Integrated ESIA Greece
Annex 6.5.2 - West - Bear Baseline Study
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1 INTRODUCTION

1.1 General Information on Ursus Arctos in Greece and the Balkans

1.1.1 Distribution

The brown bear (Ursus arctos) range in Greece consists of two distinct nuclei located in Pindos mountain range (NW Greece) and Rodopi mountain complex (NE Greece) (Mertzanis 1992, 1994, 2006, Mertzanis et al. 1996 – LIFE-Nature “Arctos” project). The total area of continuous bear range and permanent bear presence has extended from 8,600 km$^2$ to 13,500 km$^2$ (MEECC, 2007, Figure 1-1). The Pindos population nucleus encompasses two regional population units: one located in the extreme NW, including the area under the present study, being also contiguous along the international borders between Greece, Albania and FYROM. This population unit includes Gramos, Voio, and Alevitsa, Mali-Madi and Triklari Mts as well as Peristeri mountain range. The second population unit - larger in number - resides in the parts of Pindos mountain range, encompassing large continuous mountain massifs in the regions of Epirus, W. Macedonia, Thessaly and recently Sterea Ellada (Mertzanis, 2002). During the last 10-15 years, brown bear population in Pindos is exhibiting a clear trend of range expansion and re-colonization of the species former range towards either eastern and more distant mountain massifs (such as Mt. Olympus), in more southern parts of the Pindos range reaching far below the 39th parallel and finally on other detached (from Pindos Mt. range) massifs such as Voras mountain massif.

Following this trend, small bear meta-populations have been established in different parts of former bear range such as: Voras mountain, from Agrafo mountain complex southwards to Oreini Nafpaktia, as well as in the area of Andixasia where linkage area conditions have been playing favourable to a bear re-colonization attempt of Mt. Olympus.

According to main geological and vegetation features the bear distribution range in Greece could be defined through three different “units”:

- Unit I: The Rhodope mountain complex (eastern distribution nucleus) which consists of a vast granite mountain complex covered with large forests. Lower elevations are covered by oak forests (Quercus conferta, Quercus cerris, Quercus petraea, Quercus macedonica, Quercus sp.), which, at higher elevations are progressively substituted by firs, (Abies borisii regis, Abies alba), beeches (Fagus sylvatica, Fagus orientalis, Fagus moesiaca), scots pines (Pinus sylvestris), birches (Betula verucosa) and spruces (Picea abies). Altitudes range approximately from 700 m to 1900 m.
Unit II: The Peristeri range (western distribution nucleus – includes the Project area) which consists of alpine meadows, large beech (*Fagion hellenicum*) forests between 1200 m and 2100 m, and oak forests (*Quercus conferta*, *Quercus cerris*, *Quercus petraea*, *Quercus trojana*, *Quercus sp.*) on lower altitudes, all covering mostly granite soils (Debazac & Mavromatis 1971, Quezel 1967). In this unit the absence of coniferous forests is characteristic.

Unit III: Large parts of northern and central Pindus range (western distribution nucleus), including: Gramos, Timfi, Smolikas, Lyngos, Triggia, Avgo and Koziakas mountains as well as the valleys of Aliakmon, Sarantaporos, Aoos and Acheloos rivers. Vegetation types consist at higher altitudes of alpine meadows, large black pine forests (*Pinus nigra ssp. Pallasiana*), large fir forests (*Abies borisii regis*), beech forests (*Fagus sylvatica*) as well as mixed forests with black pine (*Pinus nigra*), fir (*Abies borisii regis*), beech (*Fagus sylvatica*) and white pine (*Pinus heldreichii*) covering mostly limestone and ophiolitic soils. On lower altitudes the vegetation zones of Quercion-frainetto and Ostryo-Carpinion are present in a wide extent. A characteristic vegetation succession feature in this unit is that from certain latitude, black pine forests are substituted by fir forests.

Over the Balkan region 2 geographically differentiated populations can be distinguished. The Balkan distribution of brown bear is presented in *Figure 1-2*:

- **The Dinara-Pindos bears Population** which extends from the Alps on the border of southern Austria and northern Slovenia, through Slovenia, Croatia, Bosnia & Herzegovina, eastern Serbia, Montenegro, Albania, FYR Macedonia and northern Greece.

- **The Balkan-Rodopi bears population** in which we recognize two subpopulation units: the Rila-Rhodope population and the Stara Planina population. Rila-Rhodope population is located on the border between south-western Bulgaria and north-eastern Greece. It includes the three population segments in the Bulgarian Rila Mountains and Pirin Mountains and the population segment in the western Rhodope Mountains on both sides of the national borders between Bulgaria and Greece. Of the total population estimated at approx. 520 bears, only 25-40 are estimated to be found in Greece. The connection between the bears in Greece and Bulgaria is likely to consist of dispersing males from Bulgaria, as well as of family groups seasonally dispersing from Greece into Bulgaria. The Stara Planina population is located from the Kotlenska Mountains in the east to Zlatitsa-Teteven in the West, along 120 km of the Stara Planina mountain range (Balkan Range). The western end stretches into Serbia and a few bears are shared over the border.
Figure 1-1 Brown bear (*Ursus arctos*) distribution in Greece

Source: MEECC-EKBY 2007
1.1.2 Genetic and Demographic Structure

In the Pindos range, bear population is characterized as stable with locally positive trends and re-colonization trends of former range (MEECC-EKBY, 2007).

Two overall population size estimations, based on two different methods, are available for bears in Greece:

- Estimation of the total number of females with cubs of the year (FWCY). The total number of detected FWCY of a given area represents the 10-12% of the total minimum population of the surveyed same area (Bunell & Tait, 1981). Based on yearly spring field surveys to detect presence (tracks and signs) of FWCY the minimum brown bear population size in Greece has been estimated at 190-260 individuals. (Mertzanis et al., Red Data Book 2009).

- Population estimation based on non-invasive genetic sampling. This protocol has given a point estimation of the bear population in Greece at 410 individuals (Karamanlidis, 2011).
Hence, low rates of genetic variability have been detected in the NE Pindos region (Grevena-Andixasia) (Scouras & Drosopoulou 2005). However the existing data on the minimum bear population size in the wider Project area has been estimated at 141 individuals (Karamanlidis, 2011).

The Dinara-Pindos bear population as a whole is considered as stable with steady growth in Slovenia and Croatia, a marked drop in Bosnia and Herzegovina in 1990s due to war situation, and probably stable or slight decrease in the south of the Dinarics. The entire population size estimate is based on weak supportive evidence. In countries with bear hunting there might be the political tendency to overestimate in order to justify higher quotas. The forested areas in these countries are less contiguous than in the Carpathian area, separating to some degree the functional habitat into more or less isolated sub areas, although there are corridors. Currently the fine scale knowledge is not sufficient to determine if this population should be divided into smaller units or not (Linnell et al. 2007).

Little is known about genetic structure of Balkan-Rodopi bear population. The connections between subpopulations were recently proven, and may be the sign of recolonisation. In the early eighties Carpathian bears were released in Rhodope and Stara Planina Mountains. The numbers are not known since there is restricted access to this data (Linnell et al. 2007).

1.1.3 Connectivity

Dinara-Pindos bear population: in Slovenia in the north this population is close to the one living in the Alps and to bears in central Austria. There is not a continuous distribution of female bears with the Alps, but there is movement of male bears. In Greece the nearest population is the Rila-Rhodope population along the border of Greece and Bulgaria, but there is no evidence of connection (Linnell et al. 2007).

Balkan-Rodopi bear population: Rhodope population is near the Dinaira – Pindos population but there is no demonstrated connection. To the north of the Stara-Planina population there is a potential, but unproven, connection to the Carpathian population. The Stara Planina population was believed to be totally isolated from the populations to the south and west but there is recent evidence of bears in the corridors to the south towards Rila-Rhodopean Mountains, including family groups (Linnell et al. 2007).
Inside the western nucleus of bear range in Greece, a connectivity area (linkage area) of crucial bio-geographic importance between bear subpopulations of unit I and unit II is located in the area of Kastoria nearby the Greek-Albanian border (in the terminal sector of the TAP alignment). This linkage area is also functioning as a trans-border connectivity zone between Greece and Albania. Other intra-range connectivity areas are located between N. and S. Pindos (at the latitude of Metsovo), in Andixasia mouts. Functioning as a re-colonization route to sectors located eastwards (i.e. Mt. Olympus) (Mertzanis et al. 1996 – LIFE93NAT/GR/001080 project). It is worth mentioning that the connectivity areas are seriously compromised by the newly constructed or under construction transportation network comprising new highways and railway lines. Namely the critical linkage area near the border area of Kastoria to Albania, will be also bisected by the terminal stretch of the Egnatia highway vertical axe “Kastoria-Krystallopigi”.

1.1.4 Main Bear Habitat Features and Food Habits in Greece

Main features of bear habitat in Greece are large remote mountainous forests characterized by mixed coniferous and hardwood vegetation with openings and rich undergrowth of fruit bushes and grass, rugged topography and rocky parts. Within the known species range, landscapes with agro-pastoral features are also part of brown bear habitat in Greece. Bear habitat is primarily forested (72%). The most forested areas are in Rhodope (83.4%). Continuous forests with canopy cover exceeding 70% and covering over half the area of the forest complexes exist in about 2/3 of the Rhodope area and in about 1/3 of the western distribution nucleus (Pindos range). The main four habitat units (according to phytosociological criteria) can be briefly described as follows:

- **Quercetalia pubescentis** (Oak forests, including European habitat types 9250 & 9280). It covers 50% of the forests throughout the bear habitat. This zone is composed mainly by pure or mixed oak forests with *Fagus sp.*, *Castanea vasca*, *Acer platanoides*, *Pinus nigra*, *Carpinus orientalis* and *Fraxinus ornus*. In the western sector (Peristeri, Pindos) the pure form is dominant, in particular in Peristeri, while in the eastern sector the pure and mixed stands are in about equal proportions. They are mainly coppice forests with low productivity rate.

- **Pinetalia nigrae** (Black pine forests- European habitat type 9530*). The black pine (*Pinus nigra v. pallasiana*) appears in the geographical area of the beech and the fir but also in the area of the oak. The black pine forests show a dependence on the geological substratum. In Northern Greece these forests appear on serpentine and limestone. The black pine forests cover 19% of the forested areas up to 91% in most favourable conditions. The black
pine forms usually pure stands but also mixed with fir, beech and oaks. The stands have closed canopy, and show a high productivity rate.

- **Fagetalia** (Beech - Fir forests, including European habitat types 9110, 9130 & 9150). This zone represents 30% of the forested area and is composed mainly by beech forests. In Rhodope, and even more in Peristeri range, beech is found in pure stands while in Pindus about 43% of the beech forest is mixed with fir, black pine, oak, maple and Balkan pine (*A. borissii-regis*, *Pinus nigra*, *Quercus sp.*, *Acer sp.* and *Pinus leucodermis*). The pine forests are 30% mixed mainly with beech and oaks. This zone is characterised by forests with high productivity rate.

- **Vaccinio - Picetalia** (Spruce and Scots pine forests, European habitat type 9410). Here belong 6% of the forests, of which 81% is located in Rhodopi sector and is composed of spruce, scots pine and birch forests. This zone is totally absent from Pindos where it is very locally represented by the Balkan pine, which forms mainly pure stands. On the contrary, in Rhodope the mixed stands formed by the above species prevail, in combinations with beech and, in lower percentage, oaks. These forests are characterized by closed canopy and are relatively continuous, particularly in Rhodope, presenting the highest productivity rate in Greece. In particular with regard to the spruce, the standing volume ranges from 246 m³/ha at the worst sites to 1,160 m³/ha at the best.

The main habitat features for the species as described above include also the following European habitat types: 9180*, 91E0*, 9250, 9260, 9270, 9560*, 91F0 and 7230.

A comparative analysis between the three sectors of the bear range in Greece, show that the global bear diet is dominated by food items of plant origin: 93% and 89% for the western nucleus, and 88% for the eastern nucleus. Fleshy and dry fruits compose the major proportion of the vegetable part in bear diet. Animal material mostly composed by insects (especially ants), reptiles (*Testudo sp.*) and livestock carcasses (and other species to be identified) completes the rest of the diet with 7%, 11%, and 12% respectively. Up to 30 plant and animal species were identified in the bear’s diet meeting the species nutritional needs.

1.1.5 Reproduction Biology and Social Structure

Sexual maturity comes at the age of 4 –5 years. The female gives birth every 2-3 years in mid-winter. Average litter size is 1.8-2.2 cubs. Cases of 3 cubs in one litter as well as one case of 4 cubs in a litter have been registered. First telemetry data have shown that the female separates from yearlings after they are at least one year old. Telemetry studies showed that duration of
hibernation of a female with yearlings was 95 days (in Rhodope nucleus) (Mertzanis et al. 2005) and an average hibernation duration period of 84 days (Kanellopoulos et al. 2006).

Bears are solitary and elusive animals. Males and females meet only during mating season: from May to late July. The family group, composed always by the female and the cubs, forms a strong nucleus that usually splits after 2 years’ time. Telemetry data from a radio-tagged adult female bear in Rhodope showed that family separation occurred 19 months after cubs’ birth.

1.1.6 Activity, Spatial Behaviour and Habitat Use

Previous studies (2000-02) in part of the Project area (in Prefecture of Kastoria) using telemetry in six different individuals showed that bear activity period ranged from nine to ten months annually and that during the winter period a clear decline of activity level due to hibernation was recorded. Data on home range surface showed a notable variation between male adult individuals (values ranged from 102 km² to 507 km²) and between seasons: from 48.6 km² in summer to 314.2 km² in autumn.

A considerable degree of home range overlapping is observed between all 6 bear specimens of the sample. Home range (HR) overlapping seems to result from the relatively large home ranges of the adult males and appears to be a common feature in other bear populations in Europe and even in the cases of restocked populations like in Adamello-Brenta Alps, Italy, suggesting that food abundance in the study area should not be a limiting factor (Preatoni et al., 2005).

Clustering of radiolocations in bear home ranges indicated core areas of selective use. Concentrations of radiolocations for adult males showed intensive use of around 15% of the total home range extent.

Almost all the scope of the altitudinal range available in the study area was used by all five male bears of the sample. Significant use of the altitudinal zone between 900 and 1500 m was a common habitat use pattern for all five male bears with concentration of radiolocations in this altitudinal zone ranging from 77% to 90%.

The area consisted mainly of low productivity forested areas (51%) with chestnut (Castanea sativa) and oak (Quercus spp.) as dominant species forming mixed and pure stands. The summer home range included agroforestry areas (31%) and cultivated lands (18%) as well. The female individual moved within altitudes between 800 and 1200 m. Summer habitat use was proportionate to the availability of habitat types (X²= 2178, df=2, p=0.05).
Habitat use of the studied brown bear sample was not proportional in all cases to the availability of the different habitat types in the study area, but appeared to be selective. Mixed agro-forestry habitats (MAG) were the habitat type mostly used by the sampled bears. This type was used by all five male bears, of which three individuals showed a clear preference and two used it at the expected rate. The preference for this habitat was more pronounced during the end of summer and the beginning of autumn (Kanellopoulos 2002).

1.1.7 Denning Sites and Main Features

The denning sites have to fulfil certain physiographic criteria but also some specific features and characteristics related to low disturbance levels in order to be selected by bears and used for several years (Camarra 1987). Denning sites are usually located in remote inaccessible areas, with forest or subalpine vegetation in mature stands of conifers or deciduous forest species. Altitudes of recorded bear dens locations in Greece range from 1000 to 2000 m (Mertzanis et al. 1996 – LIFE03NAT/GR/001080 project, Kanellopoulos 2003). Dens are usually constructed in rock cavities or dug under large tree roots. Mostly preferred aspects for den locations are S, SE and SW whereas N or NW aspects seem to be avoided. A systematic avoidance of denning sites close to forest roads or to human activity areas has also been observed (Giannakopoulos in prep).

1.1.8 Conflicts and Threats

Wherever bears occur in Europe they come into conflict with human land uses and activities, although the extent and nature of these conflicts vary widely from country to country. Considering human population densities in Europe, the existence of diverse conflicts is not surprising. The major conflict areas are outlined below (Linnell et al. 2002):

- Livestock

Bear predation on livestock is by far the most widespread conflict. Although all species such as cattle, horses, goats can be killed by bears, depredation on domestic sheep is the most serious and widespread conflict. Losses vary widely throughout Europe (Kaczensky 1996) depending on husbandry techniques.
• Beehives

Bear damage to beehives is common throughout its range in Greece and can be of local economic importance. Modern electric fences have also proved to be successful at preventing damage.

• Crops

Bear damage to orchards and crops is widespread, but not as well documented as damage to beehives and livestock.

• Bear – human interaction

Bears that lose their shyness are a major conservation issue, especially in small populations where every single bear is valuable for increasing the population. Instead of shooting a nuisance bear aversive conditioning is often tried first to discourage a bear from seeking food close to humans. These measures include; shooting with rubber bullets, electric shocks, fire crackers or chasing bears with dogs. Translocation of “problem bears” is very rarely used in Europe (Linnell et al. 1997).

The major proximate threats facing bears are as follows:

a) Excessive human caused mortality through direct killing (legal control permits or poaching), often motivated by conflicts, or from traffic accidents. Capture of wild cubs to become dancing bears has been a frequent problem in the Balkans in the past, but appears to have been stopped.

b) Fragmentation of habitat due to habitat destruction or the construction of roads and other barriers. In Europe, bear distribution is tightly linked to forest cover, and only forested areas can host bear populations or serve as dispersal corridors. These need to be identified and protected.

c) Infrastructure. Continental Europe is a crowded continent, with a very extensive infrastructure system of high-speed highways and railways. In some regions (i.e. Spain and Slovenia) these hinder contact between populations and contribute to bear mortality. Efforts to build underpasses or overpasses (so called “Green bridges”) appear to have been successful, for example in Croatia.

d) Habitat degradation. Forestry practices can have varying effects on bear populations. In the boreal forest habitats of Scandinavia, clear-cut logging has had no major effects on bears (see articles by Swenson et al.), however, in more deciduous forests where mast is an important food source, any changes to the forest composition could have more severe effects (i.e. clear-cuts of oak forests in Greece). However, a major threat from forestry also lies in the increased human access to bear habitats resulting from road construction, as well as through habitat change.
e) Artificial food sources are often exploited by bears. These include feedings sites to aid in hunting and human garbage disposal sites. Although such food sites are an important part of the management strategy of countries such as Slovenia, frequent use of these sites by bears may lead to habituation and the development of problem behaviours.

f) The demographic and genetic viability of the smallest remnant populations is probably very low because of their small size and isolation.

g) Public attitude will greatly influence the future for bears in Europe. Bear management that has negative effects on people will not be successful in the long run. Human dimensions research and public education programs are starting to become an important part in the conservation programs of most European countries that contain bears. Public involvement in management will also become more relevant in the future.

h) Fragmentation of management authority is a potential danger for species that occur at low population density and roam over large home ranges. With increasing regionalization there is a tendency to pass more responsibility for wildlife management down to more local levels. Without effective co-ordination this can lead to severe problems for population level management. Effective bear conservation requires co-operation that covers administrative units at all scales, including the international level.

i) Human related disturbance: Disturbance (in relation to bears) could be defined as a perturbation situation (of variable duration) and 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 depends also on the intensity level, duration, nature and type of human activities occurring in a given bear area. Disturbance could affect bears at two different levels as defined by Servheen (1985):

- **Ecological disturbance**
  
  This category of disturbance is mainly related to a change of the structure of the physical landscape (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.

- **Behavioural disturbance**
  
  This category of disturbance causes an influence to the behaviour of the bears through 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, numbers of residents in the area, numbers of domestic livestock grazed, or numbers of settlements (Servheen 1994). Effects of disturbance could be immediate (short term effects) or on a long term basis. Weaver et al. (1985) have made an attempt to group and categorize human activities by the degree and type of related disturbance using criteria as: the type of activity (motorized, non-motorized, or explosive), the nature of the activity (linear, point, or dispersed), the time length of activity (diurnal or 24-hour) and the disturbance intensity (high or low).

Disturbance can influence bear habitat use in two ways, either causing actual displacement or leading to modification in use patterns that reduce the time available for a bear to use a given area.

Ecological disturbance 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.

Behavioural disturbance is usually temporary, but as bears are affected by behavioural disturbance, they will change their habitat use patterns to avoid disturbance. This behavioural change is usually long-term or permanent. Behavioural disturbance changes the use of existing resources without changing the actual existence and availability of these resources. Also the level of human disturbance affects the degree of accessibility of the habitat to bears (Servheen 1994). In such situations a specific type management called “time-of-entry-limitation” is necessary (Servheen 1994). 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.

A possible approach to evaluate effects upon bears would be by analysing bears’ spatial use in areas of comparable energetic value but with differing levels of human activity. Then it may be possible to assess the influence of human activity (Weaver 1985).
1.1.9 Conservation Status Evaluation in Greece

According to the six year official report on priority fauna species under Directive 92/42 (Annex II), submitted by the Hellenic Ministry of Environment to the EU in 2007 the overall status evaluation for the brown bear (Ursus arctos) can be described as follows (Ministry of Environment-EKBY, 2007):

- **Population estimation and trends**

  It is very important to note that although the overall evaluation leads to a picture of positive population trend, this may be the momentum effect of previous conservation efforts. This being said it has to be underlined that the potential or effective risk of population decrease at a local scale due to the negative impact of adverse human activities (e.g. poaching, use of poisoned baits) still persists and affects and therefore should not be underestimated. *Conclusively Pindos bear sub-population appears to be NOT lower than “favourable reference population” BUT Rodopi subpopulation appears to be LOWER than “FRP”.*

- **Habitat for the species estimations and trend**

  Although the overall picture indicates a positive trend in surface (of range and occupied area), at a local scale the potential risk or effective impact of adverse human activities such as: criminal forest fires, construction of large infrastructure (such as highways and namely Egnatia and E65 highways, water impounds etc.), as well as detrimental logging practices (such as clear-cutting of oak forests) seriously affect bear habitat quality, effectiveness and connectivity. If not mitigated these negative factors are expected to have a subsequent cumulative effect upon population status as well. Therefore risks of further habitat degradation (potential/effective) due to large infrastructure (e.g. highway construction) and detrimental forest management practices at national and trans-border levels still persists.

From all the above it can be inferred that species viability can be judged only on a medium-term basis with the scores presented in Table 1-1:

<table>
<thead>
<tr>
<th>Table 1-1</th>
<th>Ursus arctos Conservation status evaluation in Greece</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>Favourable (FV)</td>
</tr>
<tr>
<td>Population</td>
<td>Inadequate but improving (U1+)</td>
</tr>
<tr>
<td>Habitat for the species</td>
<td>Inadequate but improving (U1+)</td>
</tr>
<tr>
<td>Future prospects</td>
<td>Favourable (FV)</td>
</tr>
<tr>
<td>Overall assessment of Bear Conservation Status</td>
<td>Inadequate but improving (U1+)</td>
</tr>
</tbody>
</table>

*Source: Ministry of Environment-EKBY (2007)*
2 RELEVANT LEGISLATION

- National legislation

  The brown bear is a strictly protected species in Greece (law 86/69, article 258 clauses 2e & 2z) according to which killing, capture and exhibition to public view are strictly prohibited.

- International conservation treaties ratified by Greece

  o Annex 4 and Annex 2 of Council Directive 92/43/EEC on the “Conservation of Natural Habitats and of Wild Fauna and Flora” (Habitat Directive) requires strict protection of Brown bear (the brown bear is listed as a “priority species in Annex II) as well as special conservation of species habitats (to be part of Natura 2000 network). Furthermore several habitat types (mainly forest) composing bear habitat are listed as priority habitat types on the same EU Directive.

  o Greece has ratified by means of 1335/83 Law, the European Bern Convention (convention on the Conservation of European Wildlife and Natural Habitats, 19.9.1979). The brown bear is listed on Annex 2 of the Bern Convention.

  o The brown bear is also listed on the International Convention on Biological Diversity

  o Greece has ratified the CITES Convention (Convention on International Trade in Endangered Species of the Wild Fauna and Flora - 3.3.1973) in 1984, under which international trading of any bear specimen (dead or alive or part of it) is strictly prohibited.

  o European Community (EC) Regulation No. 338/97 of 9 December 1996 on the protection of species of wild fauna and flora by regulating trade also includes the brown bear.

  o According to the IUCN criteria the brown bear is listed as an “endangered” species in Greece according to the recently updated Red Data Book (Legakis and Maragou 2009).

3 METHODOLOGY

3.1 Study Areas

Brown bears are characterized by a high ecological plasticity, an opportunistic behaviour with highly adaptive skills (Herrero, 1978). Although these species attributes may show a potential ability of brown bears to adapt and survive into a large scope of habitat conditions (even marginal) in reality brown bears do remain dependent on specific habitat characteristics that have to be present at least in the core area of their habitat range and which subsequently play a key role on the species main biological functions and ecological requirements. Such characteristics are related to habitat quality, availability and accessibility in terms of adequate food resources, security/refuge and other specific ecological requirements proper to the species yearly reproductive cycle such as suitable seasonal habitat for denning (winter habitat) and litter rearing (spring habitat). As mentioned above, bears spatial behaviour can be characterized by high mobility levels such as long travelling distances or large home ranges (Kanellopoulos et al. 2006). Bears travelling itineraries usually follow the least energetically costly routes (Sgardelis, Kallimanis, 2005) by using either specific physiographic (i.e. valleys, ridges etc.) or human-related features of the landscape (trails, forest roads etc.). It is worth mentioning that the travelling routes are usually constant in space and time and that bears do memorize them and teach them to their descendants.

In order to specify where the proposed TAP alignment crosses through important habitat units for bears, initially former data on brown bear presence and distribution in Western Macedonia was used (Figure 1-1). According to these data, but also according to the limited time available in the field, the focus was put, as mentioned above, on 4 main sectors of interest (A,B,C and D). The selected study areas, which were surveyed during the field trip of 4-8 July 2011, are presented in Table 3-1 and Figure 3-1.

<table>
<thead>
<tr>
<th>Area</th>
<th>Location</th>
<th>KP</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Vermio</td>
<td>427.0-443.7</td>
</tr>
<tr>
<td>B</td>
<td>Kleisoura</td>
<td>490.0-496.0</td>
</tr>
<tr>
<td>C</td>
<td>Aliakmonas cross</td>
<td>520.7-529.0</td>
</tr>
</tbody>
</table>

The region between Polla Nera and Kato Grammatiko villages

The region between Variko and Verga villages
The riparian forest of Aliakmonas River crossing

The area north and northwest of Agia Kyriaki village up to the borders with Albania

The first sector (A) is located in the north slopes of Vermio Mountain. The altitudinal range is approx. 450-1150 m and the vegetation is characterized by the presence of oak (*Quercus sp.*) and beech (*Fagus sylvatica*) pure or mixed extensive forests. There are also small meadows and orchards. A recolonization process by bears is underway during the last 6-7 years in this region.

The surrounding area of Kleisoura village (sector B) is supposed to be an efficient corridor connecting the subpopulations of Vitsi and Askio mountains. Anecdotal evidence of permanent presence of bears support this argument. The landscape in this sector is mosaic with cultivations, meadows and grasslands but also stands of beech or oak forests. The elevation ranges from 750 to 1250 m and the terrain is rather rough with steep slopes.

The third sector (C) includes mainly cultivations and the riparian forest belt of Aliakmonas River. There was strong evidence of bear presence and activity in this region prior to the field survey, despite the fact that it is a lowland area (altitudinal range: 650-700 m).

The last selected area (sector D) is located near the Greek-Albanian borders. At the west side of TAP alignment there is a densely forested valley mixed mature oak forest with black pine stands. The low human activity and disturbance at this remote and mountainous area (altitudinal range: 850-1000 m) makes it an ideal habitat for bears.

Detailed maps, photographs and other information about the selected study area sectors are presented in *Section 7*. 
### Figure 3-1  Location of Study Area Sectors along the TAP Route

![Location of Study Area Sectors along the TAP Route](image)

**Source:** Google Maps. Prepared for ERM field survey (July 2011)

#### 3.2 Sampling Methodology

**3.2.1 Evaluation of Bear Presence in the Targeted Area**

To collect as much information and data as possible within the limited available period of time (5 field days) for the type of data required, two main survey tools have been used: direct interviews and field surveys.

The primary objective of the field survey was the detection of bear signs of presence and activity in the pre-selected study area sectors. Upon arrival in every study sector, local people was interviewed and enquired whether bears were present in this area. Related questions about the population trend over the past years (permanency of presence) were also raised, the reproduction status (presence of cubs) and the conflicts with humans (reported damages on
livestock or cultivations). Interviews were mainly focused on shepherds, farmers and hunters because they can be considered as better informed.

Ground surveys for collection of bear signs were also conducted. Because of field ruggedness and heterogeneity, "piecewise" (nonlinear) type "transects" (Anderson et al. 1979) were chosen for field sampling, covering all major ecological components of the surveyed zone included in TAP routing corridor. Their length and density were adjusted to the ecological diversity of the investigated sectors. The sampling network used mostly forest roads (of various degrees of accessibility) as well as trails and paths. The use of sign surveys to document species presence and distribution has a long tradition in bear research and management, especially in small endangered populations and in situations where logistic and financial constraints are a constraining issue (Klein 1959, Clevenger et al. 1997, Cuesta et al. 2003, Karamanlidis et al. 2007). Given the limited amount of time and restricted access due to dense vegetation and terrain ruggedness at the selected study sectors, albeit was not possible to survey thoroughly along the TAP route or cover large portions of the surrounding buffer zone in order to look for bear signs. Instead, only small portions of the TAP routing were surveyed, where access was easy and the probability to locate bear signs was higher. Additionally, forest roads either on foot or by car at low speed were searched. The location and the length of these roads were selected on the basis of proximity to pipeline centreline and according to reported evidence of bear presence by interviews. The main bear sign categories that were identified during the survey were:

- Tracks-footprints
  Besides direct sightings, footprints are the clearest sign of bear presence because of their characteristic size and shape, hard to confuse with any other mammal species, especially when clearly impressed on soft ground (mud) or snow. Footprints metric data may be helpful to differentiate age classes and sexes (i.e. width of a fore paw of an adult male may range from 10 to 15 centimetres (slightly smaller in females)). Both paws, the fore and the hind, have unretractile claws, longer in the fore paw. Bears do not walk on their claws as members of the canine and feline species do (digitigrades), but on the soles of their feet (plantigrades). In bears, like in most mammals, the hind footprint is slightly bigger than the fore print.

- Scats
  Among all categories of bear presence signs, scats is the one which most objectively shows (although indirectly) the species spatial distribution due to its random occurrence which is also related to the species high mobility range. While other signs depend upon environmental conditions (mud or snow for footprints, thorny bushes or coniferous trees for
hairs) or human related activities (i.e. sheep or beehives damage), scats do not require specific conditions. Unlike other species, bears do not bury or hide feces, do not use “latrines”, and do not need particular spots to mark their home range, but simply leave excrements randomly within their home range. Bear feces, present seasonal variations in colour and texture depending on the type of food items consumed by bears.

- Feeding signs

Bears in search of food leave signs which can be easily identified and interpreted. However if those signs are isolated, i.e. no other signs present on the spot at the same time, like tracks, scat or hairs, they may not be enough to demonstrate a bear's presence or passage. Such signs might be removed stones, chewed or uprooted grass or herbivorous plants, evidence of digging, destroyed ant hills, damaged beehives or the mauled remains of domestic animals. Bears feeding signs on orchards (i.e. apple and pear, cherry, hazelnut, rowan), clear signs of its incursion, are often left, like broken branches or other heavy damage.

- Dens and resting places (daybeds)

Bears usually find or construct their dens in fall in order to use them during the winter sleep. These dens can be natural cavities in or under trees, logs, in rock crevices or caves, or holes they dig into the ground usually under big trees. Female bears give birth in the den during the winter and tend to stay near the den for a few weeks after they emerge if they have cubs. Dens can be used for several consecutive years when located in remote, safe and suitable habitat. Bears, like moose and deer, create shallow depressions in the ground to rest in during daytime. These beds may only be used once, or if there is a large carcass nearby they may be used many times. Sometimes the bear will line the beds with branches or grass for extra warmth.

- Territorial & reproductive marking

Signs left on trees by claws or bites are mostly found during the mating season (May to July) and characterize mainly male individuals in reproductive “competition”. Formerly it was thought that such markings were left for territorial purposes (as with other species), but later, when it was discovered that bears were not ‘territorial’ in that sense, bites and scratching signs, associated with scenting, were considered to be a type of information code and communication process between mainly male individuals sharing the same area with home range overlapping and especially during the mating period. These signs of presence are usually common on coniferous tree trunks such as spruce and pine, but also on electricity poles (Karamanlidis et al. 2007), while less frequency of such signs appears on broadleaved trees (i.e. like beech and oak). Scratching are usually made above one meter of height, while hairs left while rubbing, may also be found, the DNA contained in their roots being widely used as the key biological material for genetic finger printing of the individuals from a given population.
• Hairs

Although it cannot be put forward as a survey technique, with some practice and knowledge of where to look, it is relatively easy to find hairs on a bear trail. Bears change their coat once a year in spring-summer (June-August) and in this period it is quite easy to find clumps of hair over bushes or stuck to tree bark. The places to look are narrow trails where the bear gets “combed” by the shrubs encountered on the way or resinous tree trunks (pine, spruce and larch) where it goes to rub itself. Bear hairs have a woolly and soft wavy look, and are long and resistant.

3.2.2 Evaluation of Bears Spatial Behaviour Using Telemetry Data

This type of data source came additionally in the frame of a LIFE-Nature project involving bear monitoring in a large portion of the study area. It is project LIFE09NAT/GR/000333 “Improving conditions of bear-human coexistence in Kastoria Prefecture, Greece – Transfer of best practices”. This LIFE-Nature project is implemented in the area of Kastoria and this specific action (“A.1 Identification-delineation of road network with high risk of bear traffic fatalities”) aims at the identification of the bear critical crossing areas along the highway E45 which functions as a deadly barrier to bears. These telemetry data have been correlated to TAP alignment using Kernel indicators in order to detect the intensity of habitat units comprised within the TAP buffer zone of alignment (routing).

In particular and for the needs of this study, additional telemetry data were used from 5 radio tagged bears (2 adult females, 2 adult males under project LIFE 09NAT/GR/000333 and one sub-adult male). Of these, 4 bears were radio tagged in May-June 2011 under the following protocol: bears were immobilized using Aldrich foot snares and were anaesthetized with a zolazepam-tiletamine /medetomidine /ketamine combination and reversed with atipamezole (Riegler et al. 2009). Bears were fitted with Tellus GSM collars equipped with remote drop-offs. GPS collars were fitted with devices such as VHF transmitter, mortality -activity sensors and were programmed to record a bear location for intervals ranging from 30-120 min. The Tellus/GPS-GSM collars locations were transferred via cell phone coverage and data were downloaded via e-mail through internet connection every 8 hours from Televilt-Followit server. Data were mapped on Google-Earth or GIS layers. Bears home ranges were calculated using the minimum convex polygon (100%MCP), and the fixed Kernel method and 50% contours of activity for core areas (areas of high intensity of use). Fixed Kernel Method home range analysis was performed because, in addition to estimating home range size, it reveals range use patterns, using a
smoothing factor determined by least squares cross validation (LSCV) (Seaman and Powell 1996).

3.2.3 Evaluation of Habitat Suitability Using Spatial Statistical Modelling (ENFA)

The suitability of landscapes as part of bear habitat included in the TAP buffer zone was additionally evaluated by using specific predictive models. The evaluation scoring incorporates the bear denning value of the surveyed areas.

Many predictive models have been used to study the spatial distribution of plant and animal species (Guisan and Zimmermann, 2000) and based on the relationship between species presence and environmental parameters (Austin et al. 1990). In addition, all these methods require not only presence data, but also absence data. In wildlife ecology studies it is very difficult to detect absence in the field. Ecological niche factor analysis (ENFA) solves exactly this problem (Hirzel et al. 2002).

Generalized linear and generalized additive models have become very popular for predicting animal distributions (Guisan et al. 2002, Quevedo et al. 2006). Yet, although absence or pseudo-absence data are available, more robust models can be built on only presence data by using the ENFA (Hirzel et al., 2001). However, the robustness of ENFA makes it particularly suitable and efficient when data obtained do not indicate true absences, but rather lack of information (Hirzel et al. 2001).

In conclusion nature is too complex and heterogeneous to be predicted accurately in every aspect of time and space from a single, although complex, model (Guisan and Zimmermann, 2000).

In order to estimate the brown bear habitat suitability in the pipeline corridor, the Environmental Niche Factor Analysis assisted by GIS statistical and mapping tools was used. The habitat suitability results were estimated using ordination techniques (PCA), marginality and specialization indices. Ecological niche factor analysis starts off at the same point as the single variable analysis, comparing the distribution of values where the animal is present with the distribution of values in the background (environmental factors influencing the distribution). ENFA relies on identifying differences in the two distributions with respect to the mean (marginality) and with respect to the standard deviation (specialization). This idea is applied to all variables in the study area and the environmental variables are related to topography, vegetation and land use, as well as to the composition of the spatial neighbourhood around each cell. The final habitat
suitability scoring is estimated with the use of ordination techniques, such as principal component analysis. The analysis estimates an overall marginality index, which expresses the difference between the mean animal preference and the mean condition of the study site. Also, the overall specialization index is estimated, which is a measure of the range of environmental conditions the animal tolerates, compared to the range of values recorded in the study site. For both indices, values close to 0 indicate a species which can equally well utilize the entire area, and values close to 1 indicate a highly specialized species that can only use a small part of the available landscape (Hirtzel et al. 2002, Mertzanis et al. 2008). The analysis was performed using the Biomapper 3.0 (Hirtzel et al. 2002, 2004) and ARC GIS 9.10 software packages.

Given the available time frame and digital layers, in total for the ENFA analysis 7 key environmental (eco-geographical) factors have been selected and used in order to run the model (Mertzanis et al. 2008). These factors include elevation, slope, aspect, vegetation, which affect selection of brown bear (*Ursus arctos*) habitat. The human disturbance factors include main roads, forest roads and villages. Elevation, slope and aspect were derived from the digital elevation map (DEM). The vegetation types were from the CORINE Land Cover 2000 in a buffer of 5 km. The following figures (*Figure 3-2 to Figure 3-8*) illustrate the scoring of each of the eco-geographical factors that have been used in synthetic the multivariate analysis (ENFA model).

3.2.4 Model Validation

Model validation was achieved through a Jake-Knife Cross-Validation process. The presence points were partitioned into 10 subsets of equal size. Nine of them were used to calibrate the habitat suitability map and the last one was used to evaluate the result. Absolute Validation Index (AVI) was introduced into the model validation, and defined as the percentage of predicted suitability exceeding 0.5 of the validation cells. By replicating this process 10 times, each subset was used in turn for the validation purpose. The mean and the standard deviation of the accuracy assessment were calculated for model validation.
Figure 3-2  Scoring of elevation

Source: Callisto GIS Team (October 2011)
Figure 3-3  

Scoring of slope

Source: Callisto GIS Team (October 2011)
Figure 3-4  Scoring of aspect
Figure 3-5  Scoring of distance to villages and towns

Source: Callisto GIS Team (October 2011)
Figure 3-6  Scoring of distance to main forest roads

Source: Callisto GIS Team (October 2011)
Figure 3-7  Scoring of distance to paved roads

Source: Callisto GIS Team (October 2011)
Figure 3-8  Scoring of Land Use

Source: Callisto GIS Team (October 2011)
3.3 Limitations – Uncertainty – Bias

Before presenting the results of the present study, some constraints dealing with limitations, bias sources and uncertainty should be clarified.

Bias and uncertainty sources are related to low sampling effort (due to the limited available fieldwork time), intrinsic problems that arise due to the elusive nature of the bear, stochastic events related to human caused mortality and inadequacy of data related to habitat attributes digitized.

Moreover, information on bear dens and denning sites cannot be spatially accurate during this baseline study unless intensive telemetry coincides during the hibernation period (winter). Although telemetry data are available in this study thanks to the aforementioned LIFE project (in a portion of the area targeted by the present study) they have not yet covered the required winter time period in order to obtain further and more spatially accurate information on bear denning activity and denning sites.

Because of the limited field trip duration, many sectors have not been surveyed adequately for their value as a denning site or sector. Habitat modelling can reasonably compensate this habitat underestimation problem as it usually successfully predicts the suitable denning sites and/or sectors.
4 RESULTS

4.1 Bear Presence along the Route

The presence and recent activity of bears was confirmed by field data (signs, telemetry) or/and interviews in all selected study area sectors (A, B, C and D).

4.1.1 Interviews

A total of 10 interviews were conducted during the fieldtrip. The interview took place along three of the study sectors (A, B and D). According to the interviewed local people, bears are present in all these regions. They mainly reported direct sights of animals, repeated findings of signs or livestock and tree damages. Although their population estimates are subject to bias, they gave valuable information about the permanence, the distribution and the reproduction activity of bears in the selected study areas. For detailed presentation of the conducted interviews refer to Table 4-1.

Table 4-1 Interviews to local people

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Date</th>
<th>Location &amp; people</th>
<th>Study Area KP segment</th>
<th>Reported evidence of activity</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4/7/2011</td>
<td>Ano Grammatiko Game warden</td>
<td>A 428.2-444.7</td>
<td>direct sights, tracks, scats, tree damages</td>
<td>permanent presence of at least 3 bears (including female with cub) the last 6-7 years</td>
</tr>
<tr>
<td>2</td>
<td>5/7/2011</td>
<td>Agia Foteini Farmer</td>
<td>A 428.2-432.3</td>
<td>tree damages</td>
<td>sporadic presence of bear</td>
</tr>
<tr>
<td>3</td>
<td>5/7/2011</td>
<td>Agia Foteini Hunter</td>
<td>A 432.3-436.6</td>
<td>direct sights</td>
<td>permanent presence of 2-3 bears</td>
</tr>
<tr>
<td>4</td>
<td>5/7/2011</td>
<td>Kato Grammatiko Farmer</td>
<td>A 439.5-442.6</td>
<td>tracks, tree damages</td>
<td>permanent presence of 2 bears</td>
</tr>
<tr>
<td>5</td>
<td>6/7/2011</td>
<td>Kleisoura Shepherd</td>
<td>B 489.8-492.9</td>
<td>direct sights, livestock damages</td>
<td>permanent presence of 2 bears northeast and southeast of Kleisoura village</td>
</tr>
<tr>
<td>6</td>
<td>6/7/2011</td>
<td>Kleisoura Municipal worker</td>
<td>B 489.8-496.0</td>
<td>direct sights</td>
<td>permanent presence of 4-5 bears (including females with cubs) in the adjacent area and sporadic presence very close to Kleisoura village</td>
</tr>
<tr>
<td>7</td>
<td>6/7/2011</td>
<td>Kleisoura Farmer</td>
<td>B 489.8-496.0</td>
<td>-</td>
<td>permanent presence of 4-5 bears</td>
</tr>
<tr>
<td>8</td>
<td>7/7/2011</td>
<td>Verga Shepherd</td>
<td>B 492.8-496.0</td>
<td>marks on power poles, tree damages, scats, tracks</td>
<td>permanent presence in the area between Kleisoura and Vasiliaida villages</td>
</tr>
<tr>
<td>9</td>
<td>8/7/2011</td>
<td>Polyanemo Shepherd</td>
<td>D 540-543</td>
<td>direct sights, scats, tracks</td>
<td>permanent presence in the area between Polyanemo and Ieropigi villages</td>
</tr>
<tr>
<td>10</td>
<td>8/7/2011</td>
<td>Ieropigi Shepherd</td>
<td>D 540-543</td>
<td>direct sights, livestock damages</td>
<td>permanent presence in the area between Polyanemo and Ieropigi villages</td>
</tr>
</tbody>
</table>

Source: ERM field survey (July 2011), reported by D. Tsaparis
4.1.2 Signs of Bear Presence

Signs of bears were detected at 12 survey points in the study sectors B, C and D during the field trip of 4-8 July 2011 (photographic documentation for these signs is given in Section 7) while 8 additional points in the same areas were reported by other field teams. Detailed description and other information for each one of 20 different points is presented in Table 4-2. Ten points were located inside the predefined buffer zone of 500 meters and the rest at distances ranging between 635 and 5000 meters away from TAP alignment. Locations of bear signs recorded in study sectors B, C & D during the field survey are also presented on the maps in Figure 4-1 to Figure 4-3.

Table 4-2 Bear signs of presence and activity as recorded during the field survey

<table>
<thead>
<tr>
<th>Survey point</th>
<th>Date</th>
<th>Coordinates</th>
<th>Distance from route and direction</th>
<th>Evidence of activity within the Project area</th>
<th>Habitat type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bear 1</td>
<td>6/7/2011</td>
<td>N 40° 32.755' E 21° 29.187'</td>
<td>25 m north</td>
<td>Feeding signs, hairs</td>
<td>Cultivations, meadows, Fruit trees (Prunus sp.)</td>
</tr>
<tr>
<td>Bear 2</td>
<td>6/7/2011</td>
<td>N 40° 32.947' E 21° 28.646'</td>
<td>635 m north</td>
<td>Feeding signs &amp; possibly daybed</td>
<td>Mixed oak forest riparian vegetation</td>
</tr>
<tr>
<td>Bear 3</td>
<td>7/7/2011</td>
<td>N 40° 32.580' E 21° 27.347'</td>
<td>65 m north</td>
<td>Daybed</td>
<td>Mixed oak and beech forest</td>
</tr>
<tr>
<td>Bear 4</td>
<td>7/7/2011</td>
<td>N 40° 32.618' E 21° 26.946'</td>
<td>30 m south</td>
<td>Trails in grass</td>
<td>Mixed oak and beech forest, meadows</td>
</tr>
<tr>
<td>Bear 5</td>
<td>7/7/2011</td>
<td>N 40° 32.625' E 21° 26.930'</td>
<td>27 m south</td>
<td>Territorial &amp; reproductive marking, hairs</td>
<td>Mixed oak and beech forest, meadows</td>
</tr>
<tr>
<td>Bear 6</td>
<td>7/7/2011</td>
<td>N 40° 32.656' E 21° 26.893'</td>
<td>5 m south</td>
<td>Feeding signs and trails in grass</td>
<td>Mixed oak and beech forest, meadows</td>
</tr>
<tr>
<td>Bear 7</td>
<td>7/7/2011</td>
<td>N 40° 29.395' E 21° 9.954'</td>
<td>20 m northeast</td>
<td>Tracks</td>
<td>Riparian forest, cultivations</td>
</tr>
<tr>
<td>Bear 8</td>
<td>7/7/2011</td>
<td>N 40° 29.466' E 21° 10.067'</td>
<td>225 m northeast</td>
<td>Tracks</td>
<td>Riparian forest, cultivations</td>
</tr>
<tr>
<td>Bear 9</td>
<td>7/7/2011</td>
<td>N 40° 29.475' E 21° 10.275'</td>
<td>500 m northeast</td>
<td>Tracks</td>
<td>Riparian forest, cultivations</td>
</tr>
<tr>
<td>Bear 10</td>
<td>7/7/2011</td>
<td>N 40° 29.248' E 21° 10.115'</td>
<td>90 m northeast</td>
<td>Tracks</td>
<td>Riparian forest, cultivations</td>
</tr>
<tr>
<td>Bear 11</td>
<td>8/7/2011</td>
<td>N 40° 32.597' E 21° 03.356'</td>
<td>785 m southwest</td>
<td>Territorial &amp; reproductive marking, hairs</td>
<td>Mixed oak and black pine forest meadows, cultivations</td>
</tr>
<tr>
<td>Bear 12</td>
<td>8/7/2011</td>
<td>N 40° 33.118' E 21° 01.466'</td>
<td>approx. 2500 m west</td>
<td>Territorial &amp; reproductive marking, hairs</td>
<td>Mixed oak and black pine forest meadows, cultivations</td>
</tr>
<tr>
<td>Bear 13</td>
<td>11/7/2011</td>
<td>N 40° 34.333' E 21° 27.500'</td>
<td>approx. 3100 m north</td>
<td>Tracks</td>
<td></td>
</tr>
<tr>
<td>Bear 14</td>
<td>11/7/2011</td>
<td>N 40° 34.117' E 21° 26.850'</td>
<td>approx. 2500 m north</td>
<td>Tracks</td>
<td></td>
</tr>
<tr>
<td>Bear 15</td>
<td>11/7/2011</td>
<td>N 40° 34.567' E 21° 26.483'</td>
<td>approx. 3300 m north</td>
<td>Tracks</td>
<td></td>
</tr>
<tr>
<td>Bear 16</td>
<td>12/7/2011</td>
<td>N 40° 33.417' E 21° 06.650'</td>
<td>approx. 3400 m northeast</td>
<td>Tracks</td>
<td></td>
</tr>
<tr>
<td>Bear 17</td>
<td>12/7/2011</td>
<td>N 40° 33.383' E 21° 06.463'</td>
<td>3200 m northeast</td>
<td>Tracks</td>
<td></td>
</tr>
</tbody>
</table>
Survey point | Date       | Coordinates          | Distance from route and direction | Evidence of activity within the Project area | Habitat type
--- | --- | --- | --- | --- | ---
Bear 18 | 12/7/2011 | N 40° 33.867' E 21° 07.637' | approx. 5000 m northeast | Territorial & reproductive marking |  
Bear 19 | 17/6/2011 | X: 259804 Y: 4485847 | Tracks | Riparian vegetation |  
Bear 20 | 5/10/2011 | N 40° 33.100' E 21° 03.670' | approx. 170 m northeast | Tracks | Mixed black pine and oak forest.

Note: Signs Bear 1-12 reported by D. Tsaparis, Bear 13-18 reported by Y. Iliopoulos, Bear 19 reported by S. Zogaris & Bear 20 reported by A. Stefanaki

Source: ERM field survey (July 2011)
Figure 4-2  Map of bear signs as recorded in sector (C) during field survey

Source: Google Maps. Prepared for ERM field survey (July 2011) - reported by D. Tsaparis
4.1.3 Telemetry Data

Telemetry data collected during period May – August 2011 from 2 (one adult male and one adult female) out of 5 bears (2 adult females, 2 adult males and one sub-adult male) of the sample bears fitted with GPS/GSM collars clearly indicate intersection sectors in study areas C and D between bear activity and movements and pipeline route alignment (Figure 4-4).

Comparing telemetry data from all 5 radio-tagged bears versus the TAP alignment we notice that the overall home range surfaces (MCP 100%) from the 4 bears are intersected by the TAP routing and re-routing sector (in the final part included in study sector D) (Figure 4-5).
Moreover and by using Kernel density estimators (Figure 4-6), we notice that for all five bears the Kernel nuclei with the higher intensity of home range use (100% MCP) are also intersected by the TAP alignment in study sectors B, C and D.

In particular we notice that this intersection becomes even more critical (and will become especially during the TAP construction phase) in study sectors (C) and (D) where the pipeline alignment cuts directly through used parts of brown bears home range with the highest frequency score (Figure 4-4). The same problem will occur in the terminal segment of the rerouted pipeline that is expected to intersect several home range portions with highest scoring of HR use intensity within study sector (D).

Figure 4-4   Activity of 2 radio-collared bears in study sectors C & D versus pipeline routing

Source: Callisto NGO Program LIFE09NAT/GR/000333 (June to August 2011)
Figure 4-5  Home Ranges of 4 Bears intersected by the TAP Route

Source: Callisto GIS Team (October 2011)
Figure 4-6  Kernel Density of Bear Presence at Study Sectors B, C and D

Source: Callisto GIS Team (October 2011)
4.1.4 Other Important Features

Results of bear habitat modelling -Habitat suitability range and potential distribution

A total of 3245 GPS locations from bears collars (n=5) were taken into consideration from the total radiolocation sample, as they were located within a distance of 5 km buffer versus the TAP routing corridor. Additionally 223 bear signs (footprints, feeding sites, hairs, etc.) of brown bear presence and activity collected during 2007 and 2011 by systematic ground surveys of Callisto Field Team were also taken into account for the analysis. Moreover 20 bear signs were found during field trip (July 2011) in this study.

The frequency distribution of brown bear locations (n=500) versus the distance from the TAP alignment and routing corridor is presented in Figure 4-7.

Figure 4-7 Frequency distribution of bear GPS locations versus distance from route

Bear signs were found from 0 to 4952 m away from the TAP alignment and they were most frequently observed at a distance range of 2400 m. A significant part of bear activity signs (17%) occurred within a buffer of 1000 m from the TAP alignment.

Signs were found at an altitude from 600 m to 1444 m in the wider area of the pipeline routing and they were more frequently observed at 600-700 m.
The altitudinal distribution of bear signs is presented in Figure 4-8.

**Figure 4-8** Distribution of bear signs in relation with elevation

![Distribution of bear signs in relation with elevation](image)

*Source: Callisto NGO Program LIFE09NAT/GR/000333 (June to August 2011)*

The higher frequency at the lower altitudinal range (600-700 m) clearly indicates that even though some segments of the pipeline alignment do cross low altitude areas (i.e. sector C) this does not minimize the impact effect upon brown bears habitat use and activity.

**ENFA Modelling**

The overall distribution of bear habitat suitability range scoring is presented in Figure 4-9. The Ecological Niche Factor Analysis showed that brown bear scored 0.79 on the marginality index and 0.65 on the tolerance index. Values close to 0 indicate that a species can use equally habitat conditions of the study area, while values close to 1 indicate a highly specialized species. Moreover, ENFA analysis showed that brown bears were mainly distributed in areas with oak forests, mixed forests and agro forestry landscapes.

The distribution of forests determines the suitable habitat distribution (0.71). Brown bears avoid paved roads (distance to roads = -0.08) and villages (distance to villages = -0.09). Cross-Validation value was 0.68+0.18 (Bowcy index), indicating a good model performance.
Suitable brown bear habitats were distributed on both sides of TAP. Moreover there are 3 main highly suitable areas-corridors of bear presence and activity defined in study sectors A, B, C and D respectively as follows:

- Giannakoxori-Rodoxori villages (Vermio mountain) (study sector A);
- Variko-Kleisoura_Korrissos-Vasiliada-Lehovo_Melisotopos and Drosoro villages (study sector B);
- Ampelokipi-Mesopotamia, Oinoi villages to the Greek-Albanian borders (study sectors C and D).

A more detailed picture of habitat suitability scoring is illustrated in the three following maps (see Figure 4-11 to Figure 4-13) covering each one of the aforementioned sectors. In study sector (A) the highest habitat suitability units appear at two spots (marked) (one north and west of Rodohori village and the other N and NE of Pyrgos village) where the pipeline alignment cuts directly
through. In this precise study sector the existence at the immediate vicinity of the pipeline alignment of a game refuge located east of the village of K. Grammatiko, a SCI (Natura 2000 site located south of the TAP alignment) enhances the reasons why special attention should be given in the possibility of an alternative TAP rerouting at this local scale in order to minimize impact on this very important sector.

Figure 4-10  Habitat Suitability Map including Sector A and Adjacent Region

Source: Callisto GIS Team (October 2011)
Figure 4-11 Habitat Suitability Map including Sector B and Adjacent Region

Brown bear (Ursus arctos L.) study-construction and operation area of the Greek section of the Trans Adriatic Pipeline (TAP)

Source: Callisto GIS Team (October 2011)
Evaluation and mapping of potential denning sites

An evaluation of sectors presenting the highest probability of occurrence of bear denning sites along the TAP alignment was performed by using the following 4 main ranking classification criteria: slope, aspect, distance from human settlements and infrastructure, forest cover (density).

The aforementioned criteria were selected according to already existing robust field data: from 33 dens recorded so far, including the dens from the radio tagged bears (n=11) in north-western Pindos mountain range, all dens were located on steep slopes with a mean slope of 24° (range: 7.54° - 48.08° ± 1.92) and 48% of the den recorded on southwest aspect and mean elevation 1045 m (range: 432 m-1796 m ± 81.69). The mean den distance from villages was 2.34 km (range: 384 m – 5196 m ± 263.27) (Mertzanis et al. 2011, Giannakopoulos et al. in prep).
The derived map and relevant sectors are presented in *Figure 4-13*. Study sector B presents the highest probability for the highest concentration of denning sites according to the highest suitability scoring. It is also worth noting that in study sector A there is a clear intersection between the TAP alignment and at least two locations with high suitability scoring for the occurrence of denning sites.

*Figure 4-13* **Potential Denning Sites along the TAP Route**

![Map of Potential Denning Sites along the TAP Route](source_image)

*Source: Callisto GIS Team (October 2011)*
5 CONCLUSIONS

5.1 Key Habitats within Study Area – Other Population Aspects

Vermio 1 (KP segment 429.4-436.6)
No signs were found during the field survey session. However, records from previous years indicate sporadic but regular presence of individuals in the area as a result of a dynamic recolonization process of former bear range. Furthermore, information from interviews with local people as well as the high habitat suitability clearly indicates the permanent use of this area by bears given the former range recolonization process which is underway.

Vermio 2 (KP segment 439-444.5)
It is also recognised as a bear habitat unit of high suitability. Although no signs of presence were found, a high probability of den sites occurrence is present. TAP alignment is expected to have more serious long term effects in the Mt. Vermio (in the whole study sector A) by altering (due to the removal of important surface of mature forest vegetation stands) suitability of a large habitat unit characterized by dense mature deciduous forests of high trophic and refuge value for bears.

Kleisoura (KP segment 490.2-496.2)
Strong evidence of bear presence in this area was found during the field survey. Feeding signs, territorial and reproductive marking (marks on electric poles) and daybeds where located within the 500 m buffer zone indicating permanent use of the area by bears. Additionally, the habitat is of high suitability for bear (especially at 497.5-500 km) and the possibility of den sites is among the highest.

Aliakmonas cross (KP segment 526.7-528.7)
There was strong evidence (footprints) of frequent use of the riparian forest as a functional corridor between larger parts of habitat in adjacent regions but also as a functional habitat per se. The latter was strongly evidenced by telemetry locations. Although there is no possibility of winter dens in this area the bears may use dense parts of the riparian forest vegetation as daybeds.

Borders region (KP segment 539-543.2)
Bears are present in this area as clearly indicate the frequent bear marking on electric poles (a sign of reproductive and territorial behaviour), the regular use by two radio-collared bears and the high possibility of den sites on either side of TAP route. The habitat is of high suitability for bears, especially at the west side of TAP alignment (Base case).
6 FIELD SURVEY SHEETS

All pictures contained within this Annex were taken by ERM.

Table:

<table>
<thead>
<tr>
<th>Survey point:</th>
<th>Long.</th>
<th>GPS Elev.</th>
<th>Date</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bear 02</td>
<td>E 21° 28.646'</td>
<td>905 m</td>
<td>6/7/2011</td>
<td>TAP</td>
</tr>
<tr>
<td>km: 491.7</td>
<td>Lat. N 40° 32.947'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>distance from route: 635 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Remarks

Signs of bear presence: Livestock damages

Depredation on a donkey eye witnessed by a farmer. The bear had buried its prey under the ground. Sometimes when bears kill or find a large dead animal they create a cache to hide and/or store it until they can eat all of it. Caches are created when the bear scrapes grass and branches surrounding ground onto the carcass (Figures A & C). Remains of donkey’s carcass were scattered nearby (Figure B).
Survey point:
Bear 03

km: 494.1
distance from route: 65 m

Long.
E 21° 27.347'

GPS Elev.
990 m

Lat.
N 40° 32.580'

Date
7/7/2011

Project
TAP

Remarks
Sign of bear presence: Daybed
Daybed in mixed Quercus – Fagus forest. Markings of bear claws (scratches) were found on the ground.
<table>
<thead>
<tr>
<th>Survey point:</th>
<th>Long.</th>
<th>GPS Elev.</th>
<th>Date</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bear 04</td>
<td>E 21° 26.946'</td>
<td>865 m</td>
<td>7/7/2011</td>
<td>TAP</td>
</tr>
<tr>
<td>km: 494.6</td>
<td>Lat. N 40° 32.618'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>distance from route: 30m</td>
<td></td>
<td>865 m</td>
<td></td>
<td>TAP</td>
</tr>
</tbody>
</table>

**Remarks**

- Sign of bear presence: Bear trail
- Bears create such trails while they are moving or resting on tall grass.
Project Title: Trans Adriatic Pipeline – TAP
Document Title: Integrated ESIA Greece Annex 6.5.2 – West - Bear Baseline Study

Survey point:
Bear 05
km: 494.7
distance from route: 27 m

Long. E 21° 26.930’
Lat. N 40° 32.625’

GPS Elev. 865 m
Date 7/7/2011

Remarks
Sign of bear presence: Markings on power poles

These signs are related with the territorial and reproductive behaviour of bears.
Bite marks (Figures A, B) & claw marks (Figures C, E).
Bear rubs on the pole leave hair deposits (Figure D).
The specific power pole locates in a small meadow surrounded by Quercus-Fagus forest.
The position of bite marks (Figure B) indicates the presence of at least one large male bear in this region.
Project Title: Trans Adriatic Pipeline – TAP  
Document Title: Integrated ESIA Greece Annex 6.5.2 – West - Bear Baseline Study  

GPL00-ERM-642-Y-TAE-0014  
Rev.: 02 / at07  

Survey point: Bear 06  

| km: 494.8 | distance from route: 5 m | Long. E 21° 26.893’ | GPS Elev. 855m | Date 7/7/2011 | Project TAP |

Remarks  
Sign of bear presence: Tree damages & bear trail  

Broken branches of a wild damson (Prunus spp.) in Figures A & B. The plums of such trees are significant part of bear’s diet during summer.  

The grass around the tree had been flattened down by bear walking on it (bear trail) (Figure C).
**Survey point:** Bear 07

**km:** 528  
**distance from route:** 20 m  
**Lat:** N 40° 29.395'  
**GPS Elev.:** 680 m  
**Date:** 7/7/2011  
**Project:** TAP

### Remarks

Sign of bear presence: Tracks & Trails

Several recent footprint impressions (probably from the same bear) were found on the wet ground surrounding a small pond in Aliakmonas river shore (Figure E).

In Figures A & B a single footprint of the front foot.  
In Figure C the hind and front footprint.  
The trail is shown in Figure D.
Survey point: Bear 08  
km: 528  
distance from route: 225m  

Long.  
E 21° 10.067'  

Lat.  
N 40° 29.466'  

GPS Elev.  
680m  

Date  
7/7/2011  

Project  
TAP  

Remarks  
Sign of bear presence: Tracks & Trails  
Recent footprints on wet mud at Aliakmonas river shore.  
Possibly two different bears (female & cub)
Survey point:
Bear 09

km: 527.8
Distance from route: 500 m

Remarks
Sign of bear presence: Tracks
Old footprint on a dirt road in the riparian forest of Aliakmonas.
<table>
<thead>
<tr>
<th>Survey point:</th>
<th>Long. E 21° 10.115'</th>
<th>GPS Elev.</th>
<th>Date</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bear 10</td>
<td>km: 527.5 distance from route: 90 m</td>
<td>Lat. N 40° 29.248'</td>
<td>695m</td>
<td>7/7/2011</td>
</tr>
</tbody>
</table>

**Remarks**

- Sign of bear presence: Tracks
- Old footprint on a dirt road near to Aliakmonas.
### Survey point:

<table>
<thead>
<tr>
<th>Survey point</th>
<th>Long.</th>
<th>GPS Elev.</th>
<th>Date</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bear 11</td>
<td>E 21° 3.356'</td>
<td>960 m</td>
<td>8/7/2011</td>
<td>TAP</td>
</tr>
<tr>
<td>Polyanemo region</td>
<td>Lat. N 40° 32.597'</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Remarks

Sign of bear presence: Markings on power pole.

Bite marks (Figures A & C) and bear hairs (Figure B) on power pole.
# Survey point:
**Bear 12**

<table>
<thead>
<tr>
<th>Survey point:</th>
<th>Long.</th>
<th>GPS Elev.</th>
<th>Date</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyanemo region</td>
<td><strong>E 21° 1.466'</strong></td>
<td>985m</td>
<td><strong>8/7/2011</strong></td>
<td><strong>TAP</strong></td>
</tr>
<tr>
<td><strong>Lat.</strong></td>
<td><strong>N 40° 33.118'</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Remarks

Sign of bear presence: Markings on power poles

Bite marks on two different power poles located very close (10 m). The Figures A and B show the first and Figure C the second pole. The depth of bite marks provides evidence of repeated use of these poles by bears.
Study area sector A

<table>
<thead>
<tr>
<th>Long.</th>
<th>GPS Elev.</th>
<th>Date</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>East of Ag. Fotini km: 428.3-432.6</td>
<td>-</td>
<td>4/7/2011</td>
<td>TAP</td>
</tr>
</tbody>
</table>

Remarks

Sporadic presence of bear (especially during summer) was reported by local people in the whole area. Bears are visiting this area mainly for feeding in cherry orchards.

Habitat types:

- Quercus pure and mixed forests, meadows and openings, cultivations (cherry orchards).

The several irrigation ponds (Figure B) give a permanent additional source of water for animals
Remarks

Permanent presence of bears in this area was reported by locals.

Habitat types:

Mature, pure and dense beech forest (*Fagus sylvatica*) (Figures B & C).
Study area sector A

Grammatiko region
km: 439.5-442.3

Remarks

Permanent presence of bears in this area was reported by locals. Possible existence of winter dens very close to pipeline alignment.

Habitat types:

Mixed oak and black pine forest with openings and meadows. Beech forest stands at high elevations. Dense forest patches and rock formations at steep slopes (Figures A & B).
### Study area sector B

<table>
<thead>
<tr>
<th>Long.</th>
<th>GPS Elev.</th>
<th>Date</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lat.</td>
<td></td>
<td>760-1230m</td>
<td>6/7/2011</td>
</tr>
</tbody>
</table>

#### Remarks

Important area for bears:

Permanent presence and reproduction of bears was reported by local people (shepherds, farmers) in the area between Variko and Kleisoura villages. Possible existence of winter dens north and south of the route at a range of few kilometres. According to interviews, in this small valley and the adjacent mountain slopes live about 5 animals.

#### Habitat types:

Oak stands (*Quercus spp.*) mosaic with meadows, agricultural land and riparian vegetation (Figures A & B). Steep slopes at 491.4-492.4 km.
Remarks

The region between Kleisoura and Verga is another important area with permanent presence of bears. Interviews with locals and plenty of signs found during this survey (see Survey points 4-7) support this argument. The Kleisoura neck is considered an effective corridor connecting the bear subpopulations of Vitsi (north) and Askio (south) mountains.

Habitat types:

Beech forest (*Fagus sylvatica*) pure or mixed (*Fagus-Quercus*) mainly south of the pipeline.
Meadows and cultivations mainly north of pipeline.
Riparian forest stands along streams at low elevation.
The area between Hilioedro and Mesopotamia villages, where the pipeline crosses Aliakmonas river (Figure A).

Habitat types:

Mainly cultivations and a riparian forest at river’s shores.

Intense and permanent use of the riparian forest of Aliakmonas river by bears was revealed by radio tracking signals received from a collared female bear during summer of 2011 (Figure B).

Close thickets of Quercus mixed forest, with dense understory vegetation (Figure C), are used by bears as daybed places. Such thickets form a narrow belt very close to river (see arrows in Figure A).
Study area sector D | Long. | GPS Elev. | Date | Project
--- | --- | --- | --- | ---
Polyanemo - Ieropigi near borders region | Lat. | - | 8/7/2011 | TAP

**Remarks**

Highly significant reproduction and feeding area for bears (Figure A).

Habitat types:

Mixed oak forests (Figure C) and black pine stands (Figure D). Densely forested hills mosaic with meadows and cultivated fields (cereal crops).

Intense and permanent use of the area by bears was revealed by radio tracking signals received from a collared male bear during the summer of 2011 (Figure B).
<table>
<thead>
<tr>
<th>Study area D</th>
<th>Long.</th>
<th>GPS Elev.</th>
<th>Date</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyanemo - Ieropigi near borders region</td>
<td>Lat.</td>
<td>-</td>
<td>8/7/2011</td>
<td>TAP</td>
</tr>
</tbody>
</table>

C

D