



CONSERVATION ACTION PLAN

for the golden jackal *Canis aureus* L. in Greece



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WWF Greece

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Executive summary

The golden jackal is a medium-sized predator and omnivore, with a range covering the southern parts of the Palearctic, South Asia and northeastern Africa. In SE Europe the preferred habitat of the jackal consists of a mosaic of small cultivations and dense scrub as well as lowland wetlands with adequately dense vegetation cover.

The south and eastern parts of the Balkan Peninsula seem to hold the largest populations of jackals. Greece, one of the region's strongholds for the species, experienced a large-scale population decline in the last 25 years. The entire jackal population is now confined to a few clusters grouped into 7 sub-areas with criteria such as connectivity and isolation. The largest sub-population exists in the coastal wetland complex of NE Greece.

Causes of decline seem to be related to the limited habitat availability due to changes in human agro-pastoral activities, which resulted mainly in reduced day-cover availability and possibly reduced food base.

This Action Plan summarises the basic aspects of jackal biology and ecology, analyses the main threats and problems of jackal management in Greece and important population survey assessment techniques: The jackals seem to do well in moderately modified agrosystems with non- invasive human activities. Barriers for jackal expansion and population recovery seems to be the mountains with extensive high forests or unbroken scrub, heavy snowy winters and irregular food supply, large intensively cultivated areas without cover, urbanisation and established wolf populations. Agropastoral changes during the past 25 –30 years in lowland Greece resulted in habitat and human use changes, which have largely contributed to the massive jackal population declines.

Within the overall goal of “Maintaining and restoring, in coexistence with people, viable populations of jackals as an integral part of Mediterranean ecosystems and landscape in Greece and SE Europe”, this Action Plan has identified three specific objectives: i) To allow the jackal populations to stabilise or recover and spread throughout Greece wherever it is biologically and economically feasible; ii) To ensure jackal-human coexistence by improving the animal's public image, safeguarding a safe habitat and reducing possible conflicts with local people and iii) To propose some action for long term management of jackal populations.

The Action Plan presents the principal actions that should be undertaken for ensuring a long-term survival of jackals in Greece. These actions are under the following main themes:

- preservation and restoration of safe and good quality habitat,
- scientific research and monitoring to develop a database in order to improve management decisions for jackal conservation and promote co-operation of the jackal hosting countries in the region,
- legislation improvement,
- public awareness, education and information to improve the animal's public image.

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A. Introduction

The golden jackal (*Canis aureus*), hereafter “jackal”, is the most northerly and most widely distributed of the 3 jackal species (*C. adustus*, *C. mesomelas*, *C. aureus*). It is the only jackal species that occurs outside the Sub-Saharan Africa. The golden jackal occurs in North and East Africa, South-eastern Europe, Middle East and South Asia up to Burma and Thailand.

The jackal in Europe is distributed in small and scattered populations, mainly along the Mediterranean and Black Sea coast of the Balkan Peninsula (Demeter & Spassov 1993, Krystufek *et.al.* 1997). Most of the jackals were concentrated in the eastern parts of the peninsula mainly in Bulgaria (Krystufek *et.al.* 1997) and were also widespread in a large part of Greece until recently (Map 1). The jackal in this area occurred only in habitats consisting of agricultural land – scrub mosaics, lowland wetlands and riverine forests (Demeter & Spassov 1993, Giannatos *et.al.* in press).

The jackal has become by far the most rare canid species in Greece (Giannatos & Ioannidis 1989; 1991, Karandinos & Paraschi 1991, Giannatos *et.al.* in press) as its distribution range and population have been declining during the last 3 decades. Officially, the species is neither considered “game” nor a protected one, but it is listed as “vulnerable” in the Red Data Book for Greek Vertebrates (Karandinos & Paraschi 1991). The existing scientific literature regarding the jackal ecology and conservation status in Europe is limited.

In order to develop conservation measures for the species and an action plan for its conservation, WWF Greece launched a countrywide survey, population census and mapping of its range and tried to document the population trends during the last 25 years and to identify the major causes for population decline.

The jackal is not as controversial or damaging as its larger counterpart, the grey wolf (*Canis lupus*), although in high-densities predation on small-sized stock does occur (Genov & Vassilev 1991, Yom - Tov *et.al.* 1995). The species does not have such a negative image among hunters and rural people as the red fox (*Vulpes vulpes*), which is considered as a small-game eliminator and poultry-lifting animal. Due to the low level of human – jackal conflicts it seems that conservation measures for the species would be easier to enforce than with other sympatric canids.

The Action Plan presents the principal actions that should be undertaken for ensuring a long-term coexistence between jackals and humans in Greece under natural conditions. It focuses on a detailed analysis of the needs of local jackal populations, limiting factors, conditions for population stabilisation and recovery and on the specific problem of managing the jackal throughout Greece but it also stresses the necessity for a trans-national approach and co-ordinated national efforts.

B. Background information

B.1. Description of the species, distribution, status and populations

The golden jackal is a medium-sized canid usually the size of a cocker spaniel dog. The animals in South-eastern Europe, Asia Minor and Caucasus, belong to the subspecies *C.a. moreoticus*, which seems to be one of the largest in the world, with animals of both sexes averaging 120 - 125 cm in total length and 10 - 13 kg in body weight (Annex I). Only the North African subspecies *C.a. lupaster* seems to be larger in size (Ferguson 1981). The available data on external measurements of jackals in the region is however little (Annex I).

Pelt colours are quite variable, but usually reddish, golden-brown and silverish predominate, while individual variation in body colour and especially in head and throat markings is quite common.



The golden jackal is a widely distributed canid, mainly in tropical, sub-tropical and southern temperate areas in East and North Africa, SE Europe, Asia Minor, Caucasus, Middle East, parts of Arabian peninsula, Iraq, Iran all Indian sub-continent and Sri-Lanka to Burma and Thailand. In this huge range jackals occupy all types of habitat but extreme deserts and dense forests.

In Europe, Asia Minor and Caucasus, which form the north-western distribution limit of the species range, the jackal distribution is composed of scattered jackal populations along the Mediterranean and Black Sea coasts and following the Danube and its tributaries penetrates the inner lowland areas reaching central Europe (Turan 1984, Demeter & Spassov 1993, Krystufek *et al.* 1997). The population of jackals expanded in the last 2 decades to the north-west to reach Hungary (Heltai *et al.* 2000) and Serbia (Krystufek *et al.* 1997). The population in Hungary seems to be quite dynamic since in a 10-year period a good number of jackal groups have been established so far in the SW part of the country (Heltai, Lanski *pers. comm., pers. obs.*). The jackal population increased in Serbia since the late '70s when it was nearly extinct (Milenkovic 1983). Now two areas – north-eastern Serbia and lower Srem, form the centres of jackal distribution in Serbia. In north-eastern Serbia, jackal

populations were especially large in vicinity of Negotin and Bela Palanka, where during the last decade, about 500 specimens were shot (Savic *et.al.* 1997, Milenkovic & Paunovic 2003).

The largest jackal population in the region seems to occur in Bulgaria (Spasov 1989). The Bulgarian jackal population experienced a 33-fold increase in range from the early sixties to mid-eighties (Krystufek *et.al.* 1997). The causes of this rapid expansion were reported to be the felling of the big continuous natural forests and planting of scattered coniferous stands which formed very dense impenetrable scrub, the highly increased food base in the form of domestic and game animal carcasses from the state game farms, the reduction of the wolf, the abandonment of use of poisoned baits and possibly natural cycles of the jackal population dynamics (Spasov 1989, Genov & Vassilev 1991). An educated estimate for Bulgarian jackal population in the early '90s was put up to 5000 individuals (Demeter & Spasov 1993). The jackal population in Bulgaria increased till 1994 and since then it seems to have been stabilised (Spasov *pers. comm.*).

According to the Albanian Vertebrate Red Data Book (Bego 1997), the jackal in Albania is on the verge of extinction with possible occurrence in only 3 lowland wetland locations along the Adriatic Sea. The status of the jackal population in Turkey, Romania, North Black Sea coast and Caucasus region is largely unknown. In Romania and north-western Black Sea coast there are indications of jackal expansion (Krystufek *et.al.* 1997, Sogolev *pes. comm.*) while in Turkey it was reported that the species was on decline (Kumerloeve 1986). Unfortunately, there was no systematic research and regular monitoring of the Balkan jackal population while data on jackal harvest or damages caused by the animal in the region are highly controversial (Spasov 1989, Demeter & Spasov 1993).

Distribution and numbers of jackals in Greece

According to records of the Greek Ministry of Agriculture (unpublished data), the decline of the jackal population started in the '70s and was even more intense in the early '80s. Already the 1980 harvest was much reduced in comparison to that of the years 1974 to 1979 (Tab.1). The recent population estimate comes from the 2000-01 countrywide WWF Greece survey (Tab. 2). The techniques used for the survey are presented in detail in Chapter 5. The survey of WWF Greece covered all Greece except the Athos peninsula.

The jackal range in Greece is discontinuous, fragmented and it is divided into 7 sub-areas. Each sub-area contained one to nine jackal population clusters containing from 1 to 42 jackal territories each. Each sub-area forms an island jackal population and the communication between the others looks nearly impossible due to natural and man-made barriers. Within sub-areas the communication between population clusters looks most possible since there are no serious barriers between them. However, in Peloponnese, which has the most sparse cluster pattern, the communication of small jackal population clusters throughout the peninsula seems very difficult (Map 2). Also, the population cluster in the westernmost peninsula of Halkidiki (Kassandra) is totally isolated (Map 2).

Table 1: Numbers of jackals killed (Ministry of Agriculture unpublished data)

SUB-AREA	Jackals killed annually in the 1974 – 1979 period (min. – max.)	Jackals killed in 1980
PELOPONNESE	517-1049	192

FOKIDA	1-8	5
SAMOS	13 –96	0
SERRES	14 – 63	52
HALKIDIKI	33-90	20
VISTONIDA- NESTOS	53-122	16
EVROS	27-74	1
REST OF GREECE	34 – 254	83
TOTAL	903 – 1332 animals	369 animals

Table 2: Minimum number of jackal group territories in Greece (2000 –2001 survey data)

<i>SUB-AREA</i>	<i>Number of jackal territories</i>
PELOPONNESE	43 – 46
FOKIDA	9 –11
SAMOS	13 –20
SERRES	1-2
HALKIDIKI	26+
VISTONIDA- NESTOS	53
EVROS	8 – 12
REST OF GREECE	1?
TOTAL	153 – 170

The minimum total jackal population in Greece for the groups that were found in spring 2000 – 01, was estimated to be about 1000 adult and sub-adult animals in 153 – 170 family groups (Giannatos *et.al. in press*)

Detailed information on the natural features, human infrastructure and jackal population estimations of the surveyed areas in 2000– 01, is provided below:

Table 3. Carnivore, ungulate and lagomorph presence in the areas of survey

SUB-AREA	Wolf (<i>Canis lupus</i>)	Fox (<i>V. vulpes</i>)	Wild cat (<i>Felis silvestris</i>)	Otter (<i>L. lutra</i>)	Badger (<i>M. meles</i>)	Stone marten (<i>Martes foina</i>)	Weasel (<i>Mustela nivalis</i>)	Roe deer (<i>C. capreolus</i>)	Wild boar (<i>Sus scrofa</i>)	Brown hare (<i>Lepus europaeus</i>)
Peloponnese ¹	-	+	-	+	+	+	+	-	+	+
*Fokida ¹	+	+	+/-	+	+	+	+	+	+	+
Samos island ^{1,2}	-	-	-	-	-	+	+	-	+	+
*Serres ¹	+/-	+	+	+	+	+	+	+/-	+/-	+
*Halkidiki ¹	r	+	+	+	+	+	+	+	+	+
*Vistonida – Nestos ¹	+/-	+	+**	+	+	+	+	+/-	+	+
*Evros ¹	r	+	+	+	+	+	+	+/-	+	+

INDEX: + = Present, _ = absent, +/- = thinly present in the area - only transient animals, r= very rare

* Animals' presence only in the jackal distribution range

** Very few in the high density jackal areas, but common elsewhere

1: Giannatos unpublished data

2: Dimitropoulos *et.al.*1998

PELOPONNESE

Peloponnese is a peninsula with an area of 21,000 km² and extensive coastline. It is separated by the rest of mainland Greece with a 5.75-km isthmus, which was cut some 120 years ago to facilitate navigation. Most of the area is mountainous with 7 peaks over 2,000 m and numerous reaching over 1,000 m.

The bulk of the human population, settlements and developments occur in the lowland and coastal zones, however small villages and isolated houses are distributed throughout the area of Peloponnese. The road network is dense but outside the main roads traffic remains low throughout most of the year.

The jackal population in Peloponnese is now highly fragmented and greatly reduced in comparison to those of the '70s when up to 1000 jackals were killed annually in this area alone. The decline is especially pronounced in the south where the bulk of the population existed. (Maps 1, 2). According to the bag record of the Min. of Agriculture in the late '70s more than 60% of all the jackals in Greece, were killed in Peloponnese. The bulk of these animals (3800 animals in a 6 year's period) were taken in just two prefectures of Southern Peloponnese - Laconia and Messinia (Annex I).

The total minimum number of jackal groups in Peloponnese is 43- 46. These groups are scattered in 8 to 9 population clusters composed of 1 to 10 territorial groups each. The communication between some of these clusters seems quite difficult, but scattered reports and sightings of jackals all over Peloponnese, especially in the south and north, shows that it is not totally impossible.

CENTRAL GREECE - FOKIDA

In Fokida jackals occur only in the coastal zone. This is a steep and ragged area with some small valleys in the mouth of torrents and temporary streams, which are the only locations where small human settlements exist. There is also a remnant wetland in the mouth of Mornos River (Map 4). The river has been diverted to provide water for the metropolitan area of Athens, so it is mostly dry during summer and early autumn. A secondary national road from Antirio to Amfissa, which receives a fair amount of traffic mainly by trucks, follows the coastline. The inner roads of the prefecture receive very little traffic load throughout the year.

As far as the fauna (Table 3), important change that could influence the status of the jackals in the region seems to be the expansion of wolves. The wolf range has expanded recently, reaching parts of the coastal area, where a few territories seem to have been established since 1996 (pers. obs.).

Total minimum number of jackal groups in Fokida: 9 - 11 in 2 population clusters.

Most of the groups occur in a small coastal wetland remnant of Mornos delta and the other in locations east along the coast (Maps 2, 4, 5). The communication between the 2 clusters seems quite difficult.

Mornos delta has one of the highest densities of jackals found during the 2000-01 surveys. In this area there were 26 –30 jackals minimum, in 5– 6 groups, in an area of 17 km². The area is a very productive alluvial plain with small-scale cultivations mainly alfalfa, some olive and citrus plantations and scattered farm or summerhouses all over the area. Stock raising is quite pronounced with numerous small flocks of sheep, some dairy cows and chicken pens for domestic consumption. Large scale fishing farms as well as one ostrich and one poultry farm exist in the region. The jackal dispersal routes

in this small area are almost completely blocked by extensive urbanisation, lack of cover and steep mountains in the west and most of the north; while in the south there is sea (Map 4). In the eastern part of the area there is an ongoing destruction of the jackal habitat through extensive building and land filling activity next to a very important daytime refuge for the easternmost jackal group. The nearest jackal group cluster is 23 km from the eastern limits of Mornos. The only route for immigration and gene exchange between these population clusters is by following the narrow coastal zone. However, a large portion of the narrow steep coastal belt is occupied by the national road, which forms a very important barrier for jackal dispersal and communication. A major cause of jackal mortality in that area seems to be the road kills in the coastal road that receives a fair amount of traffic. During a period of two years (2001 – 2003), 5 road-killed jackals were found on this road.

The area of Fokida is probably one of the few in Greece where no jackal population declines were reported during the last 20 – 25 years. However, the possibilities for further population expansion are slim, since the animals have to face the very rough inhospitable terrain, the national road barrier and the expanding to the coastal zone wolf population.

SAMOS ISLAND

Samos is a 472-km² island in the Eastern Aegean Sea (Map 2). The island is very mountainous with 12 peaks over 1,000 m. The distance to the opposite Asia Minor coast is 1.7 km in its nearest point (Samos Straits). The major economy sector of the island is tourism. The road network is dense but the traffic is relatively slow due to the rough terrain. The traffic increases considerably during the summer tourist season.

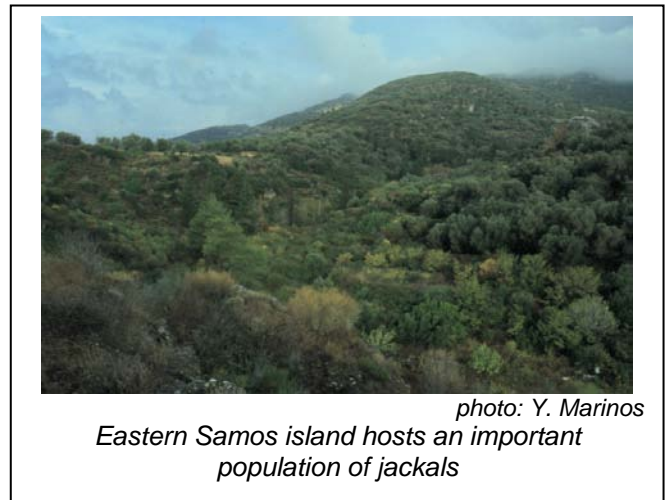
Total minimum number of jackal groups in Samos is 13 - 20.

Most of the groups (8 - 15) were found in the eastern part of the island, which has more fragmented habitat in the form of scrub – small cultivations mosaic, small settlements, numerous scattered farmhouses and the topography is milder. The communication between all groups of the island is possible, since there are no important barriers and distances are small. Very important recent faunal change that

could influence the status of the jackals in the region, at least indirectly, seems to be the recent establishment of a wild boar *Sus scrofa* population. High mortality of jackals during the wild boar hunting period was recorded in Eastern Samos when jackals were shot during the drive hunting procedure. The second very important source of mortality seems to be road kills. The jackal population in the island seems that is going through important fluctuations. The jackal numbers were reduced considerably after the large forest fires in 1999 but recovered quickly 3 years after.

HALKIDIKI

Halkidiki is the only peninsula of Northern Greece. This area ends up in three smaller peninsulas: Kassandra, Sithonia and Athos. The peninsula is very thinly populated with few scattered settlements. Halkidiki is hilly to moderately mountainous covered by extensive forests in the interior and thick Mediterranean vegetation along the coast. There are scattered cereal fields all-over the area while the north-eastern parts are intensively cultivated. The major economy sector is tourism.



Total minimum number of jackal groups in Halkidiki: 26 in 5 population clusters composed of 1 to 7 groups each.

All these population clusters occur in the coastal Mediterranean zone of Halkidiki. The possibility for communication between the groups of the 4 eastern clusters is very possible. It seems also that the area of Athos probably holds a large number of jackals. As mentioned above this area was not surveyed. The 5 groups from Kassandra, the western peninsula, are completely isolated probably for many years (Map 2).

The jackal population in Halkidiki has shrunk during the last 20 – 25 years, but not as dramatically as, in other areas in Greece.

CENTRAL MACEDONIA - SERRES

Most of the area is flat or hilly and intensively cultivated, with very little cover. Cereals and maize are the major crops, cattle mainly, sheep and a few water buffalo is the livestock of the area. Important economy sectors are agriculture and light industry. There are scattered large settlements in the lowlands, but small and few in higher elevation areas.

The jackal population in this area has completely crashed (Maps 1, 2). Only one remnant group was found northeast of Lake Kerkini, which seems to be seriously threatened by the large shepherd and stray dogs that are common around settlements and stables. The jackals in that area, were very shy and according to the locals rarely heard them vocalising. They hide in the scrub thickets at the north side of the lake. The number of animals in this group was estimated to be 3 – 5 individuals.

There is also unconfirmed information of a possible jackal group in Axios riverine forest, about 30 km north of Thessaloniki.

VISTONIDA - NESTOS

This area is composed of three large coastal wetlands of international importance (Ramsar), i.e. Mitrikou lake, Vistonida lake and Nestos delta, which extend along more than 100-km coastline. The area includes several river deltas, 24 lagoons, 2 larger and 18 smaller lakes, the greatest riparian forests in Greece and large marshes. The most important economy sector is agriculture with maize, cotton, alfalfa and vegetables as major crops and few but large flocks of sheep. Medium size settlements are scattered all over the plains but few along the river and the coastal zone.

Total minimum number of jackal groups in Nestos – Vistonis area: 53 in two clusters, in the riverine forest area of Nestos delta (42 groups) and around the lakes Vistonis and Ismaris (11 groups).

This is the largest, healthiest and most dynamic jackal population in Greece. In parts of this area the density of jackals is between the highest recorded in Greece (Giannatos *unpublished data*, Valkanis, *pers. comm.*). Individual animals have been seen in all surrounding area far from the established groups, close to large urban areas of the region. In this area some of the largest litter sizes in Greece have been recorded during the last 3 years (Giannatos *unpublished data*).

EVROS

This area is composed of the largest river delta in Greece with 2 major lagoons by the sea. The area in the north and west of the delta is surrounded by hills covered by Mediterranean forest. Most of the delta area is intensively cultivated and there are remnants of riparian forest along the river while in the hills there are few cultivated areas. Major livestock in the lowlands is cattle while in the hills goats are also common. Most of

the area is thinly populated with a few settlements..

Total minimum number of jackal groups in Evros: 7 –8 in two clusters. One group was detected in the north near Soufli and 6-7 in the south within and around Evros delta.

The northern jackal group, near Soufli (Kornofolia and Lykofi villages) was established after 10 - 15 years of absence from the area. According to information from the local people and the Forest Service large number of jackals colonised the area of Soufli around 1998. Since then, at least 5 animal kills have been reported in the area. Recently the jackal sightings in the area became very few and only after good guidance it was able to locate the existing group. We can only presume that the animals emigrated from a nearby area for various reasons and finally a small group managed to establish itself in this location. Their origin is unknown. The communication between this group and those in the Evros delta seems improbable.

B.2. Life history

Habitat

Based on the predominant habitat types the jackal presence areas were divided into two main categories: lowland wetlands with scrub cover (mainly in Northern Greece), and maquis - small cultivation mosaic (Southern Greece, Halkidiki). The highest location, in which jackals were observed in Northern Greece, was in Halkidiki (Kassandra), at 250m asl, while in the south (Peloponnese) jackals were observed even up to 1050m asl. The largest population cluster, located in Nestos – Vistonida area, NE Greece, was found in an area of less than 10 m asl. Possible explanation of such preferences seems to be that in the Peloponnese most of the lowland habitats have been destroyed by urbanisation and intense cultivation, while in the higher areas some traditional agriculture based on animal husbandry still exists and could provide some scavenging opportunities for jackals. The jackals were therefore occupying less favourable habitats, where they could survive at lower densities. In Northern Greece the higher elevation areas has extensive high forests or unbroken scrublands, severe winters and wolves are common and widespread. Also the coastal zone in Northern Greece has not received so much pressure as in Peloponnese so there is space for jackals.



photo: Y. Marinos
Wetlands constitute an important habitat type for jackals in Greece

The mean distance of the observed jackal groups from the nearest human settlement during the survey was found to be 2.61 km (0.1 – 4.5 km) (n = 112). It looks that the jackals prefer to be close to human settlements where there are scavenging opportunities. Presence of jackal groups very close to human settlements as well as jackal visits inside the settlements during the night was recorded (Map 5, Giannatos unpublished data).

The jackals in all the regularly monitored areas in Greece were using thickly vegetated areas for daytime rest and breeding (Map 5). These areas were usually difficult for humans and domestic animals to penetrate and were composed of a dense and tangling mixture of reeds (*Phragmites australis* or *Arundo donax*), bramble (*Rubus* spp.),

Mediterranean scrub or tamarisk (*Tamarix* spp.). The dense thickets, which developed in the undergrowth of some old plantations of poplar trees (*Populus* sp.), were also used as daytime covers. Dense high crops, such as maize were used as daytime cover for a limited time period annually. Daytime cover areas have been recorded even close to houses or small settlements. The presence of these important thickets allows the jackals to live in areas very densely populated and used by humans and benefit from anthropogenic food sources. The density and distribution pattern of daytime cover areas seems to be crucial for the number and composition of jackal groups in an area. According to Spassov (1989), the expansion of jackal range in Bulgaria was strongly associated with the clearance of natural forests and replanting with dense conifer stands so the animals benefited by the artificial creation of daytime cover areas.

In conclusion, optimum habitat seems to be cultivated areas and wetlands in lower elevations, with adequate cover to be used for hiding and breeding. Areas like these usually have high human use but this could be beneficial for jackals since there is constant year round food supply due to the human activities (animal carcasses, many rodents, human waste, animal excrements etc.) as well as open foraging lands. The jackals in these areas could attain very high densities.

The jackal habitat in Greece is discontinuous, mostly linear and fragmented and the same is true for the animal's distribution. The shape of the jackal range (Maps 1, 2) is elongated as it follows coastlines of lakes and the sea as well as riverbeds and streams. This shape of range and distribution is vulnerable to fragmentation and it is important to maintain communication corridors between the jackal groups to avoid inbreeding. Corridors could be every habitat that does not contain barriers.

Important barriers for jackal distribution seems to be:

- mountains with extensive, high forests or unbroken scrub, heavy snowy winters and irregular food supply,
- large, intensively cultivated areas without cover,
- intensively used urban areas and
- established wolf populations

Systematic persecution by humans in combination with some of the above conditions could also form important barriers, but culling alone is very difficult to annihilate a dynamic jackal population (Spassov 1989, Krystufek & Tvrtkovic 1990, Genov & Vassilev 1991, Yom –Tov *et.al.* 1995, Nemtzov & King 2002, Giannatos unpublished data).

Social behaviour and reproduction

Usually mated pairs hold territories. The largest group observed during the 2001-03 study period numbered 7 individuals in spring. However in Nestos - Vistonida area in Northern Greece a group of 13 individuals has been observed (H. Jerrentrup, pers. comm.). In the study areas the animals were strictly nocturnal and emerged from the dense cover only 15' to 30' min after sunset. However, in the wetlands of northern Greece, where human settlements were far apart and the area was protected, they could be seen also during daylight hours, but they were ready to retreat in dense cover on any human disturbance or even presence. During the night the jackals become very bold and they approach human settlements and stock raising pens. (Map 5, Giannatos unpublished data).

The characteristic jackal howling is a regular night time sound, which was usually heard nearly every night in areas with adjacent jackal groups, but not so often in areas with low jackal densities and rarely from transient individuals.

The jackals are sexually mature at 11 months but they are most likely to postpone reproduction and stay with the parental pair as helpers for at least a year (Moehlman 1983). Oestrus period is once a year, generally in January-March. Parturition occurs after 63 days and litter size varies from 2 to 10 pups. In Southern Bulgaria the dates of birth are reported to be between April 10th and May 20th, while in Northern Bulgaria between April 25th and May 20th (Vassilev & Genov 2002). Mean litter size for Bulgaria was 5.9 (n=300) and litter size was 6 (range 3 – 12), higher in the south of the country, while in the north it was 4.9 (3 – 8). However the litters with more than 10 were only 1% (Vassilev & Genov 2002). In the study areas in Southern Greece between 2 - 4 cubs (n=4) were observed following their parents in late June and early July, while in Northern Greece 9 cubs have been observed the same period (Giannatos unpublished data).

Food ecology

The jackals are opportunistic foragers and not persistent hunters. They like easy human-produced food and in areas near human habitation have been known to subsist almost entirely on garbage and human waste (Mac Donald 1979).

Very little is known for the feeding ecology of the jackals in SE Europe as well as Asia Minor and Caucasus. A small sample from Hungary indicates that rodents and carrion are the major food items there (Lanszki & Heltai 2002). Preliminary report from scats that have been collected in Greece, as well as our own direct observation in the field, show that, rodents, insects, carrion, and fruits comprise the jackal's diet (Giannatos unpublished data). In Israel and Bangladesh the golden jackals were reported as scavengers eating mostly garbage and carrion, but also as important rodent predators (Poche *et.al.* 1987, Yom –Tov *et.al.* 1995). In Greece in two years of intensive monitoring of jackals in Samos and Mornos, no jackal presence around garbage dumps was recorded. An explanation could be that in these areas, close to the garbage dump there were large numbers of stray dogs, while most of garbage volume was composed by package with very little organic material. However most of the jackal groups were recorded close to human settlements (see habitat section).

Territoriality, dispersion and population dynamics

The data presented below come from preliminary analysis of the systematic radio-tracking and direct observations in Mornos and Samos. Only 3 animals from the 5, which were fitted with radio-collars, were tracked for more than 12 months. A female that was intensively radio-tracked for 15 months in Mornos and Samos, had a home range of 2.2 km² while 2 sub-adult males in 12 months had 8.1 km² and 15 km² in Mornos and Samos area respectively (Maps 4,5). 7-8 months after initiation of tracking both sub-adults became loners and their home ranges overlapped with the territories of at least 2 or more jackal resident groups (Giannatos unpublished data). In protected areas of East Africa territories of 0.5 to 2.5 km² were found, using individual recognition (Moehlman 1983), while in Azerbaijan an area of 8 km² was reported by Gitajatov 1965 (in Demeter & Spassov 1993), with no information of how the jackals were monitored.



photo: Y. Marinos

Attachment of a radio collar to a male jackal

The golden jackals can live in high-densities, which means that the areas required for maintaining minimum viable populations could be quite small. In Greece, in the alluvial plain of Mornos, nearly 30 animals were recorded in spring 2003, in an area of 18 km² (~ 1.7 adults+subadults/km²) (Giannatos unpublished data). Similar densities could be found in some areas of Eastern Samos, although total count there, was difficult due to the hilly terrain and the taller vegetation which both reduce visibility. The lowest density of jackals that was recorded in poor quality habitat types in Peloponnese, was one group per 12 km² (minimum 0.4- 0.5 adults + subadults/ km²). In the Nestos area, NE Greece, local concentrations of more than 3 animals/ km² were recorded (unpublished data), while in most of the surveyed areas 2 – 3 groups/10 –12 km² (1 – 1.5 adults + subadults/ km²) was the average (Giannatos *et.al.* in press). In Israel's Golan Heights a density of 2.5 jackals/km² was considered to be very high and proposals to lower them to 1 jackal/km² were made, in order to reduce the damages to livestock (Yom-Tov *et.al.* 1995). In Azerbaijan a density of 0.73 jackals/km², was reported by Gitajatov 1965 (in Demeter & Spassov 1993).

It seems that the jackal population can increase dynamically in a short period, when habitat conditions get improved. In Samos island a rapid population increase in less than 3 years from 13 -14 to 20 groups was documented, despite heavy losses from hunting and road kills (20 killed jackals in 150 km², Giannatos unpublished data). In Bulgaria the jackal range increased 33-fold in approximately 23 years (Krystufek *et.al.* 1997) and the jackal population in Dalmatia expanded considerably since the middle of the last century (Krystufek & Tvrkovic 1990). In Hungary the jackal population expanded rapidly in a period of less than 10 years and occupied a large area in the south part of the country (Heltai, *et.al.* 2003.).

In conclusion, jackal populations seem to be very resilient, can recover quickly after considerable population declines and expand rapidly as soon as the conditions become favourable.

B. 3. Jackals and humans

Public attitudes

Through personal contacts with many people in rural areas we got the feeling that the people's attitude towards jackals run between ignorant and tolerant, especially in Northern Greece. However, in areas of the Peloponnese, where damages on livestock occurred, many people disliked jackals.

In order to find out views and real attitudes of the local people towards jackal conservation, in summer and fall 2002, the WWF team in Samos Island carried out a systematic human dimension survey. The purpose of this study was to establish a baseline assessment of the general public, hunter and student attitudes and beliefs about jackals and to build co-operation between interest groups so to better manage jackals.

A sample of 401 local people out of a total population of 5212 in the major jackal area of the island was personally interviewed using standard Human Dimension (HD) questionnaire (Bath 1996, 1998).

The sex structure of respondents was men: women = 59/41. Age structure: 36% up to 35 years old, 48% between 35 and 60 years and 16% over 60 years old. Hunters comprised ca. 12% of the sample and nearly all the respondents kept domestic animals, mainly poultry. Apart from the general public 314 high school students from Samos and 90 from Fokida were interviewed (Liarakou & Marinos 2003).

Some interesting points from the conclusions are summarised below:

A) The general attitude for the jackals in Samos seems to be quite positive for the preservation of the animal. Some indicative responses are presented in Tables 4 and 5, in comparison with attitudes towards wolves from Sweden, France and Croatia.

B) The knowledge for many aspects of natural history of the animal was very poor, especially for people less than 60 years old while the knowledge for the natural history and behaviour of the animal was lowest among young students (12-15 years old) in both Samos and Fokida. This creates a false image of the animal so this is probably the reason of the relatively high percentage of teenagers in both areas in Greece who disliked or think that it is not worth preserving the animal (Tables 6, 7). Most of the students and younger people had an image of jackal as a wolf-like animal (large body size, serious predator to livestock and large game, mountain animal). This should explain the fear of the teenagers to walk through areas with jackals, which is higher than their counterparts in Spain for the wolf (Tab. 8). Similarly, while most (72%) of the respondents in Samos believed that jackals were not dangerous for humans, among the students only 50% believed so (Liarakou & Marinos 2003).

C) The students in Fokida had less positive attitude towards the jackal. This should be attributed probably to the resettlement of the wolf in the area, during the past decade. Fokida is a relatively poor rural prefecture and consequently the damages that the small stock farmers suffered by the wolf were not tolerated in an area where large predators were absent for many generations. The general perception among local people was that the “environmentalists” released these wolves as well as snakes to rebuild wild populations on expense of the local peoples’ livelihood.

Table 4. GENERAL PUBLIC - Responses to the statement: Which of the following describes best your feelings toward wolves (Europe) / jackal (Samos)

	Like (%)	Dislike (%)	Neutral (%)
Samos (jackals) ¹	51	21	28
Sweden (wolves) ²	49	Not available	30
France (wolves) ³	43.5	29	27
Croatia (wolves) - 3 regions ⁴	26.2 / 15.2 / 12.6	37.4 / 46.6 / 62.0	36.4 / 38.2 / 25.4

¹ Liarakou & Marinos 2003, ² Ericsson & Heberlein 2003, ³ Bath 2000a, ⁴ Bath 2001

Table 5. GENERAL PUBLIC - Responses to the statement: Is it good to maintain wolves (Europe) / jackal (Samos) in the country / locally, so that the next generations can enjoy them

	Good (nationally)	Good (locally)	Bad (nationally)	Bad (locally)	Neutral (nationally)	Neutral (locally)
Samos (jackals) ¹	70	68	13	15	17	17
Sweden (wolves) ²	79	65	N/a	N/a	N/a	N/a
France (wolves) ³	36.7	32.4	40	48.5	23.3	19.1
Croatia (wolves) - 3 regions ⁴	58 / 49.5 / 30.4	50.3 / 38.4 / 20.4	35.4 / 43.3 / 56.9	38.4 / 53.2 / 70.4	16.6 / 6.2 / 12.6	11.3 / 8.4 / 9.1

¹ Liarakou & Marinos 2003, ² Ericsson & Heberlein 2003, ³ Bath 2000a, ⁴ Bath 2001

Table 6. STUDENTS - Responses to the statement: Which of the following describes best your feelings towards wolves (Spain, Croatia) / jackal (Samos, Fokida)

	Like	Dislike	Neutral
Samos (jackals) ¹	56	20	24
Fokida (jackals) ¹	49	24	27
Spain (wolves) ⁵	57	3	40
Croatia (wolves) – 3 regions ⁴	25 / 31 / 23.1	4 / 9.4 / 7.3	71 / 59.7 / 69.5

¹ Liarakou & Marinos 2003, ⁴ Bath 2001 ⁵ Bath 2000b

Table 7. STUDENTS - Is it good to maintain wolves (Croatia) / jackal (Samos, Fokida) locally so that the next generations can enjoy them

	Yes	No	Neutral
Samos (jackals) ¹	58	14	28
Fokida (jackals) ¹	41	14	45
Croatia (wolves) – 3 regions ⁵	74.2 / 64.4 / 50.6	8.1 / 17.4 / 20.5	17.73 / 18.2 / 28.9

¹ Liarakou & Marinos 2003, ⁴ Bath 2001 ⁵ Bath 2000b

Table 8. STUDENTS - Responses to the statement: I would be afraid to hike in the woods if the jackals (Samos / Fokida) / wolves (Spain, Croatia) were present

	Yes	No	Neutral
Samos (jackals) ¹	41	40	19
Fokida (jackals) ¹	47	28	25
Spain (wolves) ⁶	35	52	13
Croatia (wolves) – 3 regions ⁵	62.1 / 62.9 / 62.6	28.3 / 22.7 / 25.3	9.7 / 14.4 / 12

¹ Liarakou & Marinos 2003, 4 Bath 2001, 5 Bath 2000b

D) A very high proportion of hunters (92%), believed that the jackal was harmful to small game despite that 61% oppose to jackal hunting. The same proportions for the general public were 69% and 70% respectively. Also the general attitude of hunters towards jackal conservation was less positive than that of the general public (Liarakou & Marinos 2003).

The results of this first survey on human dimensions for predators in Greece, gave some indications that possible target groups in public education campaign for the jackals in Samos mainly but also in Fokida should be hunters and younger people, especially students.

Damage to livestock

According to local shepherds in the Peloponnese, few damages to livestock were recorded in some mountainous areas and were caused basically by roaming jackals. In the Peloponnese, stray dogs and jackals were the only animals that could prey on small livestock, since there were no wolves. The shepherds usually knew which of the two canid species was responsible for the losses.

In areas with relatively large jackal populations no complaints about livestock damages were recorded. Individual jackals or small jackal groups, have been radio-tracked or seen quite frequently very close to sheep pens, around cattle and nearby chicken pens at night, but no complaints for losses from the stock owners were ever recorded (Map 5). It is considered that the depredation on livestock by jackals, in Greece, is rather local and minimal.

However, the jackals were considered a serious problem animal in Bulgaria where 1053 attacks on small stock (mainly sheep and lambs) were recorded between 1982 – 87 in the southern part of the country, along with some damages to newborn deer in game farms (Genov & Vassilev 1991). The golden jackals in Golan Heights – Israel were also reported to kill 1.5 to 1.9 % of the newborn calves in the area (Yom Tov *et.al.* 1995). In both cases the damages were attributed to the unnaturally high numbers of jackals that boosted due to the high availability of human produced food and/or habitat manipulation (Spasov 1989, Genov & Vassilev 1991, Yom Tov *et.al.* 1995).

In both Israel and Bulgaria the damages were attributed only to high jackal numbers, but it is important to mention that the preventing measures to avoid depredation seem that were lacking in both cases. Genov & Vassilev 1991, reported that in Bulgaria most of the attacks on livestock happened in the flocks of sheep that grazed unattended at night in

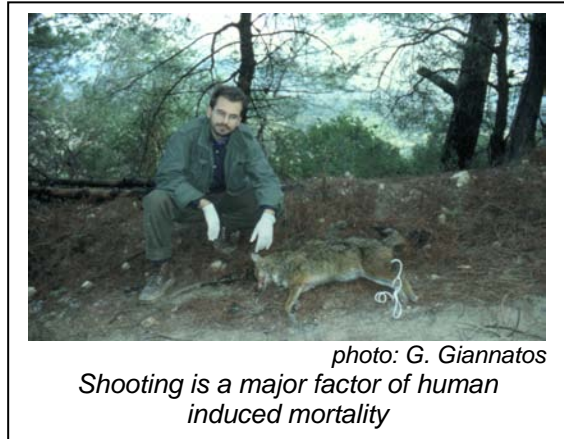
pastures. In Israel the cattle grazed unattended all year round in paddocks and gave birth in the field, so the opportunistic jackals would learn to exploit newborn calves, taking advantage of their high numbers (Yom Tov *et.al.* 1995). In the Peloponnese, the only area in Greece where predation by jackals on small livestock occurred, the damages happened in areas where the jackal population occurred in marginal mountainous habitat and the sheep and goats grazed unattended at night. It is worth to mention that the wolf has been absent from the Peloponnese since the 1950s, whereas the prevention measures are all forgotten. On the contrary, in areas with high jackal densities (Mornos, Northern Greece, Samos) the preventive methods used at night (keeping of sheep and goats in enclosures, presence of livestock guarding dogs), were more from enough to prevent any losses.

Even without preventing measures, the highest damages by jackals in the Balkans that were reported from Bulgaria. are minimal if they are compared, for example, with the domestic animal losses by wolves. The compensated domestic animal losses due to wolf depredation in Greece, which is only a fraction of the total wolf caused losses was in 1998: 5894 sheep and goats, 880 cattle and very few horses (Godes 2002) and between April 1989 and June 1991: 21000 sheep and goats plus 2729 cattle (Papageorgiou *et.al.* 1994).

B.4. Threats, limiting factors, and obstacles to conservation

Hunting and poaching

Many poisoning campaigns against “vermin” (wolf, fox, jackal, stone marten, corvids) were being implemented by the Ministry of Agriculture up to 1981. According to the Ministry’s statistics, on the average 1000 jackals (Table 2), 740 wolves and 50,000 – 74,000 foxes were killed annually in Greece, by hunters and organised carnivore-poisoning campaigns (Min. of Agriculture, unpublished vermin control statistics, Papageorgiou *et.al.* 1994). The jackal was considered vermin up to 1990 and until 1981 a bounty was paid for each animal killed. After 1981 the poisoning campaigns were restricted in smaller areas in order to control fox overpopulation, but also stone martens and sometimes wolves, until they officially stopped in 1993. During the period 1981 - 93, jackals were also killed in some areas although they were not targeted. The jackal was the first to be removed from the vermin list in 1990 and was followed by the wolf and fox in 1993. After the complete ban of the poisoned baits the wolf and fox populations recovered quickly and expanded in most of their former range, but not the jackals (Godes 2002, Anni & Drougas, *pers. comm.*, Giannatos *unpublished data*).



There are still illegal cases of use of poisoned baits to reduce the numbers of foxes, which are currently the most numerous and one of the most widespread carnivores in Greece (Adamakopoulos *et.al.* 1991, Anni *pers. comm.*, *unpublished data*). The extent of this practice in Greece is unknown but we have seen foxes and dogs poisoned during the jackal status survey (2000 –01).

A high proportion of hunters in Greece still consider jackals as animals harmful to small game (look at 2.4, public attitudes) and although they are not hunted intentionally, most hunters would readily kill jackals, during the hunting activity. Usually, due to their shy

nature, the jackals avoid any contact with humans, especially in unprotected areas, where they are strictly nocturnal. Due to this behaviour the losses from hunting activity remain low. However, the type of the hunting practice could impact differently on the jackal mortality. Nearly all shot jackals in Samos in 2001 - 03, were killed during the drive-hunting for wild boars (Giannatos *unpublished data*). This practice, which is used only for wild boar hunting, involves large groups of hunters and many dogs that chase off the boars from their dense cover to ambushing guns. In the hunting period 2002 -3 in Eastern Samos in an area of 150 km², hunters killed approximately 15 jackals (out of 20 known deaths), most of them during wild boar hunting (Giannatos *unpublished data*). The direct human caused mortality in Samos was 1 dead jackal per 7.5 km², which is similar to the annual culling in high jackal density areas in Bulgaria i.e. 1 animal per 6 km² (Spassov *pers. comm.*) and in Croatia 1 animal per 7.13 km², during the population boom in the late '80s (Krystufek & Tvrtkovic 1990).

Despite, the high mortality rates, in the same period the jackals repopulated areas and expanded their range in all parts of Samos. This is again, an indication that the suitability of the habitat is more important for population recovery. However, in low jackal density areas, like South - Central Peloponnese (Megalopolis), the mortality from wild boar hunting could be detrimental to the already declining jackal population.

Habitat quality and food availability

Optimum habitat for the jackal in Greece seems to be a mosaic of Mediterranean scrub and small cultivated fields as well as lowland wetlands with sufficient cover (look 2.4, habitat). The high human presence and/or use in these areas do not deter the settlement of jackal groups as soon as there are sufficient densely vegetated areas to serve as daytime refuges. The trophic position of the jackal as an omnivore forager and scavenger and not a persistent hunter, could facilitate its existence in human dominated environments, where activities like stock raising and small-scale cultivations dominate.

Important habitat and human use changes have happened during the past 25 -30 years in the middle- and low altitude areas in Greece during which, the jackal population declined. The abandonment of the small cultivations in the middle altitude areas, the decline of small-stock raising, the changes in animal husbandry, the intensification of cultivations in the lowlands, the urbanisation and forest fires in large parts of lowland Greece, contributed to jackal population reduction into small clusters, gradually isolated from each other. These population clusters were highly vulnerable to direct human caused mortality (road kills, shooting), probable diseases (from stray dogs) and catastrophes (flooding, forest fires etc..) and therefore susceptible to inbreeding and final extirpation.

Greece as a mountainous country has many mountain barriers mainly in the central and western parts of the country so the small jackal populations that were naturally there, were more vulnerable to the agro-pastoral changes in the past 25 - 30 years (Maps 1, 2). The monitoring of disappearance in species like the Iberian lynx *Lynx pardinus* (Rodrigues & Delibes 2003), show that extinction in fragmented animal populations is related to the size of fragments and the distance between them.

In northern and eastern parts of the country as well as western Peloponnese most of the lowland areas were under intensive agricultural schemes and the 73.2 % of marshes and wetlands have been drained and destroyed in the past 70 years (Psilovikos 1992). It is also important to mention that in most of the mainland Greece there is a widely distributed wolf population, which dominates the medium and higher altitude areas (Godes 2002, Papageorgiou *et.al.* 1994, Giannatos *unpublished data*).

In areas such as the northern coast of Peloponnese and Attica the jackal retreated due to extensive urbanisation of the coastal and hilly areas. More than 30 % of the human population is concentrated in Attica, a 2% of the country's area (National Statistical Service of Greece 2002), so the surrounding mountain foothills and most of the coastal areas have been extensively developed. The coast of Northern Peloponnese has also been developed in a nearly continuous 80 km coastal zone.

Additional to these habitat alterations, the intensive persecution of the jackals in the '70s and '80s along with the forest fires in the Mediterranean zone increased the probability for local extinctions.

At the verge of extinction are currently the small isolated population clusters in Halkidiki, Serres and in parts of Peloponnese and Fokida (Map 2), due to their minimal size and possible inbreeding.

Numbers, densities and demographic fluctuation

The jackal belongs to high-density population canids which means that they occur in relatively high numbers in small areas. This is an important conservation issue, since in the first place, it is not necessary to establish large protected areas to ensure the survival of viable jackal populations. No studies or tests exist to show how small a completely isolated population of jackals could be and still survive for a long period.

If a population of 100 jackals was assumed to be viable as it is considered for wolf (Boitani 2000), then a high-density population ($1.7 / \text{km}^2$) needs to occupy habitat of less than 60 km^2 , with density of $1/\text{km}^2$, which is about average, it needs 100 km^2 area, while for low density a 250 km^2 area is needed. In contrast, to conserve a similar size wolf population needs to have at least 2000 km^2 for very high density populations, from 3500 to 10000 km^2 for average density population and larger than that for low density populations (Boitani 2000).

In Greece the jackal population fragments that were composed of more than 15 non-isolated family groups (approximately 90 animals), were the ones in Nestos –Vistonida, eastern Halkidiki, Samos and probably southern Peloponnese.

It seems that jackal numbers can recover and increase dynamically in a short period, when conditions are favourable. During only a 4-year period, a large population fluctuation was documented in Samos Island. The jackals declined considerably to reach a very low point until the early 2000 and then rapidly recovered. The causes of this recovery were not well understood and documented; it was assumed that the recovery of the vegetation after the huge forest fires that burned nearly 30% of the island in 1999 was an important positive change. The new undergrowth was dense so many new jackal groups were able to re-establish.

Interactions with feral dogs, other canids and wildlife

Preliminary field data indicated that the relationship of the jackal with other canid species was that of a competitor. The wolves usually dominated the jackals and the jackals dominated the foxes.

The range of jackals and wolves in Central and Northern Greece was almost mutually exclusive. In Fokida a jackal group abandoned its territory when a wolf pack of 4 established itself (*unpublished data*). In 3 cases during the 2000-01 jackal survey, wolves approached the jackal-calling stations at a quick trotting pace, presumably to chase off the jackals. According to Genov & Vassiliev (1989), Spassov (1989) and

Krystufek & Tvrtkovic (1990) the wolf presence is an important limiting factor for the jackal distribution in the Balkan Peninsula.

It seems that jackal population density is a factor that could greatly influence the presence of foxes. Although no actual observations of direct fox - jackal interactions were made during our 3 year study, foxes in Fokida occurred permanently only in the fringes of the jackal territories. However, in the winter, a few individual foxes have been recorded within the jackal territories and in one case a fox was observed very close (ca. 250 m) to a jackal group of 4. In southern Peloponnese an increase of the fox population was observed in areas where the jackals have been decimated (Giannatos *unpublished data*). No foxes are present in Samos Island (Dimitropoulos *et.al.* 1998). In Israel where jackals and foxes co-exist, the jackals may kill or displace foxes (Macdonald 1987). In Nestos area, the foxes were absent from the high jackal density areas, while in the same areas, the wild cats (*Felis silvestris*) became rare when jackal population increased (Valkanis *pers. comm.*, Giannatos *pers. observation*). In contrast, badgers shared the same hiding areas with jackals and used even the same day-cover locations.

Dogs barked aggressively whenever jackal howling was heard and at close quarters some became strongly agitated. During the 2000-01 countrywide jackal survey, in many cases dog groups (3–7 individuals) approached the calling stations at a running manner, barking in a hostile way after the hearing of broadcasted jackal howls. The reaction of unleashed dogs in close quarters with jackals was to chase them away instantly. In few cases stray dogs were doing damages to small stock animals, which were attributed to jackals (Giannatos *unpublished data*).

Besides direct competition, the dogs may transmit infectious diseases to small jackal population clusters, something that could lead to their elimination. The state veterinarian in Samos Island attributed a recent jackal decline in the island, to the Leishmaniasis outbreak in the numerous stray dogs. The jackals that were recovered from road accidents at the Hellenic Wildlife Hospital (EKPAZ) proved to be much more sensitive to Erlichiosis than the stray dogs (*Dragoumis, pers. comm.*). Greece is considered a rabies – free country, with the last isolated incident recorded in 1987. In neighbouring countries according to the World Health Organisation (www.who-rabies-bulletin.org), rabies cases have been reported from northern Bulgaria, while in Turkey rabies is widespread with epidemic outbreaks. Albania was rabies -free until 2001 when one rabies incident was detected near the Yugoslavian borders. Since then no other rabies cases were reported from that country. The FYR of Macedonia was rabies-free at least until 2001, but there is no data since then. More to north, in the FR of Yugoslavia there were rabies incidents all over the country (*WHO rabies bulletin* 1999, 2003). A disease outbreak could be detrimental to small isolated populations of jackals, which are widespread in Greece or adjacent countries with limited jackal distribution. However, the vulnerability of jackal to rabies is a controversial matter. In Israel, the annual rabies cases for jackals were very low ranging between 0 and 10% as a percentage of the cases in all wild carnivores (Nemtsov & King 2002). This proportion remained low and stable even during a sylvatic rabies (wild animal rabies) outbreak, despite the very high density of jackals in the country. In contrast the same years, the percentage of rabid foxes was much higher ranging from 23% during the period of low sylvatic rabies cases to nearly 80% during rabies outbreak (Nemtsov & King 2002).

In some areas hunters claim that the expansion of wild boars in the jackal habitat drove away the jackals from the usual daytime cover areas. It is possible, in areas with limited cover availability that the wild boars did so, but the largest jackal population in NE Greece thrives in an area of high wild boar density. This indicates that the two species can live in the same area if there is enough space.

Legislation

The species in Greece is legally unclassified i.e. it neither appears in the list of game animals that could be hunted in Greece nor in the protection list. The jackal was considered as vermin up to 1990 and until 1981 a bounty was paid for each animal killed.

The jackal is not considered a priority species for the European Union (it is included in the Annex V of the Habitats Directive, 92/43 EC), so any conservation activity has to be done with national funds only.

C. Goal and objectives of the Action Plan

The overall goal is to maintain and if possible restore, in coexistence with people, viable populations of jackals as an integral part of ecosystems in Greece. The restoration and conservation of the jackal populations as well as those of other important animals in SE Europe are an essential part of the effort to conserve the biodiversity of the region and to ensure the functionality of its ecosystems.

In order to fulfil this goal the following specific objectives have to be achieved:

- Facilitate and allow the recovery, stabilisation and maintaining of the jackal in suitable areas of Greece with as less dependence as possible to human related food sources;
- Achieve a sustainable compromise between the conservation needs of the jackal and those linked to developing and maintaining human economic activities;

These objectives can in turn be achieved through a series of joint and integrated actions, which both from an operational and descriptive viewpoint, can be grouped together according to the various perspectives that best describe the problem. In the following chapter these actions are described in detail.

D. Actions for the achievement of the goals and objectives

The management plan required to safeguard the status and promote recovery of the golden jackal in Greece is going to focus on actions for habitat conservation, research and monitoring, species conservation and public awareness education and information.

All the actions are ranked in priority order and category on the nature of action. Also, a link with each other and a time frame is provided.

The priority rank is assigned as follows:

P1. Action that has to be taken to prevent extinction or irreversible decline in the foreseeable future

P2. Action that has to be taken to prevent significant decline in numbers or habitat quality

P3. All other actions to be taken to meet the plan objectives

Proposed actions are categorised as:

A Administration

E Education

L Enforcement

M Management

R Research

D.1. Habitat conservation actions

Objective: To safeguard the existing habitat patches and to facilitate communication between jackal populations

The preservation and restoration of safe and high productivity habitat is first priority for jackal conservation. Large part of the jackal's former range has been seriously transformed and now the population is composed of island-clustered fragments. The size of minimum viable population for a completely isolated population is unknown. However in our opinion the initial goal should be to maintain population fragments of at least 15 family groups, a bit less than 100 adult and sub-adult animals. This population size is already accepted for preservation of other canids (Boitani 2000) and also it could be feasible for the fragmented jackal populations of the region. Further habitat fragmentation should be stopped to secure the continuity of viable jackal populations. Important habitat alterations that will modify habitat and reduce the vegetation cover should be strongly opposed. These habitat alterations are the following, ordered in high to small destructive impact: urbanisation, exclusive fencing, bush and reed clearing in the fringes of the cultivated areas, conversion of traditional small scale agro-system to irrigated intensive monoculture without hedgerows. Future highway or road upgrades should not be built through jackal habitat unless an adequate number of wildlife passages are built to avoid transportation related mortality, minimise fragmentation of the jackal population, and promote dispersal. The Mediterranean bush encroachment and the creation of large unbroken scrub areas could be a barrier too, but this is an uncommon case in the jackal habitat in lowland Greece.

The densely vegetated daytime refuges are essential for jackal occurrence. The size of the daytime patches and their distribution pattern clearly influences the distribution and population status of the jackal groups.

In areas where active management is possible, such as NATURA 2000 sites, the creation of more daytime cover areas by allowing the re-vegetation of selected areas would be an important step for jackal population recovery. Already, 60% –70% of the Greek jackal population exists in NATURA 2000 sites (see Annex II). Areas with first priority for habitat maintenance and restoration are, in ranking order: Serres (Kerkini), Northern Peloponnese, Fokida, Southern Peloponnese, Evros and Halkidiki.

Important tool for active management of the jackal habitat could be the agro-environmental projects, which promote the non – intensive agricultural practices and the existence of hedgerows and bushes in the farm perimeter. Projects like these are already underway or are going to be implemented in some areas of mainland Greece and focus on the preservation of habitat of vulnerable or endangered species including bears and wolves (Agro-environmental EIPA (EK) 1257/99, Article 22 and 53 Chapt. 2). Only one such a project is underway in the jackal distribution range. This is the “Project for the conservation of Thracian lakes and lagoons of NATURA 2000 sites (A11500010 and A 1130009)”, which is implemented in an area of 200 km², which includes the majority of the largest jackal population in Greece in Nestos – Vistonida area. (Agro-environmental EIPA (EK) 1257/99, Article 22 and 53 Chapt. 2, action 3.10).

Priority: P1

Category: M, L,

Correlated actions: 4.2.1, 4.2.2, 4.3.1, 4.3.2

Time frame: Short term

D.2. Research and monitoring actions

Objective: Develop a database, to improve and update management decisions for jackal populations in Greece and SE Europe, Asia Minor and the Caucasus region.

The knowledge about jackals in the region is relatively scarce yet this knowledge is absolutely necessary in order to properly manage the species. It is very important to monitor annually the jackal populations to get knowledge about its trend and habitat status. Important research steps for the near future will probably be the gathering of basic knowledge about features of daytime cover areas, population dynamics, dispersal and inbreeding level.

D.2.1. Annual long-term monitoring

The monitoring should be an annual survey of the jackal population in Greece and adjacent countries in the same time-period by using the same methodology, in order to identify changes in distribution and numbers and detect possible threats. The monitoring should focus in areas with small isolated jackal populations. First priority areas in Greece should be Serres (Kerkini), Peloponnese, Fokida, Evros and Halkidiki.

Priority: P2

Category: M, R

Correlated actions: 4.1, 4.2.3

Time frame: long-term

D.2.2. Scientific Research

Current research priorities are:

- a) Determine the minimum area required for a daytime cover in order to hold a jackal family group. It is unknown which is the minimum size of the dense vegetation patch in order that a jackal family group feels safe to breed into. The habitat conditions and human use around the hiding patches probably influence its occupation. There are indications that the shape of the daytime cover areas is also important, as breeding jackals do not seem to prefer the narrow hedgerows along the edges of fields.
- b) Determine the optimum distribution of the daytime cover areas to maintain healthy continuous jackal populations as well as documentation of jackal dispersal in order to identify distance of communication between population clusters and type of the terrain, which facilitates or prevents the animal movements.
- c) Determine the Minimum Viable Population size for jackals
- d) Determine the influence of stray dogs to jackal populations. In some areas (Samos, parts of Peloponnese) there is high stray-dog presence and numbers within the jackal territories and in many cases jackal-dog interactions occur near livestock pens, villages and isolated settlements. Direct or indirect impacts of these interactions are not well documented and impact of competition on local jackal populations is unknown. Important issues for study should be disease spreading, overlapping food habits, direct competition and exclusion from clumped food supply.

- e) Identify the level of inbreeding in the population clusters of jackals, especially in areas where the jackals are isolated for long time. Due to the topography, natural conditions and the human created barriers in Greece, many jackal populations were of small size and isolated. In the past, probably even relatively large jackal populations went through population bottlenecks due to the poisoning campaigns in the '70s and '80s. Priority populations for research are these in Kassandra (Halkidiki), Peloponnese, Samos. Already samples of tissue have been gathered from jackals all over Greece for genetic fingerprinting.

Priority: P2 for a, b, P3 for the rest

Category: R

Correlated actions: 4.1, 4.2.3

Time frame: 3 years would be minimum

D.2.3. International co-operation

A close link has to be established or existing links have to be strengthened between the countries that have jackal populations. This is especially important with researchers in neighbouring countries that host jackal populations. Currently a very good contact with Turkish scientists was established while the more than 10-year old contact with the Bulgarians was renewed. Close co-operation has already been established with the Hungarian research team with research visits exchanges as well as a good contact with prospects for co-operation with the Serbian scientists. Major objectives for this co-operation should be to:

- a) Promote international co-operation and exchange of experience among experts working on the species in SE and Central Europe.
- b) Establish an annual long-term monitoring all-over the region with the use of same methodology
- c) Create national management plans in each country of the region

Although the connectivity of the jackal populations in the Balkans is very little known and the patchy distribution of the species in most of its range needs more attention, we shall provide some suggestions for probable population linkages.

- The Greek jackal population is possibly connected with the opposite Turkish side of the Evros delta in the area of Gala lakes
- The Bulgarian population probably is connected with the Turkish in the Strantzha region along the Black sea coast, with the Romanian along the Danube and with the Serbian further west in the area of Negotin. There is a slight possibility that some jackals could reach Greece through Arda valley, but no such incident is yet documented.
- The Serbian population is probably connected with the Hungarian population and possibly the Romanian.
- The Dalmatian population along the coast from Montenegro to Croatia and recently up to Italy has to be considered a distinct population. The current connectivity between the sub-populations in this region is unknown as well as if there are resident jackal groups in Slovenia.

- The Albanian remnant population in Skoder area is probably connected to a Montenegrin sub-population.

Priority: P3

Category: M, R, A

Correlated actions: 4.2.1, 4.2.2

Time frame: long-term

D.3. Improvement of legislation

Objective: To provide a legal framework, which will support and facilitate conservation actions

D.3.1: Adoption of the action plan by the Greek Authorities

An adoption of this Action Plan by the Ministries of Agriculture and Environment will certainly help jackal conservation and management in Greece. On a national level, the local and peripheral authorities will be forced to deal with jackal conservation and lobbying groups will have a more powerful tool to achieving their goals.

Priority: P2

Category: A, L, M

Correlated actions: 4.1, 4.3.2

Time frame: short term

D.3.2: Protection by National Law

The species is legally unclassified in a national level while it is not considered a priority species for the European Union.

The animal is fulfilling the criteria to be listed as an endangered species in most of its range in Greece. Although the intensity of habitat destruction eased recently in most of the jackal range there is still ongoing destruction in various localities, which threaten the remnant population fragments of jackals. It is therefore a need to include the jackal and its habitat into the protected list.

The inclusion of the Golden Jackal into the Annex II of the Habitats Directive (92/43 EC), as a species of Community importance needs the co-ordination of all the jackal hosting countries. The task is difficult since the animal is not considered a large predator (such as the wolf, bear, lynx, Iberian lynx and the wolverine) due to its ecological and morphological features. Also it is expanding its range in parts of Balkans and central Europe for reasons probably related to non-barrier habitat conditions and high availability of human produced food supply. The upgrading of the species in the Habitats Directive requires a lot of effort and very strict documentation from the jackal hosting countries in the region.

Priority: P3

Category: A, L

Correlated actions: 4.3.1

Time frame: short term

D.4. Public awareness, education and information

Objective: To improve the animal's public image and as a result facilitate future conservation measures

People living in or frequenting jackal habitat must be educated about the role of the animal in the ecosystem. This information should be directed to decision makers, those with commercial interest within jackal habitat, and the public in general. A campaign to inform the public should be an integral part of the conservation program.

A good educational campaign should be prepared and conducted by going through the following steps:

- a) Identify target groups, their existing knowledge levels and attitudes as well as assess the current educational information.
- b) Design efforts and messages targeted by group.
- c) Implement the educational campaign.
- d) Conduct an evaluation of the educational efforts. What effects did they have? What has to be improved? To what extent were attitudes of the target group changed and what brought about the change?
- e) Monitoring: Attitudes and beliefs of the target groups as well as the goals of the campaign have to be reassessed in a continual process. In other words, after running an educational campaign for some time one must go back to step "a" again and start the process over again

WWF-Greece in the framework of the jackal conservation project did a small-scale information campaign, which was addressed to the general public, and it produced two sets of brochures and a number of press releases and media reports. Also the long-term presence of the research team during the study in areas where jackals live had a very positive effect in changing the attitudes of a number of local people through personal contacts and participation in the survey. The jackal was a rather unknown animal for the general public, with a confused status and image but since the project and the campaign of WWF-Greece some people got some information at least that the animal is threatened. However, yet a large-scale evaluation of these educational efforts and a monitoring of the attitudes and beliefs of the target groups are still missing.

The plan to start the process of a public information and education program has to follow the recommendations of the Human Dimension survey, which was carried out by WWF-Greece. The analysis of questionnaires provided directions about target groups, their knowledge levels and attitudes as well as it assessed the current educational information level, and so we are now in the step "b" of the campaign logical process. The target groups that have to be addressed by now are: hunters, students, local shepherds and general public.

The education campaign should focus on:

- the production of communication material for students and general public on aspects of the biology of the animal and its role in the ecosystem

- the provision of communication material for environmental education in schools and the conduct of lectures with the produced material in schools of jackal areas
- Finding ways to improve attitudes of local hunters towards jackal by emphasising the role of jackal in the Mediterranean ecosystems as rodent predator and scavenger and not a persistent hunter of small game as well as a limiting factor for fox population

Finally information material should be produced on preventing measures to be taken by the shepherds in Peloponnese to avoid depredation problems by jackals on small livestock. The problem of predation on livestock is considered to be very local in Greece and of a minimal importance that could be prevented easily. Good enclosures for night livestock pens plus the presence of medium-size watchdogs are enough to prevent damages. In areas with jackal presence the unattended night grazing of small stock should be strongly avoided.

Priority: P3

Category: E, M

Correlated actions: 4.3.2

Time frame: 1 –2 years

E. Rapid assessment survey techniques

In order to assess the importance of current threats and the management actions needed to allow recovery or stabilisation of the jackals it is important to determine the distribution and status of the targeted populations. The ability to use non-invasive, inexpensive, user-friendly survey methods to assess rapidly the status of the animal population with relatively high degree of accuracy is a major scientific quest. This is especially important for animals that have not previously been studied and their status is risky so the available data is minimal. In this case the enforcement of appropriate management decisions is absolutely crucial for their future.

Below we describe in brief the methods we have used to assess the population status of the jackals in Greece in a relatively short time period.

a) Questionnaires – interviews – information gathering.

A successful survey starts with the gathering of all possible reliable information. Local people, national and local authorities, game wardens, foresters, hunters, shepherds, outdoorsmen, nature lovers, etc., could provide important information and give an initial idea about the jackal status in an area. With appropriate questionnaires one could get important information on the approximate distribution of the species in the past, the present distribution and the possible movements of jackal groups. The number of questionnaires is not always the criterion for the vigour of the information; instead information from knowledgeable people is more important.

b) Acoustic stimulation – call-ins

In locations with appropriate jackal habitat the actual status of the jackals can be verified by using stimulating call-ins. The species is quite vocal and relatively easy to detect wherever there are established territories. The current population status of the jackal in Greece was assessed with a calling survey method that combined acoustic and visual observations of jackals after stimulation with playback howls.

In brief this survey method includes broadcasted howls that were played at night, always 1 hour after sunset on calm, dry nights in locations with good visibility and acoustics, and usually – but depending on the terrain - at a high vantage point. Each howl session had 30-sec duration and was followed by 5-minute pause at a time. In each site the broadcasted howls were played for 30 minutes. The direction of speakers was changed every 2 – 3 trials depending on the landscape structure and the wind direction. During and after each howl trial members of the field team recorded the directions and the possible numbers of the responding animals. In case of an immediate response from close-quarters high intensity spotlights were used to survey the area at 360° around the position of the count point to look for the approaching animals. If we had a response from large distance or no response at all, we surveyed the area with the spotlights after the 2nd or 3rd trial (5-10 minutes from the beginning of sampling), in order not to scare away possible approaching animals. The effective area of coverage depends on the landscape relief and should be under ideal conditions 12 km² maximum (2-km radius from the calling station). More information about the conditions and the technical details of the method can be found in: Giannatos *et al.* (in press) and http://www.panda.org/about_wwf/where_we_work/europe/where/greece/jackals/wwf_project.cfm

This survey method proved to be quick, easy to use and inexpensive. Jackal groups were detected even in areas with very thin presence, in marginal habitats, or even close to fierce competitors like stray dogs. Absence of response cannot be translated to absence of jackals, but possible absence of established territorial groups. In two areas where the jackal group territories were well known there was an absolute accordance between the actual number of groups and the number recorded during the 2000 – 01 acoustic survey (Giannatos *et al.* in press). Similar methods have been extensively used to survey social and vocal carnivores (Mc Carley 1975, Harrington & Mech 1982, Creel & Creel 1996, Jaeger *et al.* 1996, Ogutu & Dublin 1998, Mills *et al.* 2001).

c) Transect counts

The transect counts could be done by driving at low speed through quiet and usually dirt forest roads at night within the selected area. The animals were located with the use of powerful spotlight in both sides of the road - transect.

The method could be used to monitor the trend of the jackal population in a given area if the route and the time of the year are standardised. However there are objections for the reliability of the method to monitor canid abundance (Warrick & Harris 2001). The effectiveness of the sampled area during spotlighting depended on the landscape relief and the vegetation cover. Best season in temperate zone would be any time from August to March to avoid denning and whelping season. Winter months allow more visibility since the vegetation is not so lush and the fields fallow.

In Mornos study area we attempted a total count of the jackal population by using spotlighting. The area was quite open and small so the coverage was very high, since nearly 80% of the open foraging area was completely covered (Map 6). In the same area a combination of radio-tracking, known groups and acoustic stimulation was also used to come up with conclusions about total population numbers.

This method is recommended to be used in combination with other methods to have reliable results. It is also recommended for areas with relatively open flat terrain, short grass and a good road network.

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Maps and annexes

Map 1. Jackal distribution in the late '70s in Greece



Map 2. Present jackal distribution in Greece

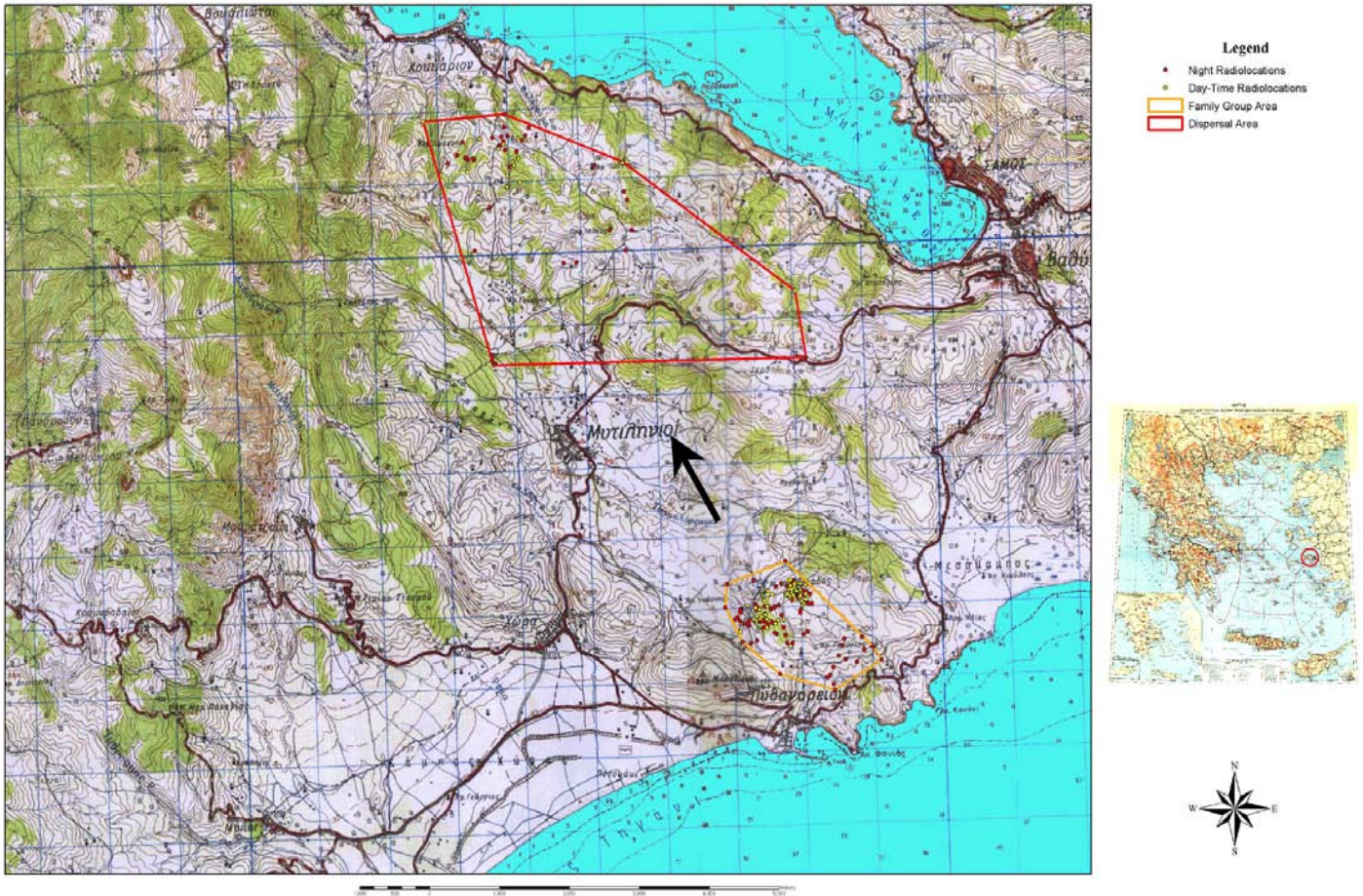


LEGEND

- 1: Evros
- 2: Vistonida – Nestos
- 3: Serres
- 4: Halkidiki
- 5: Fokida
- 6: Peloponnese
- 7: Samos

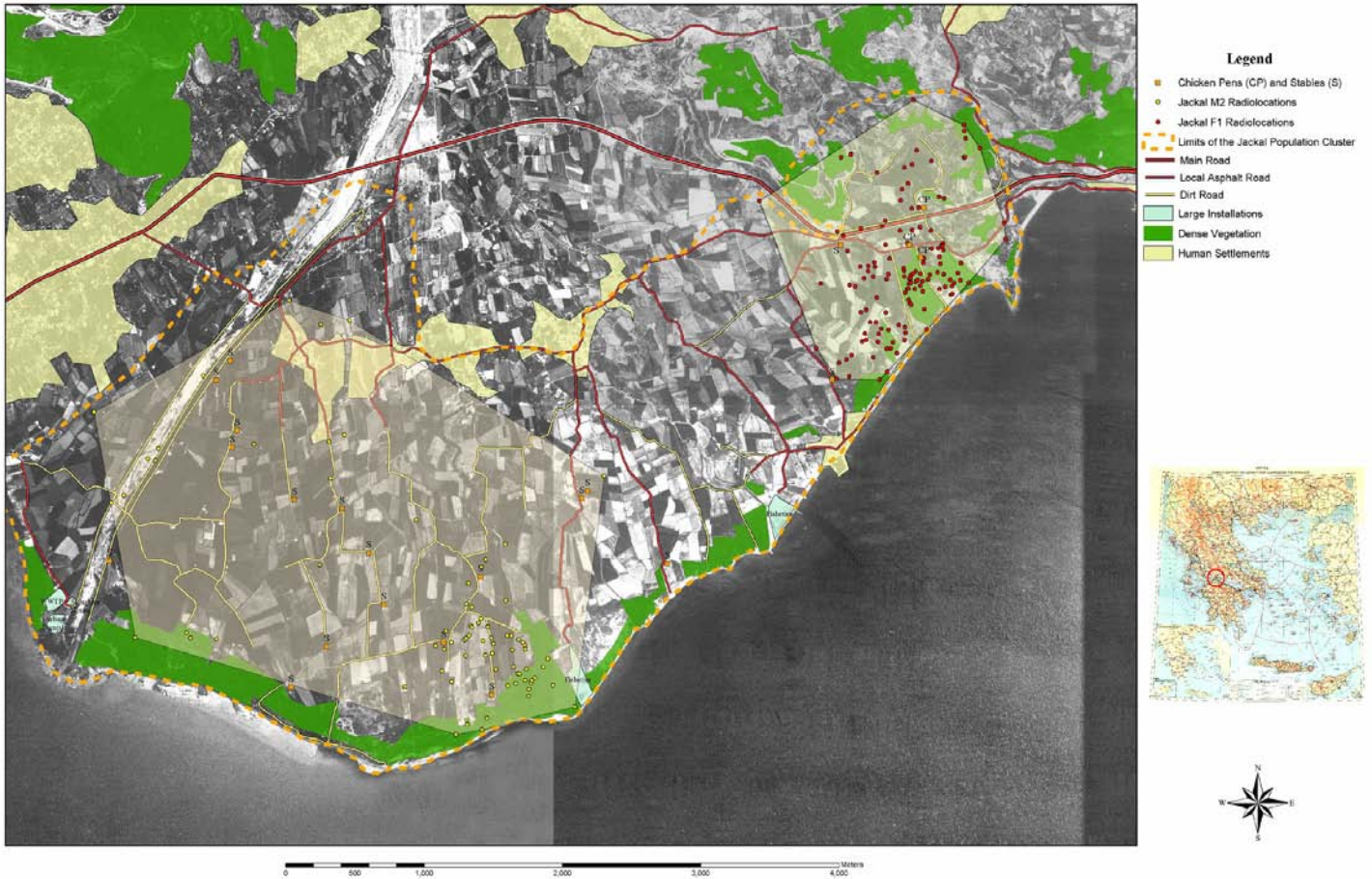
Map 3. East Samos study area - jackal home ranges

East Samos Study Area - Jackal M1 Radiolocations



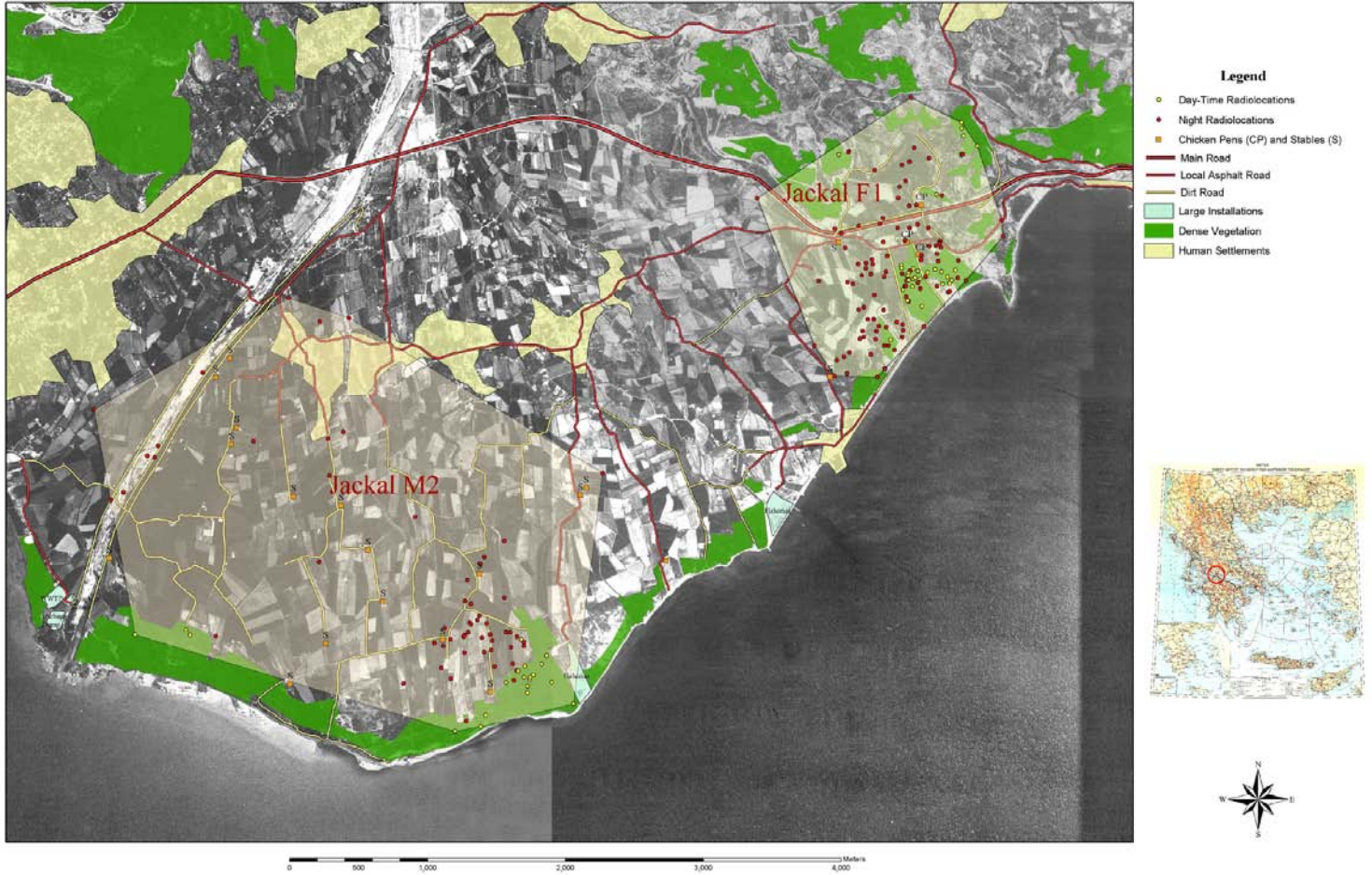
Map 4. Mornos study area – jackal home ranges

Mornos Study Area - Jackal Radiolocations



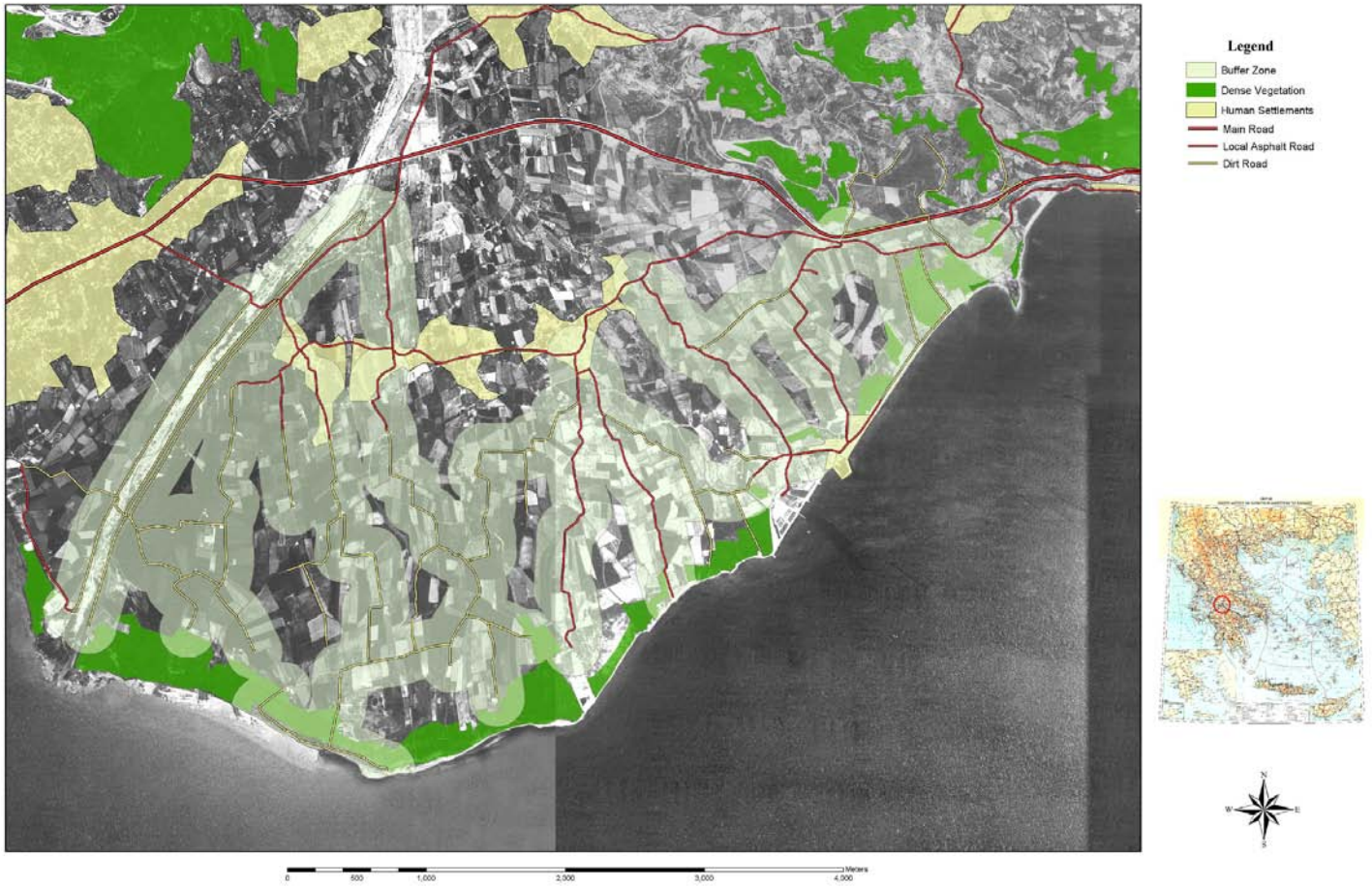
Map 5. Day-cover and foraging areas in Mornos

Day Cover and Foraging Areas for Jackals in Mornos



Map 6. Area covered by spotlight survey in the Mornos study area

Mornos Study Area - Spotlighting Survey Route and Effective Buffer Zone Coverage



ANNEX I. Body measurements of Canis aureus moreoticus

Bulgaria:

Head and body length: male 85.2 cm (range 80.1-90.2, n=21), female 80.3 cm (range 75.1-84, n=21) (Demeter & Spassov 1993)

Head and body length: male 74.3 – 85.5 cm, female 75 –80 cm, Tail: male 24 –25 cm, female 21 – 22 cm (Atanassov 1955)- sample unknown.

Caucasus:

Head and body length: male 90 cm (range 65 – 105, n = 210), female 80 cm (range 52 –100, n=200), Tail: male 24 cm (range 22 –27, n = 210), tail: 23 cm (range 21 – 26, n=200) (Aliev 1968)

Greece:

Head and body length: Unsexed 88 – 96 cm, tail: 21 – 26 cm (n =10, adults) (Giannatos *unpublished data*)

Body mass:

Bulgaria: Maximum weights 15 kg for males and 11 kg for females (Atanassov 1955) – sample unknown.

Caucasus: Male 12.2 kg (range 8 – 15.5, n=210), female 11.5 kg (range 7 – 14.5, n=200). (Aliev 1968)

Greece: Unsexed 10.5 –14 kg (n = 10, adults), (Giannatos *unpublished data*).

ANNEX II: Jackals killed in the period 1974 – 1980 in Greece

PROVINCES	1974	1975	1976	1977	1978	1979	1980	TOTAL
PREFECTURES								
STEREA HELLAS								
ATTIKI	31	26	38	10	8	20	8	141
EVRYTANIA								0
VIOTIA	22	25	30	32	4	17	9	139
AETOLOAKARNANIA	20	29	22	29	15	9	22	146
EVIA	4			1				5
FOKIDA	8	3	1	1	4	6	5	28
FTHIOTIDA	33	8	12	3	5	16		77
IPIROS								
IOANNINA		7	5	2			1	15
THESPROTIA	33	26	22	32	33	22		168
ARTA			23	2	1	1	3	30
PREVEZA	19	26	30	23	50			148
THESSALIA								
LARISSA	1		5	3	4	2	1	16
MAGNISSIA	12	6	10	4	4	5	16	57
KARDITSA			2		1			3
TRIKALA	4							4
PELOPONNESE								
KORINTHIA	15	15	14	10	10	16	8	88
AHAIA	19	37	15	27	20	27	8	153
ILIAS	24	4	20	7	7	14		76
LAKONIA	235	316	313	255	386	762	74	2341

ARKADIA	9	2	9	3	10	31	29	93
MESSINIA	301	278	240	214	201	195	73	1502
ARGOLIDA	3	1	2	1	7	4		18
MACEDONIA								
KAVALA	63	69	81	39	24	31	16	323
SERRES	29	21	63	36	26	14	52	241
KILKIS		1				4	1	6
IMATHIA	1	2				3		6
THESSALONIKI	8	13	27	18	17	14	21	118
HALKIDIKI	87	61	61	33	90	39	20	391
DRAMA		3		2				5
PELLA								0
KOZANI							1	1
PIERIA	5	2	4		1			12
FLORINA								0
KASTORIA								0
GREVENA								0
THRAKI								
EVROS	55	74	28	29	27	27	1	241
XANTHI	10	17	25	25	19	37		133
KOMOTINI	3	4	1	4	1	3		16
ISLANDS								
DODEKANISA								0
CYKLADES				2				2
LESVOS								0
HIOS								0
SAMOS	57	96	79	54	27	13		326
KERKIRA	3	3	1					7
KEFALONIA								0

ZAKINTHOS								0
LEFKADA				1				1
CRETE								0
TOTAL	1114	1175	1183	902	1002	1332	369	7077

ANNEX III: Greek NATURA 2000 sites hosting jackals

Evros

GR1110005	VOUNA EVROU	I	199608	
GR1110007	DELTA EVROU KAI DYTIKOS VRAXIONAS	I	199608	√ (GR 1110001)

Vistonida - Nestos

GR1120005	AISTHITIKO DASOS NESTOU	G	199608	√ (GR 1120004)
GR1130009	<i>LIMNES & LIMNOTHALASSES TIS THRAKIS-EVRYTERI PERIOCHI KAI PARAKTIA ZONI</i>	I	199608	√
GR1150010	<i>DELTA NESTOU & LIMNOTHALASSES KERAMOTIS-EVRYTERI PERIOCHI KAI PARAKTIA ZONI</i>	I	199608	√

Serres

GR1260001	LIMNI KERKINI-KROUSIA-KORYFES OROUS BELES, AGISTRO-CHAROPO	I	199608	√
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Halkidiki

GR1270002	OROS ITAMOS-SITHONIA	E	199608	√
GR1270003	CHERSONISOS ATHOS	B	199910	
GR1270009	<i>PLATANITSI-SYKIA: AKR. RIGAS-AKR. ADOLO</i>	B	199608	√

Fokida

GR2450004	PARALIAKI ZONI APO NAFPAKTO EOS ITEA	B	199911	
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Peloponnese

GR2520003	LIMNOTHALASSA MOUSTOU	B	199704	√
GR2530002	LIMNI STYMFALIA	B	199608	
GR2540002	PERIOCHI NEAPOLIS KAI NISOS ELAFONISOS	B	199910	√

Samos

GR4120003	<i>SAMOS: OROS KERKETEFS - MIKRO KAI MEGALO SEITANI - DASOS KASTANIAS KAI LEKKAS, AKR. KATAVASIS-LIMENAS</i>	C	199512	√
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