# INTERNATIONAL CARNIVORE CONSERVATION AND MANAGEMENT

## WITH THREE CASE STUDIES IN

## SOUTHEST ASIA, CENTRAL AND SOUTH AMERICA, AND EUROPE

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## EXECUTIVE SUMMARY

Managing and conserving large carnivores in human dominated landscapes requires a multidimensional approach. First, the landscape must be viewed from the species perspective; ecological and biological factors such as habitat requirements, social structure, predator-prey dynamics, and inter- and intra-specific competition need to be addressed. Second, the relationship between humans and a species cannot be ignored; social factors such as attitudes and beliefs towards the species and the role that species has on the local, regional, or global economy should be considered. Finally, the landscape needs to be considered at a political scale; communities and cultures often create distinct boundaries represented by national borders that are traversed by wide-ranging species such as carnivores.

The tiger in southeast Asia, the jaguar in Latin America, and the brown bear in the Pyrenees mountains of France and Spain have all experienced population declines in the past century related to human activities such as hunting and land clearing. Conservation strategies have been implemented for all three with varying degrees of success. While the species' ecological and biological needs are often realized in the early stages of conservation efforts, the human perspective in the form of socio-economic factors are often implemented in the latter stages, or ignored completely. In addition, while most conservation strategies are first implemented within national boundaries, international cooperation has shown to prevail despite many countries having strained relationships.

Lessons learned from the successes and failures of the conservation strategies of the tiger, jaguar and Pyrenees brown bear highlight the need for comprehensive carnivore conservation strategies. The creation of protected areas was often the first reaction to dwindling carnivore numbers; however, the declines of tiger and jaguar populations taught the scientific community

that conservation cannot occur solely on reserves. The integration of local communities and private lands into conservation strategies is an integral, but often overlooked, component of a successful plan.

Carnivores have drawn forth some of man's strongest emotions; fear and anger from conflicts between humans and carnivores led to the decimation of many carnivore populations while at the same time their symbol of unadulterated wilderness have provoked feelings of awe and respect. In spite of intense persecution, the respect carnivores engender has enabled the animals to remain a part of many landscapes across the globe. However, given the expanding human population and resulting conflict that arises from increasing the wildland/human interface, comprehensive conservation strategies remain integral to the persistence of many endangered carnivores.

## INTRODUCTION

### The human-carnivore relationship

*History of carnivore management*

Carnivores offer unique conservation and management challenges to wildlife biologists. Large carnivores such as the grizzly bear (*Ursus arctos*), tiger (*Panthera tigris)*), and jaguar (*Panthera onca*) have extensive home ranges and wide-ranging dispersal capabilities. Most ecosystems large enough to support large carnivores are managed by several different national land and wildlife management agencies as well as myriad private landowners (Keiter and Locke 1996). Ecologic, socio-economic, and political factors must be considered in the management and conservation of any species. In addition, the spatial scale at which carnivore populations exist requires the further consideration of international cooperation and coordination.

Legislative policies and management strategies often reflect the social system in which they are implemented. Negative feelings between humans and carnivores escalated over time as civilizations have become more developed, and have been compounded by the threat carnivores potentially posed to economically important livestock, huntable wildlife, or other land uses (Kellert 1996). Thus, the killing of carnivores was either done for reasons of fear, competition with game species such as deer, or to a lesser degree, social status.

The unorganized and opportunistic persecution of predators by humans eventually evolved, in many places, into government sponsored plans for eradication using such tools as traps, firearms, and poisons (Clark 1996). Some governments encouraged eradication programs with incentives such as bounties. Policies of eradication are still present in current carnivore management strategies; however, many management agencies have incorporated regulations on the harvest of predators. While programs of eradication are designed to reduce the negative economic or ecological impacts of carnivores in an unrestricted manner, a regulated harvest involves controlling the timing, location, method, or number of carnivores killed by hunters (Treves and Karanth 2003). In contrast to management strategies that implement either restricted or unrestricted killing of carnivores, the third strategy used to manage carnivore populations, preservation, most often eliminates the harvest of carnivores altogether. Preservation is often applied in protected areas or for carnivore populations considered endangered, rare, or valuable (Treves and Karanth 2003). While preservation has garnered support in recent years, the control of carnivores is still often seen as necessary for game and livestock protection (Dunlap 1988).

*Justification for conservation*

The evolution from policies of eradication to efforts of preservation can be attributed to economic, ethological, symbolic, and/or ecologic reasons. Eradication gave way to regulated

harvest in many felid species due to their commercial value as pelts in the garment industry. For example, as the value of leopard skins and their rarity increased from the 1920s to the 1960s in Uganda, eradication was replaced by regulated harvest (Treves and Naugton-Treves 1999). In contrast to the tangible benefits received from managing a species in an economic context, the benefits associated with managing a species for ethological or aesthetic reasons are derived from the abstract pleasure of knowing the species exists. In other words, the carnivores are being conserved largely for themselves (Linnell et al 2005). Similarly, many people view carnivores as symbols of the lost wilderness and while we may not be able to achieve wilderness as many conservationists hope for (e.g. in North America, Soule and Terborgh 1999), at least some of the wildness can be restored to the landscape (Linnell 2005). Finally, it is theorized that predators exert a powerful influence on biological communities via predation and interspecific competition. Carnivores often regulate or limit the numbers of their prey, thereby altering the structure and function of entire ecosystems (Terborgh et al. 2002).

After a potential carnivore management project has been justified, wildlife managers and conservationists work toward achieving a goal by means of eradication, regulation, preservation, or a combination of the three. Linnell et al (2005) described seven levels of conservation ambition for large carnivores: (1) species presence, (2) some ecosystem processes occur, (3) species demographic viability is achieved, (4) the evolutionary potential of the species to adapt to future conditions is maintained, (5) the full community of carnivores and their prey is restored, (6) the limitation and or regulation of numbers of predators and prey are primarily determined by trophic interactions, (7) the system is able to exist in a dynamic state, fluctuating under the influence of climate, disease, and other external factors. Most current strategies are concerned primarily with maintaining species presence.

*Challenges to carnivore conservation*

In spite of the growing support for sustainable management of carnivore populations, several challenges restrict the success of achieving the aforementioned goals. Easily identifiable are the proximate limitations to sustainable management such as habitat loss, over-hunting, commercial markets for animal parts, and disease (Weber and Rabinowitz 1996). However it is the distal, or fundamental causes of species decline that are the underlying drivers for the proximate factors (Swanson 2004). Most international conservation strategies that do not succeed are flawed by a lack of biological and ecological understanding (Soule and Terborgh 1999), ignoring the socio-economic context (Treves and Karanth 2003), and not recognizing the complex policy process associated with multi-agency and multi-national projects (Clark et al. 1996). By ignoring these key variables associated with success of international carnivore conservation and management, the subsequent policy is constructed with short sightedness and narrow mindedness. To develop a successful international carnivore conservation plan, one must consider the ecological, socio-economic, and political context of the species. that results in a comprehensive approach in conservation strategies and actions. Only when these elements are viewed as interdependent, can a comprehensive approach to conservation strategies and actions be accomplished.

**Considerations for carnivore conservation strategies**

*Ecological considerations*

Conservation efforts that ignore ecological data can become too narrowly focused on single, high profile issues, such as over-harvest, and can miss other factors contributing to a species decline. Prior to initiating a management strategy, one must understand the biology and

ecology of a species including habitat requirements, genetic considerations, interspecific interactions, and diseases. In addition, the collection of ecological data needs be accomplished with the most appropriate survey techniques available.

Carnivores are inherently difficult to survey based on their secretive nature, often nocturnal habits, and low densities (Gros et al 1996). Carnivore densities may be estimated by identifying all individuals within a population by using unique features such as stripe patterns. This technique, however, can vary widely in successfully estimating population size. One such attempt was made by Indian scientists in 1971. Scientists in India recognized that, due to a high demand for tiger parts for medicinal purposes, their tiger population was in jeopardy and initiated a systematic effort to determine the status of its Bengal tigers (*Panthera tigris tigris*) (Weber and Rabinowitz 1996). Results from a survey technique called pugmark tracing indicated the tiger population was stable or increasing; however, in reality the tiger population was declining. The basis of pugmark tracing assumes that individual tigers leave uniquely identifiable paw prints, yet biological research shows that tigers do not, in fact, leave unique paw prints (Karanth 1987). When Indian biologists chose a survey technique that did not take into account the biology of the tiger, conservation efforts were hindered. Survey efforts carried out across a large landscape and involve several agencies can also suffer from a lack of consistency, or surveyor error. The quality of a survey depends on the size and ability of the survey teams, weather conditions, and areas covered (H. Quigley in Weber and Rabinowitz 1996).

By understanding the individual and population level habitat requirements of the species of interest (Scott et al. 1999) managers can concentrate management efforts in the areas most important for species conservation. Landscapes that support carnivores are noted for a large percentage of core area and habitat corridors. While the type of habitat that may comprise the

core areas and corridors may vary from species to species, contiguous habitat is a common requirement for large carnivores. Core areas are areas where human uses are greatly restricted and natural processes reign. Core areas refer to areas where conservation of biodiversity, ecological integrity, wilderness, or similar values takes precedence over other values and uses (Noss et al 1999). When core areas are disrupted by fragmentation, it is oftentimes possible to maintain connectivity between the fragments by protecting natural corridors of suitable habitat (Dobson et al. 1999).

The extensive habitat requirements of large carnivores mandate that management occur not only in public reserves, but include private landowners. Private land is often an important element in the creation of habitat corridors between core areas. While an entire arena of science has emerged dedicated to reserve design, there have also been strides made in private land management through the use of incentive programs. In India for example, conservationists piloted an incentive program to motivate local communities to protect the snow leopard (*Uncia uncia*) by creating livestock-free areas to reduce conflict with humans (Mishra et al. 2003).

Genetics is also one of the important factors in species management. Darwin (1896) was the first to consider the importance of genetics in the persistence of natural populations when he expressed concern about the loss of vigor in a deer population due to small population size and isolation. Similar concerns are expressed today regarding carnivore populations such as the cheetah (*Acinonyx jubatus)* and lion (*Panthera leo leo*) (Barnett et al 2006). Allendorf and Luikart (2007) outlined five ways in which genetic information is used in conservation of a species: (1) management and reintroduction of captive populations, and the restoration of biological communities, (2) description and identification of individuals, genetic population structure, kin relationships, and taxonomic relationships, (3) detection and prediction of the

effects of habitat loss, fragmentation, and isolation, (4) detection and prediction of the effects of hybridization and introgression, and (5) understanding the relationships between adaptation or fitness and the genetic characters of individuals or populations. Decisions in carnivore conservation regarding the number of individuals needed for a sustainable population, the size and shape of reserves, and the source of individuals for reintroduction programs all have genetic implications. For example, Pimm et al. (2006) examined the consequences of introducing a population of Texas cougars (*Puma concolor*) into south Florida with a population of endangered panther sub-species (*Puma concolor coryi)* and found that the hybrid and purebred kittens have different chances of reaching adulthood, hybrid and purebred adult females have different survival rates and hybrids are expanding the known range of habitat panthers occupy and use.

Interspecific interactions (both predator-prey and intra-predator) can be a driving force behind the demographics, spatial arrangement, and habitat selection of carnivores. For example, Karanth and Sunquist (1995 in Weber) found that relative densities of different size classes of prey in an area may be the key determinant of relative densities of tigers and other large predators. Understanding this relationship allows researchers to use prey density estimates in combination with data on tigers' prey killing rates (Sunquist 1981) to indirectly derive tiger densities from prey abundance (Karanth 1995). In contrast, Mills and Gorman (1997) found that the density of African wild dogs (*Lycaon pictus*) was inversely related to prey density. Instead of prey density, Mills and Gorman identified lion and hyena density as the most reliable predictor of African wild dog density. Through interspecifc competition, lions and hyenas cause wild dogs to select habitat that is not the most abundant in prey species. Thus for wild dog conservation, the density of competitors, not prey, should be an important criteria when considering an area for the reintroduction.

Recognizing interspecific interactions and spatial overlap is also important for understanding the potential consequences of disease on carnivore populations. Diseases such as rabies and canine distemper virus (CDV) can be transmitted horizontally among taxa as illustrated by wolf population declines initiated by disease transmission from arctic or red fox (Ballard and Krausman 1997). One condition that is conducive to disease transmission that must be recognized is the spatial overlap of wild species with domestic species. The overlap between domestic dogs *(Canis lupis familiaris*) with the African wild dog and the lion facilitated the transmission of disease and the subsequent decline of the two populations of wild animals. Conservation biologists need to identify conditions that are conducive to the spread of infections and severity of disease in advance of epidemics, and to implement control measures that will prevent or mitigate such epidemics (Murray et al. 1999).

*Socio-economic considerations*

Once baseline biological data are available, it is essential to expand the conservation equation to include relevant socio-economic factors. Conservation does not occur in a vacuum, and understanding the broader context is essential to long-term success. This is especially true for trans-boundary initiatives in which cultural and ideological concerns must be considered and balanced with those of a more ecological nature (Weber and Rabinowitz 1996). Considerations must include an examination of human-carnivore conflicts, economics, human health/disease issues, human values towards carnivores, human population growth and human density.

Historically, the factor that most influenced carnivore management consisted of human-carnivore conflict. Linnell et al. (2006) defines two types of conflict: material and psycho-social. Material conflicts have physical and/or economic components such as loss of livestock due to predation whereas psycho-social conflicts occur in the minds of individuals or groups such as

fear of injury or death. Additionally, in some social conflicts, carnivores may take on a highly symbolic role as the most important proximate factor that threatens rural lifestyles under perceived attack by national and international forces (Egan 1994, Linnell 2005). For example, when wolves were reintroduced to Yellowstone National Park, threats and acts of violence against federal employees in the West escalated (Egan 1995). Working inside reserve boundaries is not an excuse to ignore potential human-carnivore conflicts, as conflicts of all sorts are concentrated at the edges of protected areas (Naughton-Treves et al. 2000 in Treves and Karanth 2003).

Carnivores also play a significant role in economic realms. Humans derive economic value from carnivores through revenue from animal parts, trophy hunts, and ecotourism. Central and South American countries have earned capital from jaguar pelts, African countries from the pelts of the cheetah, lion, and other cats, and Asian countries from not only the hide of the tiger but also from tiger body parts such as the penis and bones. However, after the enactment of the Treaty on the Convention for the International Trade of Endangered Species of Flora and Fauna (CITES), much of the trade of spotted cats decreased. Although it was difficult to change long-established practices, many governments including that of Bolivia, were not averse to the idea of creating extensive protected areas that would help ensure the survival of a large carnivore species and bring in much needed tourist dollars (Weber and Rabinowitz 1996). On the opposite end of the spectrum, large carnivores are viewed as a source of economic loss through livestock predation, oftentimes leading to programs of eradication. The frequency and economic cost of conflicts between humans and carnivores appears to be on the rise in many areas (Treves and Karanth 2003) as humans expand in population (Woodruffe 2000). Wildlife managers must recognize the economic impact, either positive or negative, on the local communities and try to

work with the people instead of against them. If conflict exists, interventions to prevent livestock loss must be a part of a sound carnivore management plan with the caveat that it must be within the socioeconomic constraints of the community (Treves and Karanth 2003).

The degree of conflict and the economic worth of a carnivore often defines the value humans attribute to a species. For example, Rabinowitz (1992) reported a change in human attitudes in Belize toward jaguars when ecotourism resulting from jaguar preserves brought much-needed economic gains to the country. Where local support for carnivore conservation is lacking, incentive schemes and compensation can often generate goodwill (Mishra et al. 2003). An evaluation of human values towards the carnivore of interest is crucial, because without local support, carnivore conservation policies are often compromised (Treves and Karanth 2003).

Many human values towards animals are influenced by the role of the species as a reservoir for disease. While some of the prominent zoonotic diseases originate from species other than carnivores (SARS, HIV, Ebola), other disease such as rabies can persist in wild carnivore populations and can be considered a threat to human health. While carnivores play host to a number of diseases, the elusive habits of most carnivores, coupled with the lack of carnivores in the human diet, has minimized the role carnivores play in disease transmission to humans. Despite the low infection rate, any zoonotic disease that may be present in a carnivore population proposed for conservation should be taken into consideration.

*Political considerations*

The last consideration in the design of a comprehensive international carnivore conservation strategy is the political landscape. Policy pervades all conservation efforts. The conservation biologist needs “knowledge (or intelligence) that is directly useful in the policy process coupled with knowledge of the process itself” (Clark 1992:424 in Primm). Developing

better knowledge of these processes can lead to more effective participation both in policy design and policy implementation (Primm and Clark 1996).

The extensive home ranges of large carnivores transcend political boundaries and span multiple cultures, each in turn operating under different procedures and laws. When a carnivore's range straddles international borders, the management actions (e.g., logging, ranching, mining) of one country have an effect on the others. In 1994, many of the Asian countries with optimal tiger habitat recognized this and initiated the Trans-boundary Biodiversity Conservation Program to help bring together government officials from many of the states with tiger range. Cooperation is also necessary at an even broader scale when carnivores are being affected by the global trading market. Incited by worldwide concern for the wild cats in Asia, Africa, and Latin America based on the international demand for fur, the World Conservation Union (IUCN) together with the governments of Kenya and the United States coordinated an international effort that resulted in the ratification of CITES in 1975. The purpose of CITES was to aid in the regulation of international trade in designated species including cats.

An understanding of the political landscape could help avoid inconsistencies between agencies that share the carnivore habitat as was evident in the United States when the Wyoming's legislation attempted to place a $500 bounty on wolves, in conflict with federal law protecting the animals (Kenworthy 1995). If conservationists, managers, researchers, and concerned citizens possessed an explicit understanding of the policy process and how to participate in it most constructively, it would improve the odds of achieving more accommodating policies for large carnivore conservation (Clark et al. 1996).

**Implementing conservation strategies**

After ecological, socio-economic, and political factors have been considered, a conservation strategy and associated actions can be implemented in a comprehensive approach. A comprehensive approach entails defining the problem, prescribing the policy, implementation, and evaluation (Clark et al. 1996).

*Problem definition*

Designing and implementing a conservation strategy without explicitly defining the problem is parallel to navigating a complex road system without a map. It is necessary to map, or define, the carnivore conservation problem by identifying the fundamental causes that have influenced the current status of the population (Clark et al. 1996). The nature of international conservation efforts, with multiple governments, agencies, and organizations generates multiple problem definitions. Thus the task for decision makers and managers is (1) to develop a broad, systematic understanding of the problem and the many constituencies who are framing it; (2)identify and coordinate stakeholders and bring opponents toward a shared problem definition or perspective; (3) to forge an effective feasible problem solving strategy; and (4) to implement the strategy successfully (Clark et al. 1996).

If it is found in the problem definition stage that biological, socio-economic, or political data are missing, research must be applied to generate required facts. For example, if the socio-economic concern of human-carnivore conflicts exits due to livestock predation, research is needed to confirm that it is, in fact, the wild carnivore that is decimating the livestock. In Latin America, local communities claimed that the jaguar was a severe threat to livestock; however, research clearly showed that livestock losses blamed on jaguars were often related to other causes such as disease, flooding, and theft (Weber and Rabinowitz 1996). In another example, if disease is identified as the main threat to the conservation of a carnivore population, research

should be conducted that identifies the factors associated the their spread and severity (Murray et al. 1999).

*Policy prescription and implementation*

Prescribing the policy involves training, education, and wildlife management. The efforts and attitudes of the local community have a greater influence on the success of a conservation strategy that the legislators who developed the plan. The local biologists or naturalists must be trained to carry out ecological surveys that deliver reliable information (Clark et al. 1996). In many cases involving large carnivores, the only effective conservation method is preservation of the species, its prey, and its habitat. In some cases, local communities can be trained and educated in sustainable ways to extract resources from protected areas. Elsewhere, ecotourism may provide a non-consumptive, alternative source of income and/or employment (Rasker and Hackman 1996). Congruent with training and education is wildlife management. This may entail calculating sustainable harvest levels, managing habitat, surveying populations to obtain abundance estimates (for both predator and prey), reintroducing populations (predator and/or prey), and managing captive breeding facilities. The prescription may include setting strict protective measures such as patrolled reserve boundaries or establishing incentive programs (Mishra 2003).

*Policy evaluation*

A successful policy process has a strict evaluation program in which the carnivore status, habitat conditions, socioeconomic conditions and other factors related to the strategy's success are monitored (Weber and Rabinowitz 1996). The knowledge gained should then be shared with decision makers and management plans and practices adapted accordingly. Good conservation is

a dynamic process. Without monitoring an feedback, conservation is reduced to mere crisis management (Weber and Rabinowitz 1996).

**Implications**

The implications of successful international carnivore conservation are numerous. Carnivores are often a keystone, umbrella, or flagship species in conservation efforts. As a keystone species, carnivores exert a disproportionate amount of influence on the ecosystem they inhabit. The removal of a keystone species significantly changes major ecological functions of the ecosystem such as trophic relationships or community structure. As an umbrella species, the large tracts of undisturbed habitat that would be conserved for carnivores require would also conserve other species, regardless of the ecological relationship among the species. A flagship species is a charismatic creature that captures the attention of people and elicits a strong protective reaction. (Meffe et al. 1997). While the role of carnivores as a keystone species is debated, their role as an umbrella or flagship species results in the conservation of ecosystems supporting numerous species and may also serve to maintain healthy relationships between species.

## CASE STUDIES

**Tigers (*Panthera tigris*) in Asia**

One of the largest living felids, the tiger has played a significant role as a cultural icon in many Asian societies. Despite this importance, three of the eight tiger subspecies have gone extinct in the last 60 years. The remaining subspecies – the Bengal (*P. tigris tigris*), Indo-Chinese (*P. tigris corbetti*), Siberian (*P. tigris altaica*), South China (*P. tigris amoyensis*), and Sumatra (*P. tigris sumatrae*) tigers persist in fragmented populations of no more than a few

thousand individuals across 14 countries (Fig. 1) in bioregions known as the Indian subcontinent, Indochina, Southeast Asia, south China, and the Russian Far East (Wikramanayake et al. 1998) . As such, the tiger has become a symbol for conservation in the face of habitat loss and persecution. Alongside continued hunting and habitat loss, human populations in Asia have increased dramatically and per capita expendable income has risen to record levels (Mills and Jackson 1994). Higher incomes in parts of Asia have fueled demand for high-priced traditional medicines derived from animals. A direct result has been an increased consumption of tiger parts, in particular tiger bone (Jackson 1993). Congruent to the demand for tiger body parts has been loss of wild habitat and poaching of tiger prey species such as deer, pigs, and wild cattle.

Some of the most important tiger research has occurred in India and Nepal. India, home to most of the world's current tiger population, hosted some of the earliest ecological and behavioral research on tigers (Schaller 1967) and conservation initiatives. In 1971, India began a systematic effort to determine the status of its Bengal tigers and in the same year, established a country wide program called Project Tiger for the protection and conservation of this subspecies (Weber and Rabinowitz 1996). A few years later in Nepal, an intensive tiger research program

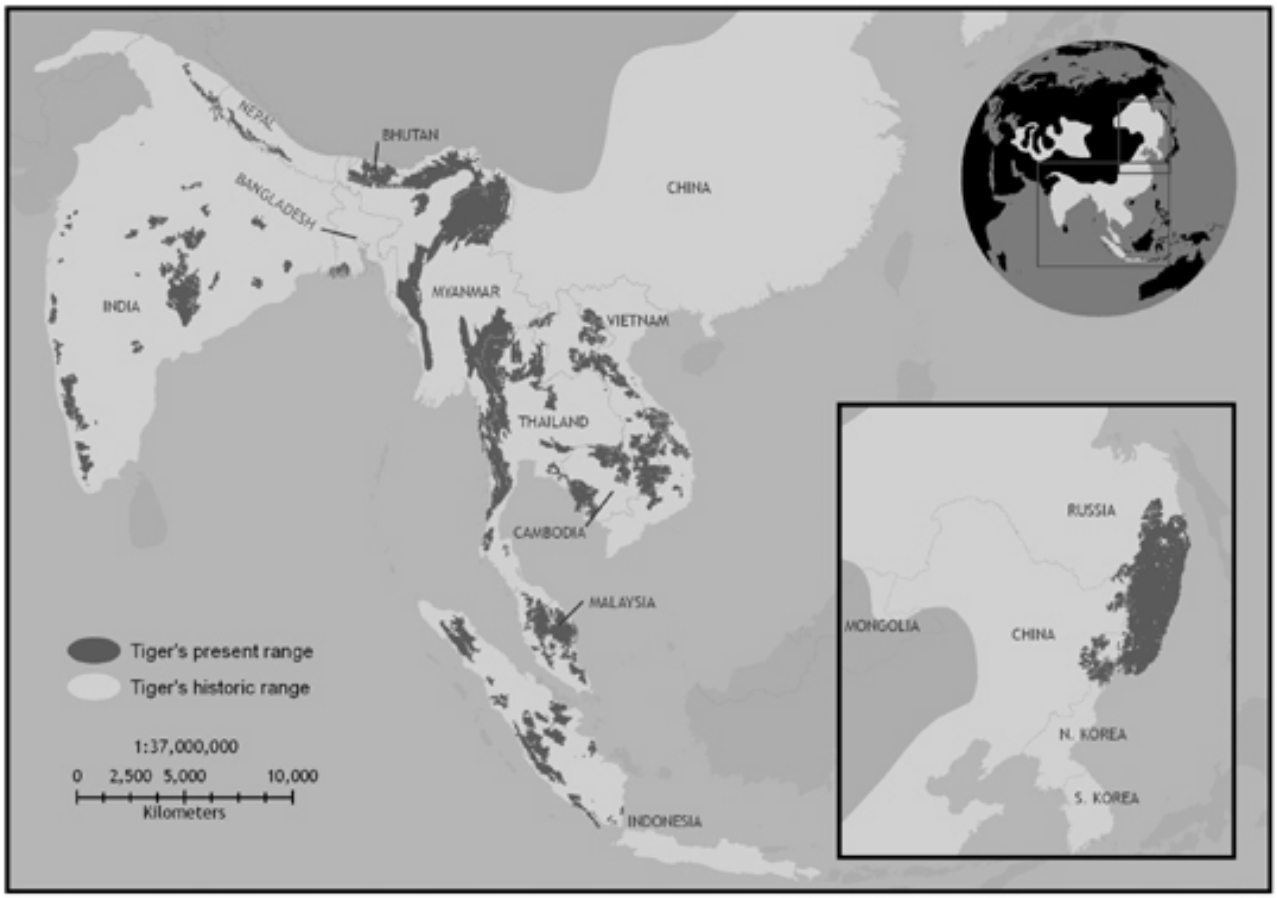


**Fig. 1. Tiger range in 2005 (dark grey) and historic tiger range (white) circa 1900 (from World Wildlife Fund, www.worldwildlife.org)**

was implemented with techniques such as radio telemetry that generated some of the best ecological research to date on tiger movements, dispersal patterns, home range size (Sunquist 1981, Smith et al. 1987) and the relationship of tigers to other large carnivores such as leopards (*P. pardus*, Seidensticker 1976). These past studies also demonstrated that tigers need large areas of appropriate habitat to survive in their natural state (Weber and Rabinowitz 1996).

Despite efforts of Indian scientists, tiger numbers in India continued to decline through the 1980's. Upon review of their census methods, it was found that the technique they were using, called pugmark tracing, did not in fact accurately census tiger populations (Karanth 1987). Population estimates based on this technique were often inflated, leading scientists to erroneous conclusions about population status. This finding led to the development of new counting

techniques incorporating camera trap photos (Karanth 1995), prey density estimates, and tiger killing rates (Sunquist 1981).

Scientists in the Russian Far East started facing similar problems in the late 1970's with their snow tracking census techniques (Matjushkin et al. 1977) of the Siberian tiger. These techniques were not modified until 1994, when the Hornocker Wildlife Research Institute and Wildlife Conservation Society began working with Russian biologists to improve and standardize this technique. In addition, learning from the mistakes of the Indian research, Russian biologists began to incorporate data from prey availability and biomass with tiger censuses (Weber and Rabinowitz 1996).

The status of the Indo-Chinese and Sumatra tigers in parts of Thailand, Cambodia, Laos People's Democratic Republic, Vietnam, Myanmar, Malaysia, and Sumatra was censused with tracking, village surveys, and camera traps. Despite the survey efforts, data on presence/absence were often the only results. Nonetheless, even this sparse data indicated that, because of poaching and other human activities, only the largest forested areas still supported any significant tiger populations.

While previous international cooperation had occurred to generate better biological field data (e.g. North American institutions conducting field research in Nepal), a major breakthrough occurred in 1994 when 11 countries with tiger range met in India to form the Global Tiger Forum. The Forum served to formalize an agreement for conserving wild tiger populations (Weber and Rabinowitz 1996). Efforts moved from an ecological arena to a political arena with this international cooperation. International and local conservation organizations began working more intensively with government departments to develop programs to monitor trade in tiger

parts, conduct surveys and establish monitoring programs, and assist in the education and training of protected area personnel.

As a result of the Forum, it became evident that forestry policies concerning the protection and management of tiger populations were rarely guided by field data. In addition, while much of the best remaining tiger habitat straddled international borders, countries showed little interest in the management practices of their neighbors. In response, an initiative called the Trans-boundary Biodiversity Conservation Program was started in 1994 to help bring together government officials from many of the tiger range states with the objective to increase regional communication among high-level officials. After several workshops and field surveys, several objectives were defined including the creation of trans-boundary protected areas and the regional coordination of conservation and management strategies (Weber and Rabinowitz 1996).

Around the same time wildlife managers were examining and forming management policies at an international scale, conservation scientists were exploring the benefits of broad scale ecology-based methods for defining conservation priorities. Despite all areas containing tigers being worthy of conservation, limited funds and personnel require an application of resources towards those tiger populations that have the highest probability of long-term persistence (Wikramanayake 1998). While past approaches to tiger conservation focused on preserving subspecies (Seal et al. 1987, Seal 1991), the phenotypic characteristics such as body size, pelage color and pattern, and cranial morphometrics used to define the subspecific taxonomy may not have been reliable enough to warrant separate classifications (Kitchener 1998) and may ultimately serve to make conservation more difficult in the long term. In addition, due to the small and isolated nature of many of Asia's protected areas, many conservationists expressed concern over the potential for the long term survival of mega fauna

such as the tiger (Rabinowitz 1993). A landscape-level approach, incorporating habitat corridors and buffer zones around protected areas, was argued to be essential to a long-term tiger conservation strategy (Nowell and Jackson 1996).

No matter the amount of ecological data generated nor the quantity of protected areas established, the conservation community recognized that the survival of the species depended not only on science, but social change as well. Countries such as China received pressure both regionally and internationally as major consumers of tiger parts and thus a major contributor in the accelerating decline of the tiger. In 1993, China banned all trade of tiger bones in response to CITES directives and threats of international trade sanctions (Hemly and Mills 1999). Also, partly in response to criticism from the conservation community, the governments in China and Taiwan established environmental education programs, conducted pharmaceutical research on the medical properties of tiger bone, and encouraged the funding of advertising campaigns to discourage use of tiger parts (Weber and Rabinowitz 1996)

While tigers have provided positive financial benefits to humans from the sale of tiger body parts, tigers have also caused financial losses to humans through livestock depredation (Sechar 1998). To offset this financial loss, many management strategies have incorporated an incentive program such as in the Russia Far East, where incentives are being used to facilitate the access of the Siberian tiger to farmed animals (Hotte and Bereznuk 2001).

Currently, efforts to conserve tigers have been successful in some protected areas and in landscapes where laws protecting tigers and their prey are strictly enforced, however only 23% of the priority landscapes for tiger conservation where tigers live are protected areas (Dinerstein et al. 2006). Yi-Ming et al. (2000) report a very active illegal wildlife trade including tiger-based

products in the Himalayan region in China, despite China's enforcement of the China Wildlife Protection Law of 1989. In 2007, investors in tiger farms began lobbying for international support to lift China's 14-year ban. The idea has received strong opposition to many tiger-range countries who drafted a decision at the 2007 CITES conference of the parties stating: "..tigers should not be bred for trade in their parts and derivatives." (CITES, 2007) in Gratwicke et al. (2008). Despite arguments from the lobbyists insisting that a legalized trade in farmed tiger parts would not hurt the wild tiger populations, Gratwicke et al. (2008) counters "Given that fewer than 2500 breeding adult tigers remain in the wild (IUCN 2006), the risks posed to wild tigers from reopening trade of any kind is one we cannot afford to take. To do so would be gambling with the future of one of the world's most iconic species."

**Jaguars (*Panthera onca*) in Central and South America**

Like the tiger, the jaguar is one of the most powerful and recurring symbols of Central and South American culture (Saunders 1991) ranging through Central America to eastern Colombia, Venezuela, Suriname, the Guianas, Brazil, and south into Peru, Bolivia, the Paraguayan Chaco, and northern Argentina (Fig. 2) (Sunquist and Sunquist 2002). The jaguar symbolized royalty and was thought to protect people against malevolent forces (Sanders 1991). However, despite its cultural stature, the jaguar was always feared and hunted as a dangerous predator. Unlike other big cats, there are no verified records of man-eating jaguars and relatively few records of jaguars killing people (Rabinowitz 2005). Conflicts between humans and jaguars are rooted in the livestock industry, exemplified in the South America Pantanal, where the largest ungulate biomass in the world is also one of the hotspots for jaguar-livestock conflict (Rabinowitz 2005). The killing of cattle by jaguars has long been used as a reason to hunt the cat for sport (Almeida 1990), making the jaguar one of the most highly prized trophy species (Weber

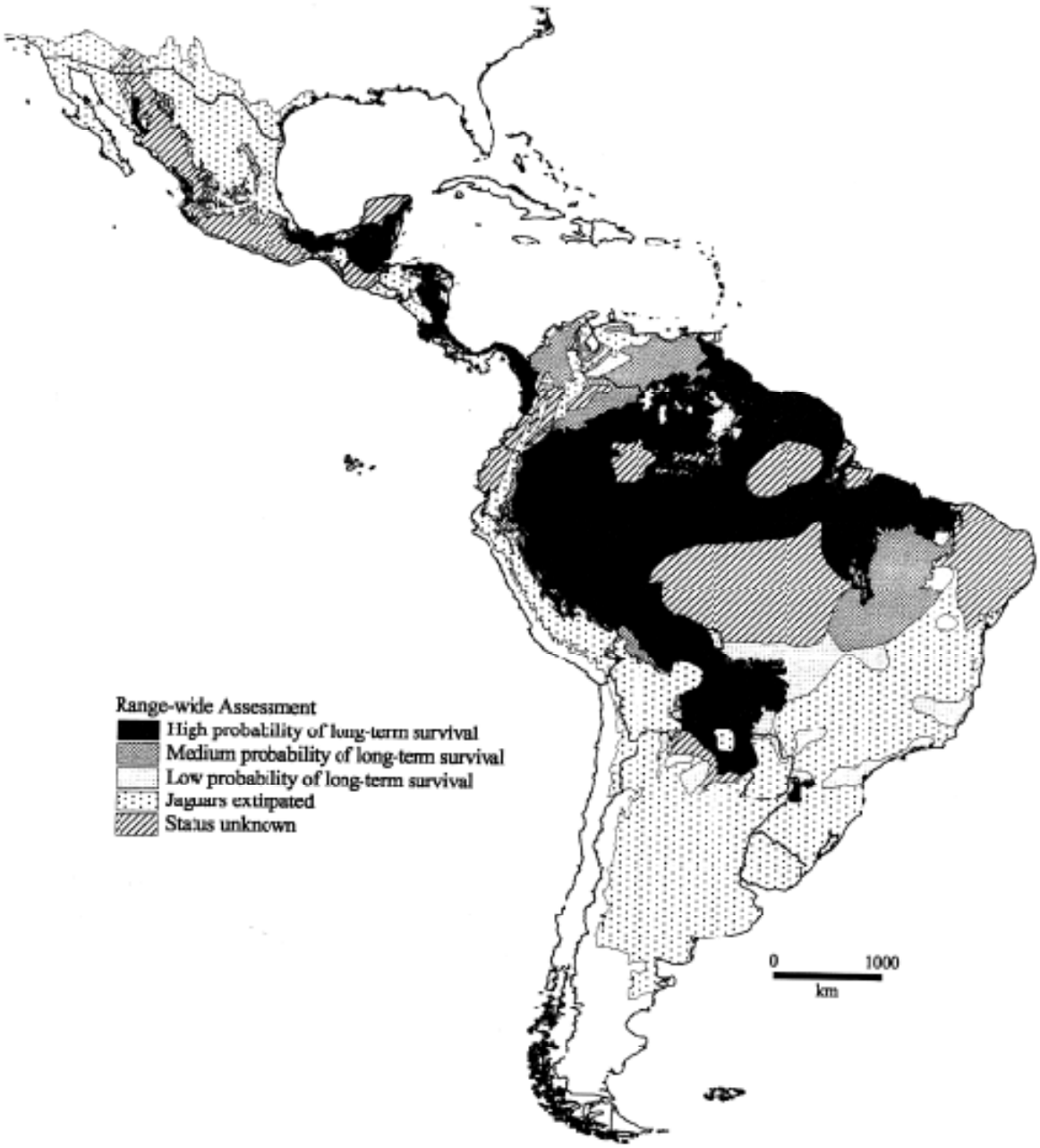


**Fig. 2. Distribution of the jaguar in Central and South America (from Sanderson et al. 2002)**

and Rabinowitz 1996). Jaguars experienced a drastic reduction in population during the 1960's when more than 15,000 jaguar skins were exported from the Brazilian Amazon each year (Fitzgerald 1989). While the trade in skins declined drastically after the enactment of CITES in 1973, jaguars continued to be persecuted as a dangerous killer of livestock as habitat became increasingly fragmented.

As jaguar populations continued to decline, it became imperative to better understand its ecology. The first systematic field surveys occurred in Brazil (Schaller and Crawshaw 1980) and Belize (Rabinowitz and Nottingham 1986). Research studies investigated the ecology of the jaguar in their natural habitat, the relationship between jaguar behavior and their prey base, and the role of jaguar as cattle killers (Rabinowitz 1986, Hoogestein et al. 1993). Research results showed that livestock losses that were blamed on jaguars were shown, in reality, to be a result of disease, flooding, and theft. Exceptions occurred when the jaguars natural prey base was scant and when livestock were allowed to roam freely throughout jaguar habitat. The knowledge gained from these studies was implemented into conservation and conflict management plans (Quigley and Crawshaw 1992), however many of the recommendations went unheeded because of strong preconceived notions about jaguars and a reluctance to change animal husbandry practices (Weber and Rabinowitz 1996).

In contrast to unwillingness of individual ranchers to help conserve jaguars, many governments, were not averse to the idea of creating protected areas for jaguars. In 1984, Belize established the Cockscomb Basin Jaguar Preserve and during the next decade additional areas of habitat were protected throughout the cat's range (World Conservation Monitoring Centre 1992) including the Chiquibul National Park in Belize, adjacent to the Cockscomb. As the jaguar preserves brought in revenue to local communities from an emerging ecotourism industry, changes in human attitudes became apparent in as little as seven years after the first preserve was created (Rabinowitz 1992).

In 1989, governmental and nongovernmental organizations attempted a new approach that transcended national and transboundary protected areas. *Paseo Pantera* was an initiative with the aim of preserving and managing biological diversity on a multinational level, from

along the entire Central American isthmus Mexico to Panama by focusing on the biological corridor utilized by several felid species, including the jaguar. The historic corridor has been fragmented over time, giving way to banana plantations and human settlement. *Paseo Pantera*'s goal was to promote the reestablishment of a regional natural corridor through cooperation among individual countries by maintaining existing protected areas, identifying key corridors between these areas, and considering major habitat restoration initiatives. In addition, programs were initiated for buffer-zone management, ecotourism promotion, and regional and site-specific education and training programs (Weber and Rabinowitz 1996). In 1994, all of the Central American republics signed the Alliance for Sustainable Development (Carr 1994). In concert with the objectives of Paseo Pantera, the Alliance agreed to establish a biotic corridor that would traverse and link their respective national territories. Costa Rica became the first nation to add a conservation area to help develop a national corridor as part of Paseo Pantera (Weber and Rabinowitz 1996).

The international approach towards conservation continued through 1999, when the Wildlife Conservation Society sponsored a priority-setting and planning exercise for the jaguar across its range. Despite the previous years of international cooperation, there lacked a consensus of information concerning the jaguar. Through the workshop, field scientists from 18 countries reached a consensus on (1) the spatial extant of their jaguar knowledge, (2) the known, currently occupied range of jaguars, (3) areas with substantial jaguar populations, adequate habitat, and a stable and diverse prey base, and (4) point locations where jaguars have been observed during the last 10 years. During the workshop, scientists conducted a range-wide assessment of the long-term survival prospects of the jaguar and developed an algorithm for prioritizing conservation units occurring in major habitat types (Sanderson et al. 2002).

While the collaboration of conservationists to acquire and protect strategically located lands was a high priority (Quigley and Crawshaw 1992), negative attitudes and perceptions by humans towards jaguars were clearly the greatest imminent threat to the species survival (Woodroffe and Ginsberg 1998). By 2002, numerous studies had investigated the feasibility of mitigation techniques such as electric fencing (Saenz and Carillo 2002), altering animal husbandry practices and incentive programs. Rabinowitz (2005) reported that while improving animal husbandry practices seemed to be the most cost-efficient method to alleviate human-jaguar conflict, there had been no noticeable change throughout much of jaguar range. "Clearly", Rabinowitz stated, "there was a serious flaw in government and privately sponsored outreach and jaguar conservation programs that were trying to address this issue". Ranchers were surveyed and invited to workshops to help further understand and improve the situation (Zimmerman 2000). As a result of the surveys, the Wildlife Conservation Society initiated a rancher outreach program and restructured its approach to the jaguar-livestock conflict issue, beginning with a series of workshops in Brazil, Venezuela, and Mexico. The most successful approach incorporated the rancher into the decision making process and that actions had to be taken both on a local and regional level (Rabinowitz 2005). Ranches could play a vital role in jaguar conservation if the involvement of the rancher is encouraged and supported by government agencies and conservation NGOs (Hoogesteijn and Chapman 1997).

**Brown bears (*Ursus arctos*) in the Pyrenees Mountains of Spain and France**

Brown bears ranged throughout Europe until human persecution and habitat destruction led to their extirpation from most of their western range and in many areas in the northern and eastern regions of the continent (Zedrosser et al. 2001). Habitat was lost through deforestation and agriculture and the persecution was often supported by state and local governments through

bounties with the objective of reducing livestock depredation. Programs of eradication were successful due to the bears low reproductive rate and sensitivity to high harvest rates (Zedrosser et al. 2001).

Through the mid 19th century, populations persisted in areas of Europe including the Pyrenees region, a mountain chain that runs along the border of France and Spain. Currently fragmented populations occur throughout northern and eastern Europe while the isolated Pyrenees population (Fig. 3) has declined on both the French and Spanish slopes (Caussimont and Herrero 1997). The Pyrenees bears were first studied on the French slope in the 1950s (Couturier 1954) and first protected in 1958 when hunting was prohibited in France (Parde 1997). In 1973, the bears were further protected when both France and Spain declared the brown bear a protected species (Quenette et al. 2001), however bear mortality due to poaching still remained high and the population continued to decline (Parde 1997). In 1979, France and Spain signed the Bern Convention for the Conservation of European Wildlife and Natural Habitat which mandates that member countries must pay attention to endangered and potentially endangered species and include protective measurements in planning and development. The European brown bear is listed on Appendix II, making it illegal to capture, keep, kill, willfully disturb, and trade (Zedrosser et al. 2001). After signing, several studies were initiated during the late 1970s and early 1980s that investigated the bears population status, diet, winter denning, livestock damage, biology, and preservation measures (Caussimont and Herrero 1997). Through this research, two disjunct populations were identified, one in the central Pyrenees and the other in the western Pyrenees (Quenette et al. 2001). The two populations are separated by 30 km and and it is assumed that they are isolated from each other (Parde 1997).

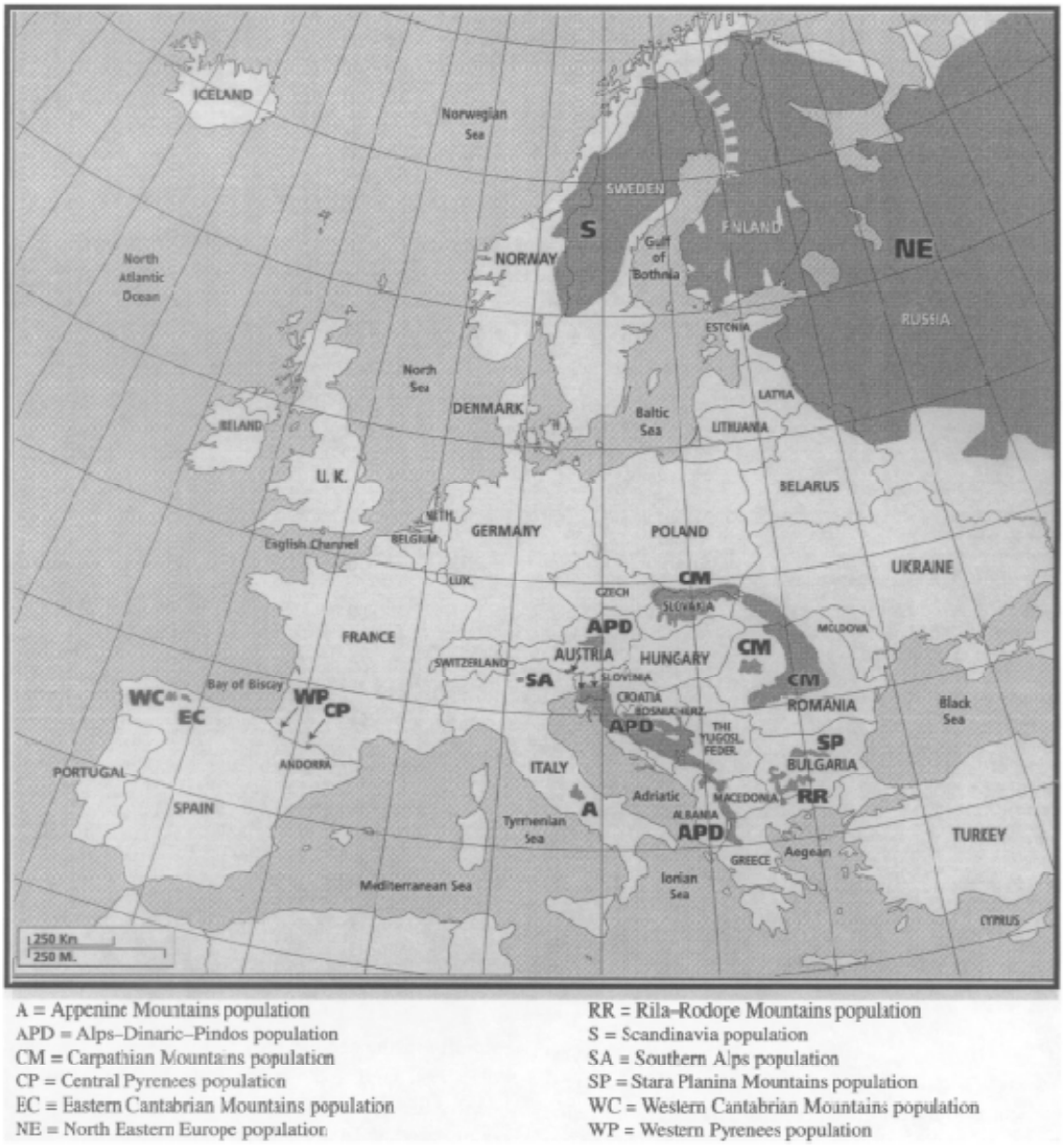


**Fig. 3. Present distribution of brown bears in Europe (from Zedrosser et al. 2001)**

The western Pyrenees population inhabits a 1,000 square kilometer area that straddles France and Spain. In 1976, the estimated number of bears on the Spanish slopes of the western population was approximately six (Caussimont and Herrero 1997). Between 1976 and 1980, four bears were shot and killed. Three of these deaths are attributed to a large project to construct

a forest trail system in a French national forest that displaced several bears causing a migration towards the Spanish slopes. Attacks on livestock during their movements resulted in the poaching of the bears (Caussimont and Herrero 1997). In 1984 both the French and Spanish slopes were surveyed with the efforts of several French and Spanish organizations resulting in an estimate of 15 bears, with two of those being in Spain. To lessen the threat of poaching and carrion poisoning directed towards the bears as a result of conflicts with livestock, farmers that lost livestock were compensated with the market value of the animal in addition to a $100 subsidy for disturbance.

As members of the European Union, Spain and France are obliged to abide by resolutions set forth by the European Parliament. In 1989 a resolution was passed to promote programs to protect the brown bear in Europe (Zedrosser et al. 2001). Another resolution passed in 1990 gave the directive to study the impact of new tourist structures constructed in bear zones, however, Caussimont and Herrero (1997) reported a lack of implementation of the resolution. Despite livestock compensation and several resolutions, by 1991, only ten bears were estimated to remain in the western population. In response to diminishing population numbers, an information campaign about bear biology was developed in the form of programs in schools and public places with supporting folders, posters, and a book (Caussimont and Herrero 1997). While the population was reported to have increased to 12 individuals by 1992 (Caussimont and Herrero 1997), a more recent study by Camarra (1999) estimated only six individuals. Zedrosser et al. (2001) warned “this remnant population is doomed to extinction unless drastic measures, such as population augmentation, are taken soon.”

The central Pyrenees brown bear population historically ranged approximately 3,000 square kilometers, of which 500 square kilometers are in Spain. An initial study by Couturier

(1954) estimated the bear population to be about 11 animals. The species slowly declined with an estimated population of ten during the 1970's and six to seven bears in the early 1980's (Parde 1997). These findings contradict the commonly held belief that the decline in bear numbers occurred as a sudden drop. An increase in the bear population during from 1914 to 1934 has been attributed to a decline in hunting pressure during the first World War. In addition during this time, there was still diverse habitat that included agricultural areas (such as crops and cattle rearing), possibly providing the bear population with a reliable food source resulting in reproductive success and recruitment. The decline from 1970 to 1990 may have resulted from a drastic increase in human leisure activities in the area, a decline in mountain agriculture, and a significant program of road-building that penetrated much of the brown bear territory (Parde 1997). The modified landscape that may have reduced food resources together with continued persecution altered the social aspects of bear behavior. The result was a birth rate of zero, leading to the demise of the central Pyrenees population.

During the early 1990's, a public information program began and a committee of private and public partners was created to direct the restoration of brown bears to the central Pyrenees study area. Participants included the Spanish and French Ministry of Environment, Association for the Economic Development of Tourism and Art, and the Association of Hunters. In 1993, the committee decided to transplant two adult female brown bears and one adult male from an eastern Europe to the French central Pyrenees as an experimental release. If the relocated bears adapted well to the French study area, more bears would be released in the same area (Quenette et al. 2001). In May of 1996, two female bears were captured in Slovenia and transported to the central Pyrenees in France. A study by Quenette et al. (2001) investigated the success of the released bears by monitoring movement patterns, including home range analysis and denning

behavior. The researchers concluded that the transplanted bears had adapted well to their environment and the "technique of transplantation may be a good tool to restore bear populations or to save small bear populations." However, the authors also cautioned that the long term success of translocation requires acceptance by local residents given the "excessive human-caused mortality that led to the extirpation of this species in the central Pyrenees."

The concern expressed by Quennette et al. (2001) was well warranted, as one of the translocated bears was shot by a hunter only a year and half after its release in the fall of 1997, leading to the death of two of the three cubs she had given birth to earlier in the year (Clark et al. 2002). In 2001, the population had grown to 5 individual bears: the remaining original female, her two cubs, one cub of the dead female, and an adult male that had been relocated in 1997 (Zedrosser et al. 2001).

## CRITIQUE

Conservation strategies targeted at wide ranging species such as large carnivores requires a multidimensional approach that considers ecological, socio-economic, and political factors. An assessment of these factors should lead to a conservation plan that is guided by a clear definition of the problem followed by the prescription and implementation of policies. Policies and management actions should be consistently evaluated.

The importance of the tiger to many Asian cultures ironically precipitated its decline. Many Asian countries, principally India and Nepal, began collecting baseline ecological data in response to what appeared to be dwindling tiger numbers. These studies were the first step towards successful conservation in that they were carried out systematically and were multifaceted. Not only did researches collect data on habitat use, but on interspecific interactions such as predator-prey dynamics and interspecific competition with other large predators such as

leopards. While early population estimates were overestimated as a result of erroneous census techniques, an evaluation of methods revealed the flaws in the technique. In response, managers developed new techniques that incorporated the previously collected ecological data. The comprehensive approach towards the consideration of ecological factors and the subsequent adaptive management was a successful component of the tiger conservation efforts. In contrast, it took Russia almost 20 years to improve their census techniques. This is a reflection of poor international communication; the lessons learned in India could have been shared with wildlife managers in Russia.

Programs such as India's Project Tiger pioneered countrywide efforts in Asia, and while an important step towards tiger conservation, this strategy focused only on the subspecies occurring in this nation. Only in 1994, 25 years after the recognition of a decline in the tiger population, did countries come together on an international scale. Given the drastic political differences among Asian countries, the international effort between 11 nations called the Global Tiger Forum was a breakthrough for tiger conservation. It was through this international forum that the tiger trade as a mechanism for tiger decline was finally recognized and education and training programs were developed. In addition, the forum fostered an international effort to protect tiger habitat that straddled international boundaries through an initiative called the Trans-boundary Biodiversity Conservation Program.

While the ecological requirements of the tiger were finally being addressed at an international scale, socio-economic considerations were also being addressed for the first time as an important component of a successful conservation strategy. Using CITES as a conduit, the international community placed pressure on China to ban the trade in tiger parts. Given the gravity of socio-economic forces that contributed towards tiger declines, the delay in addressing

this component of conservation was a significant oversight. On the other hand, the degree of pressure exerted on China resulted not only on a ban of tiger parts but in the development of environmental education programs, pharmaceutical research on the medicinal properties of tiger bone, and the funding of ad campaigns designed to discourage the use of tiger parts. While these programs appear to have succeeded (e.g., most medicinal shops no longer carry tiger parts), a lack of enforcement has facilitated an active illegal wildlife trade. This disregard for policy and the detrimental effects on tiger conservation strategies highlights the importance of protecting not only wildlife reserves, but habitat on private lands as well. This recognition could be the impetus towards reversing the downward trend in tiger population numbers.

The recent focus of conservation measures on private lands has become a critical component of the jaguar conservation strategy. Like the tiger in Asia, the decline of the jaguar was related to socio-economic factors. However in contrast to the positive financial benefits humans received from tigers and their body parts, communities in Central and South America viewed the jaguar as a cattle killer and thus a source of financial loss.

While the targeted persecution of jaguars was identified early as the main source of mortality, it was not until the inception of CITES that the international community set forth policy that prohibited the trade of jaguar pelts. Despite the international protection, jaguars continued to be persecuted as a livestock killer. Complaints against the jaguar only rose as the landscape became more fragmented and the interface between livestock and jaguars increased. As jaguar numbers continued to decline, research studies ensued. Instead of focusing solely on ecological data such as habitat use and home range size, early studies also examined the role of the jaguar as a livestock killer. Investigating the role of the jaguar in a socio-economic aspect was a significant contribution towards implementing a conservation strategy with a clear

problem definition. Through this research, it was found that the role of the jaguar as a cattle killer was actually minor except in areas where the natural jaguar prey base was scant. With a clear problem definition, policies were formulated and conflict management plans were developed. The implementation of these plans failed, however due to strong preconceived beliefs about jaguars and a reluctance to change animal husbandry practices.

Initial conservation efforts focused on private lands failed, however at the same time, the conservation of the species through the creation of protected areas was gaining ground. An interesting windfall of the newly created protected areas was the change in human attitudes as jaguar preserves brought in revenue from ecotourism dollars. Harnessing this transformation of human attitudes, international cooperation efforts were initiated that considered conservation in multiple dimensions: creation of a biological corridor, buffer zone management, ecotourism promotion, and education and training programs. Workshops were conducted to evaluate the implementation of policies and to ensure a consensus of information concerning the jaguar among the international participants.

The creation of reserves and the protection that occurred within them was recognized as only one component of a successful conservation strategy. The socio-economic aspect of jaguar conservation was continually revisited and through trial and error, researches concluded that mitigation techniques such as fencing, guard dogs, and incentive programs were not enough to alleviate rancher concerns. A major breakthrough occurred when ranchers were invited to participate in workshops. Results indicated that the most successful approach towards minimizing the human-jaguar conflict was not through traditional conflict management plans that focused on incentives, but through incorporating the ranchers into the decision making process. The realization that ranchers wanted to feel a part of the process, rather than a pawn of

the process, could ameliorate years of flawed outreach programs that overlooked the human dimensions of conservation.

The bear, compared to the tiger or jaguar, received the earliest protection with prohibitions on hunting and achieving status as a state protected species. As members of the European Union, Spain and France were also obliged to follow the numerous international policies set forth by the regional governing body in addition to other international agreements and accords. Also, the more favorable economy of France and Spain, in contrast to Asian and Latin American countries, were able to conduct ecological studies as early as the 1950's.

Despite the economic advantages and the relatively friendly international relations between France and Spain, the conservation efforts for the brown bear failed in the Pyrenees. Hunting was prohibited as early as 1958, however a lack of enforcement exacerbated the bears threatened status. Anti-bear sentiment grew over the years as the bears became protected and it became illegal to protect one's livestock. Generous incentive programs were put in place, however it appears that these reactive, rather than proactive programs failed as a means of carnivore protection. Reactive programs may even compound any anti-bear sentiment by sending the message that it is the government's fault for livestock depredation, rather than the rancher's lack of protective measures such as proper guarding. Over 40 years after the prohibition of hunting, the government finally addressed the social component of bear conservation. In an attempt to reduce anti-bear sentiment, education and outreach programs were initiated in schools and for the general public. While an earnest effort, the government's resources could have been better spent if the programs were directed towards ranchers.

With anti-bear sentiment still profuse, the French government decided that a re-introduction program was the solution for bear conservation. This was met with much public opposition and

not surprisingly, within a year of the relocation, one bear was shot by a poacher resulting not only in the death of that adult, but the death of two of her cubs. Despite protesters marching in the streets, subsequent reintroductions took place and the bears were greeted with honey laced with broken glass in the woods. If the Spanish and French governments want a viable bear population in the Pyrenees, garnering public support is essential.

Common to all three conservation strategies is the early appreciation for biological and ecological data. While conservation efforts initially took place at regional scales, most countries realized at some point that international cooperation was necessary for successful conservation strategies. The elephant in the room is the fact that for all three species, human activity was identified as the main cause for population declines yet it took the Asian and Latin American countries years to incorporate socio-economic considerations while Spain and France are still struggling to appreciate the role human attitudes and beliefs play in conservation efforts. The comprehensive incorporation of ecological, political, and socio-economic factors is challenging; countries such as Spain and France can learn from conservation strategies such the jaguar's in Latin America.

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