact means that the source is not harmful at all: usually it means a loss and fragmentation of habitat (Huber).

Costs to bears generally mean an increased probability to be killed (Servheen): the risk of mortality rises when bears interact with humans (Gibeau). Again, it is not that bears cannot live around people, it is people that cannot live around bears (Gibeau). In detail (Gunther):

1. habituated bears using habitat along roadsides or railways are more likely to be injured or killed by vehicles (Herrero *et al.* 2005 quoted by Gunther).
2. Allowing habituation may not be appropriate in areas where hunting is allowed (Herrero *et al.* 2005 quoted by Gunther).
3. In some cases habituation may lead to attraction if it gets associated with some food sources, like garbage (Huber). It is clearly a negative effect (Huber), because habituated bears are more likely to become food



conditioned if human activity is not strictly controlled (Herrero *et al.* 2005 quoted by Gunther): perhaps more often habituated bears are in close enough proximity to people that they find opportunities to become food conditioned (McLellan). Therefore habituation to associate humans to food may be detrimental (Jope 1985 quoted by Katajisto), because bears become aggressive about obtaining human foods or garbage and damage property or injure people in the process (Gunther *et al.* 2004 quoted by Gunther). People may feel threatened by highly habituated bears and thus kill the bears or want the authorities to deal with them (McLellan): food conditioned bears are generally removed due to human safety concerns (Herrero *et al.* 2005 quoted by Gunther), either by the authorities or by the public (Swenson). Especially habituation that associate humans to food may be detrimental (Jope 1985 quoted by Katajisto). In such a scenario, bears are usually losing or lacking fear of humans and this may lead to situations where closer encounters between habituated bears and humans may occur (Mertzanis). Then bears become a more serious risk to people (McLellan) and become so called "problem bears" (Mertzanis). Within the European context this type of behaviour may also lead to an increase of damage to livestock and crops (pattern of "serial" damage). This scenario has happened in Greece in 1994/95 in the case of a sub-adult male problem bear which caused serial damage upon apiaries and livestock on a daily basis for almost 2 consecutive months before being translocated (Mertzanis). Problem bears are usually removed from the population (McLellan).

4. Habituated bears are more likely to be killed illegally (poached) (Gunther).

Benefits to people include:

1. opportunities are provided for viewing and photographing of bears (Herrero *et al.* 2005 quoted by Gunther).
2. Bear viewing provides economic benefits to many areas (Herrero *et al.* 2005 quoted by Gunther).
3. Habituated bears may be less likely to attack people during surprise encounters (Herrero *et al.* 2005 quoted by Gunther).

Costs to people include:

1. more interactions with bears may increase cumulative odds of injury (Herrero *et al.* 2005 quoted by Gunther).
2. Habituated bears in areas with roads may encourage traffic jams and serious collisions (Herrero *et al.* 2005 quoted by Gunther).
3. High cost of managing habituated bears (Gunther).



4.3 Can habituation modify bears behaviour towards disturbance sources? If so, in which way? With which effects?

Experts opinion summary

Habituation can modify bears behaviour towards disturbance sources: 5 out of 5;

in the following ways:

- reducing bears negative responses: 4 out of 5 authors;
- creating attraction: 1 out of 5 authors;

and with the following consequences:

- effects on population dynamics and individuals distribution: 1 out of 2 authors;
- poorer conditions for bears in case of attractive sinks: 1 out of 2 authors.

The answer to this question is partially included in the previous paragraph.

Habituation modifies a bears response to disturbance reducing displacement or avoidance (Herrero *et al.* 2005 quoted by Gunther): habituated bears avoid disturbance less (Katajisto) or they can learn to ignore stimuli (McLellan). For example, if the stimuli are people walking or camping, then the habituated bear will not flee from these situations (McLellan).

Habituation can also reduce human related changes in diel activity patterns and the chances of confrontations between bears and people (Jope 1985 quoted by Gunther). In general, habituation reduces negative responses. This works with all human activities where there is no detrimental impact (Servheen).

In some cases habituation may lead to attraction towards the disturbance source if it gets associated with some food sources, like garbage (Huber). In case of attractive sinks this could lead to poorer condition of those bears, in addition to direct mortality (Katajisto). If different individuals, e.g. females vs. males, habituate differently habituation could also have unexpected effects on population dynamics and distribution of bear individuals (Rode *et al.* 2006 quoted by Katajisto).

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Chapter 5: Bears and cumulative effect

5.1 Is there any arising consequence deriving from the concurrent effects of the factors (human activities and conflict situations) listed above?

Experts opinion summary

The arising consequences deriving from the concurrent effects of the factors listed above are:

- bears extirpation: 2 out of 5 authors;
- the displacement of an increasing number of bears from an area: 1 out of 5 authors;
- increased bear mortality: 1 out of 5 authors;
- alteration of bear home ranges, habitat use patterns, survival, and reproduction: 1 out of 5 authors.

All factors related to human activities do produce a concurrent effect. Probably it is hard to name one single activity (except direct devastation) that has a potential to make the life of bears impossible in certain areas. This is why the combination of effects is of high importance (Huber). There are examples where single effects are seemingly irrelevant (Huber): imagine, for instance, a skiing slope with a countryside hotel and a network of forest roads around. On the forest roads one can often find tracks of a bear walking along and on the skiing slope bears can be seen feeding on berries in summer. But the garbage container of a hotel may be visited by bears that became nuisance, the noises of winter skiing can drive the female bear out of the den causing the death of the cubs, the bikers on the forest road can collide and kill a yearling bear, the road to the hotel can be improved and become a barrier for bears to cross the valley and get to the slope on the other side. In two years, in such a hypothesis, no more bears could be seen in the area... (Huber).

The effects of many human activities going on concurrently can likely be summed into a cumulative effect. A bear is unlikely aware that one man is a forester and cuts down trees, another man is a miner and digs holes in the ground and another one is a hiker wandering along a trail. But as we humans divide our activities into categories, and often discuss one category at a time (i.e. what is the effect of this mine?), we run the risk of saying, for example, "mining is bad for bears but they can tolerate this one if we do it this way", and "houses are bad for bears but this one located here won't have a huge effect on the bear populations", when in reality any one of the activities that we humans categorize may not, by itself, be a huge problem for bears, but all the activities combined over a period of time, or what the bears likely perceive, may be enough to extirpate these animals (McLellan).

In some circumstances, in fact, certain human recreational and extractive resource activities such as hiking, hunting, all terrain vehicle recreation, logging, mining, livestock grazing, roads and human developments may have relatively minor effects on bear home ranges, diel activity patterns, food resources and denning habitat when measured individually. However, the synergistic or cumulative effect of several of these activities occurring simultaneously may be



significant and alter bear home ranges, habitat use patterns, survival and reproduction (Christensen 1986 quoted by Gunther).

That is why broad-scale land-use planning is necessary to give guidance to where and to what level human activities can occur and where they cannot occur. Plans will be changed, but at least there is the basis for cumulative effects planning and trade-offs among users and areas (McLellan).

Picking up on the notion that, among bears, different individuals have different tolerance levels for human activity, there is a point where with each additional human activity more and more bears are displaced from a given area. Each individual bear has a different threshold level however. It was thought that it is possible to characterize a bear population with different disturbance coefficients for all kinds of human activity. By adding up the disturbance levels of all the various activities we would have the net effect on the bear population. That methodology was called the CEM (Cumulative Effect Model) in the United States or habitat effectiveness in Canada (Gibeau).

5.2 How can we evaluate cumulative effect on bear?

Experts opinion summary

Cumulative effect on bear can be evaluated:

- with multivariate statistics, like the CEM (Cumulative Effect Model): 4 out of 5 authors;
- through the concept of "security": 1 out of 5 authors;
- through expert opinions: 1 out of 5 authors.

Cumulative effects can be evaluated in different ways (McLellan):

- through empirical ways (McLellan): with studies that take multiple factors into account at same time, e.g. with multivariate statistics (Katajisto);
- through expert opinion or a combination of both (McLellan).

Cumulative effects can be empirically measured by indexing bear abundance over a large area that covers many human activities and accumulations of these. Assuming that general conditions have remained the same (in particular human attitudes), then it should be possible to extrapolate results as long as conditions and levels of effects are similar. Of course, it is not possible to empirically evaluate a combination of activities or levels of activities that have not happened before; extrapolation would be dangerous in these cases (McLellan).

Most cumulative effects evaluations have been based on expert opinion, sometimes using a Delphic process and incorporated into a SEMP (spatially explicit population dynamics model) with levels of confidence for each relationship assigned based on the Delphic results or the amount of empirical evidence that exists. Such models may be used for predictions, but they are also useful for communication and discussion of complex relationships, sensitivity testing of parameters and highlighting areas of greatest uncertainty where future research is needed. There are several GIS based "event simulators" that can serve as the base for these models (McLellan).



A literature review shows that for the evaluation of cumulative effect of human disturbance upon bears the use of Cumulative Effect Models (CEM) were a frequently used tool (Mertzanis).

These types of models evaluate changes in quality of habitat for brown bears as a result of habitat modification and the reduction in the effectiveness of that habitat as a result of disturbance and mortality (related to human activities) (Suring *et al.* 1998 quoted by Mertzanis). The potential cumulative effects of human activities on bears can be modelled by combining matrices of coefficients representing bear food or habitat quality, human disturbance or displacement, and human-caused mortality to map polygons representing habitat productivity and human activities that reduce habitat effectiveness or lead to human-caused bear mortality (Weaver *et al.* 1986 quoted by Gunther). Cumulative effects models are an analytical tool to evaluate the effects of human actions on brown bear habitat (Gunther). The interaction of habitat quality (vegetation, food availability, food quality, efficiency of foraging) and human activities determines the effectiveness of habitat (Weaver *et al.* 1986 quoted by Gunther).

There are several methods to build CEM. The one proposed by Weaver *et al.* 1986 uses three sub-models:

- habitat sub-model (Weaver *et al.* 1986 quoted by Gunther): it evaluates changes in quality of bear habitat as a result of habitat modification (Suring *et al.* 1998 quoted by Gunther);
- displacement sub-model: it takes into account and quantifies disturbance in terms of disturbance coefficient and zone of influence (Weaver *et al.* 1986 quoted by Gunther);
- mortality sub-model (Weaver *et al.* 1986 quoted by Gunther): it considers the reduction in the effectiveness of that habitat as a result of disturbance and mortality (mortality sub-model) (Suring *et al.* 1998 quoted by Gunther).

Such a model seems to be well adapted to an eventual methodological approach of the bear disturbance problem within the European context (Weaver *et al.* 1986 quoted by Mertzanis).

In general CEM will enhance decision making process for land and resource managers in several ways. It provides the manager with quantified and graphic representation of the effective habitat values and the mortality risks for an existing given situation (Mertzanis).

The CEM should also enable managers to discriminate which land use is contributing most to the simulated effects (sensitivity) and whether it influences habitat, habitat use and/or survivorship of bears. This can be done in space and through time and at different planning levels (Weaver *et al.* 1986 quoted by Mertzanis).

The effectiveness method (CEM) mentioned above was used in the 1980's and 1990's but is no longer used by most jurisdictions (Gibeau *et al.* 2001 quoted by Gibeau). Almost all jurisdictions now use the concept of security (Gibeau). A secure habitat is an area where an adult female grizzly bear can meet her daily foraging needs with a low probability of disturbance by people (Gibeau *et al.* 2001 quoted by Gibeau). Mattson *et al.* (1992) found that grizzly bears with access to secure habitat maintained desirable wary behaviour, had low probabilities of becoming habituated or food-conditioned and had significantly less mortality than did non-wary adult females (Gibeau *et al.* 2001 quoted by Gibeau). Resource selection indices from sample of radiocollared individuals



substantiated that adult female grizzly bears selected security areas, or at least avoided areas that were not secure. Security area analysis now provides managers with a measure of the human encounter rate for adult female grizzly bears at a much more refined scale than the habitat effectiveness model. Security areas help reduce the number of habituated bears, bears killed out of self-defence and bears killed by management agencies because of unacceptable behaviour. Management agencies in southern Canada now realize that grizzly bears require special consideration to maintain healthy populations. Many management options have been evaluated in the United States and need only to be applied and refined in southern Canada. Much of this experience can be summarized, arguably, into management of human access (IGBC 1998 in Gibeau *et al.* 2001 quoted by Gibeau). The need to control human access has been acknowledged in Banff National Park, although the mechanisms for doing so are not fully apparent. Strict control of human access has been achieved through seasonal area and/or trail closures, day use and partly size restrictions, and limiting travel to mid-day only. For example, in Yellowstone's Pelican Valley bear management area, the "area is closed April 1 through July 3. From July 4 through November 10, the area is open to day-use only between the hours of 9 a.m. and 7 p.m." (Gunther 1998:3 in Gibeau *et al.* 2001 quoted by Gibeau). The explicit acknowledgment to manage areas for grizzly bear security has been key to management success (National Parks Service 1982 in Gibeau *et al.* 2001 quoted by Gibeau). To facilitate use by bears, these security areas of no or low human use should remain in place for at least 10 years (IGBC 1998 in Gibeau *et al.* 2001 quoted by Gibeau). However, given the long life span of grizzly bears, this duration must be measured in generations and not merely in calendar years. The National Parks alone can not sustain a regional grizzly bear population. Some of the best chances for grizzly bear persistence come from outside National Parks (McLellan *et al.* 1999 in Gibeau *et al.* 2001 quoted by Gibeau), and hence a cooperative and coordinated management approach is critical. There is a clear need for complementary management guidelines that provide security for grizzly bears as they cross jurisdictional boundaries (Gibeau *et al.* 2001 quoted by Gibeau).

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Final comments and literature

Final comments

One author says that much of present enquire focused on the physical factors that influence bears but an entire body of knowledge, that maybe is even more important than biological or technical details, is missing. This area of knowledge has more to do with the expectations, perspectives and tolerances of people than anything to do with bears. "*Since 'discovering' this body of knowledge for myself a number of years ago and applying it to the Canadian National Parks I can say that I have become much more effective in bear conservation than I ever was as simply a biologist*" (Gibeau).

Here are a couple of references:

- *Tim Clark et al. 2005. Coexisting with large carnivores. Island Press 290 pp.*
- *Endangered Species Update Volume 19 No. 4 An interdisciplinary approach to endangered species recovery. University of Michigan. (this is available online)* (Gibeau).

Bears are highly intelligent, very adaptable, omnivore generalists, that readily learn from past experiences. Bears generally require large home ranges to obtain their daily, seasonal and annual nutritional needs. However, in areas with abundant, high quality, calorically dense foods, bears can obtain all their daily needs in much smaller areas. Bears are highly evolved animals that have both genetic and culturally inherited or learned abilities to utilize resources within their home ranges and cope with environmental change (even human-caused changes) (Jonkel 1980 quoted by Gunther). Some bears are aggressive or bold, others shy and reclusive. Aggressive bears generally don't live long in areas with high densities of people, but are very successful in rugged, remote terrain, with low densities of people. Some bears will avoid areas of human disturbance completely, others will change diel activity patterns to avoid disturbance. Some bears will simply habituate to human disturbance. The biggest factor that influences bears ability to cope with human disturbance is human-caused mortality. Since bears have low reproductive rates and generally have low population densities, they are very vulnerable to excessive human-caused mortality. If human-caused mortality is very low, bears can adapt to a high level of disturbance. If human-caused mortality is high, it is unlikely that bears will be able to adapt to human disturbances because they will die before they can habituate. It is important to predetermine the consequences of land use impacts on bear habitat and work to mitigate the negative impacts through modifications in location and timing of human activities whenever possible, especially those practices that lead to excessive human-caused mortality (Jonkel 1980 quoted by Gunther).

1. About disturbance on bears.

All of this is about the bear habitat size and quality. No bears can live without a proper habitat. The amount of the disturbance is one of the key elements of the



habitat quality. Disturbance itself is regularly followed by various amount of permanent infrastructure in the habitat. These together define the chances of a bear population survival (Huber).

2. About the questionnaire

There are a number of questions that are similar, i.e. the same answers are valid for more than one question. Therefore the use of questionnaire should not look at each answer independently. The whole issue is complex and interconnected (Huber).

We have covered most aspects relating bear conservation to human activities. A simplified model of the relationship is that the number of bears in an area will depend on:

1. habitat quality, or simply bear food abundance and quality. This factor can be modified by people in many ways but most often over greatest areas by forestry and grazing. Agriculture can also increase bear food abundance (but this must be linked to the following two points) (McLellan);
2. the number of people or average human density in an area. This could be measured as people/hour/km² and influences displacement and the number of bears killed by people (McLellan);
3. the behaviour of these people towards bears or how apt they are to behave in such a way that the bear will be killed by the person (McLellan).

If any of these variables can be modified, it can help or hinder bear conservation. There are other issues when dealing with small populations such as population fragmentation but these three points will be major factors with small as well as large populations (McLellan).



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