

Full Length Research Paper

Usability of large carnivore as a keystone species in Eastern Black Sea Region, Turkey

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Large carnivores are regarded as the most potential focal species in distributed areas. It is implied that keystone species are the most important species in that ecosystems to sustainability. Despite prey species has much more keystone property, in many areas, examples of the keystone species can be selected from carnivore species. The aim of the study was to investigate the keystone species property of Brown bear (*Ursus arctos*), Wolf (*Canis lupus*) and Eurasian lynx (*Lynx lynx*). The main selecting criteria for keystone species can be summarized as top predator or large carnivore important prey species or provide key resources and species having strong interactions with other species. It was observed that Brown bear, Wolf and Eurasian Lynx had keystone property in the region. These species had very crucial role to regulate the population density of other species such as Wild goat (*Capra aegagrus*), Chamois (*Rupicapra rupicapra*) and Wild boar (*Sus scrofa*). Despite having some problem with local people, Brown bear, Wolf and Eurasian Lynx can be also used as a flagship, indicator and umbrella species in Northeastern Turkey.

Keywords: Biodiversity, Keystone species, brown bear, Wolf and Eurasian lynx

INTRODUCTION

The concept of keystone species was first introduced by Robert T. Paine in 1969. Paine studied a community of organisms that inhabited the intertidal zone along Washington's Pacific coast. He found that one species, the carnivorous starfish (*Pisaster ochraceus*), played a key role in maintaining the balance of all other species in the community. Paine observed that if starfish was removed from the community, the populations of two mussel species within the community grew unchecked. Without a predator to control their numbers, the mussels soon took over the community and crowded out other species which greatly reduced the community's diversity (Paine, 1969).

The definition of keystone species was made by Power et al. (1996) as a species whose effects are large and disproportionately large relative to its abundance. It is not enough for specie to be highly influential; its role must be great in relation to its relative biomass contribution. For example, Beech trees in a beech forest are not considered keystones because their effect is not disproportionate to their relative abundance. In Powers terminology, such species are dominants but in the architectural analogy, they might be considered 'foundation

stone' species (Payton et al., 2002).

As a different view, keystone species are those which a large part of the community is dependent on (Beazley and Cardinal, 2004) and whose removal would either increase or decrease species diversity in their communities (Mills et al., 1993). The term was originally applied to a predator species (*Pisaster ochraceus*), but now the term 'keystone' has been extended to include prey species, plants, and even habitat resources.

This study discussed the usability of the large carnivore; brown bear (after here Bear), wolf and Eurasian lynx (after here Lynx) as a keystone species in Eastern Black Sea Region, Turkey.

MATERIALS AND METHODS

Study area

The study was carried out in Trabzon, Rize and Artvin province of Eastern Black Sea Region/Turkey. Caucasus hot spots extended to this region and are rich in high species and its abundance can be observed very easily. Bear, wolf, Lynx, wild goat (*Capra aegagrus*), Chamois (*Rupicapra rupicapra*), Roe deer (*Capreolus capreolus*),

Table 1. Selecting Criteria of Keystone and focal species (modified from Beazley and cardinal, 2004). Field surveys showed that Bear, Wolf and Lynx had similar criteria in the region.

Criteria	Bear	Wolf	Lynx	Reference for the criteria
1. Keystone/functionally important; Large part of community is dependent on it				
1.1 Top predator, large carnivore/meso-carnivore	x	x	x	Beazley and Cardinal, 2004
1.2 Important prey species, or that provides key resources	-	-	-	Beazley and Cardinal, 2004
1.3 Species that transforms landscapes or waterways	-	-	-	Beazley and Cardinal, 2004
1.4 Species having strong interactions with other species	x	x	x	Brock and Kelt, 2004; Christianou and Ebenman, 2005
2. Umbrella; Large area requirements; protecting it will protect many other species				
2.1 Space-demanding/wide-ranging	x	x	x	Lambeck, 1997; Beazley and Cardinal, 2004
2.2 Migratory	-	-	-	Beazley and Cardinal, 2004
2.3 Requires specialized or defined habitat	x	x	x	Beazley and Cardinal, 2004
2.4 Large vertebrate species	x	x	x	Carroll et al., 2001.
3. Flagship; Serve as symbols for conservation; public support				
3.1 Species with broad political or public support	x	x	x	Beazley and Cardinal, 2004.
3.2. Species with charismatic	x	x	x	Simberloff, 1998, Linnell et al., 2000; Leader-Williams and Dublin, 2000; Fulton et al., 2005. Tognelli, 2005.
3.3. Endangered species	x	x	x	Leader-Williams and Dublin, 2000
4. Habitat quality indicator; Signal ecological quality of habitat; sensitive to stresses				
4.1 Limited by dispersal ability	x	x	x	Beazley and Cardinal, 2004.
4.2 Limited by resource availability	x	x	x	Beazley and Cardinal, 2004.
4.3 Limited by ecological processes (i.e. fire, flood)	-	-	-	Lambeck, 1997; Beazley and Cardinal, 2004.
4.4 Sensitive to stresses (i.e. acidification, pollution)	-	-	-	Landres, et al., 1988; Beazley and Cardinal, 2004; Hannon and McCallum, 2004; Machange et al., 2005; Fulton, et al., 2005.
4.5. Sensitive to disturbance	x	x	x	Beazley and Cardinal, 2004.
4.5. Endangered species	x	x	x	Lawler et al., 2003.
4.6. Rare species	x	x	x	Lawler et al., 2003; Tognelli, 2005
4.7. Large vertebrate species	x	x	x	Power and Mills, 1995; Carroll et al., 2001; Roberge and Angelstam, 2004.

x, Species having the criteria; -, species without the criteria.

Red deer (*Cervus elaphus*), wild boar (*Sus scrofa*), red fox (*Vulpes vulpes*), golden jackal (*Canis aureus*) are other important wildlife species in the region.

Forest, alpine grasslands, alpine rocky areas, sub-alpine and water lands are the main habitat types. *Picea orientalis*, *Abies nordmanniana ssp. nordmanniana*, *Pinus sylvestris*, *Fagus orientalis*, *Carpinus betulus*, *Castanea sativa* are the main tree species distributed in the forests. Verçenik (3711 m), Kaçkar (3932 m), Altıparmak (3472 m) and Karçal (3428 m) mountains are the most important mountains shaping the topography of the region.

Methods

Firstly, the selecting criteria of keystone and other focal species

were examined from published and unpublished literature. The main selection criteria for keystone species was summarized as top predator or large carnivore/meso-carnivore, important prey species or key resources that provided species that transforms landscapes or waterways and species having strong interactions with other species. Focal species selection criteria were also presented and keystone property of species were evaluated (Table 1). Secondly, field surveys were carried out from 2005 to 2010 in the region. The distribution of three species overlapped in the region (Figure 2). The habitat use and interactions of these species to other species and local people were monitored in the field surveys. The effects of large carnivore species to other species such as Wild goat (*Capra aegagrus*), Chamois (*Rupicapra rupicapra*) and Wild boar (*Sus scrofa*) were searched. Finally, the usability of bear, wolf and Lynx as a keystone species in the region was discussed giving attention

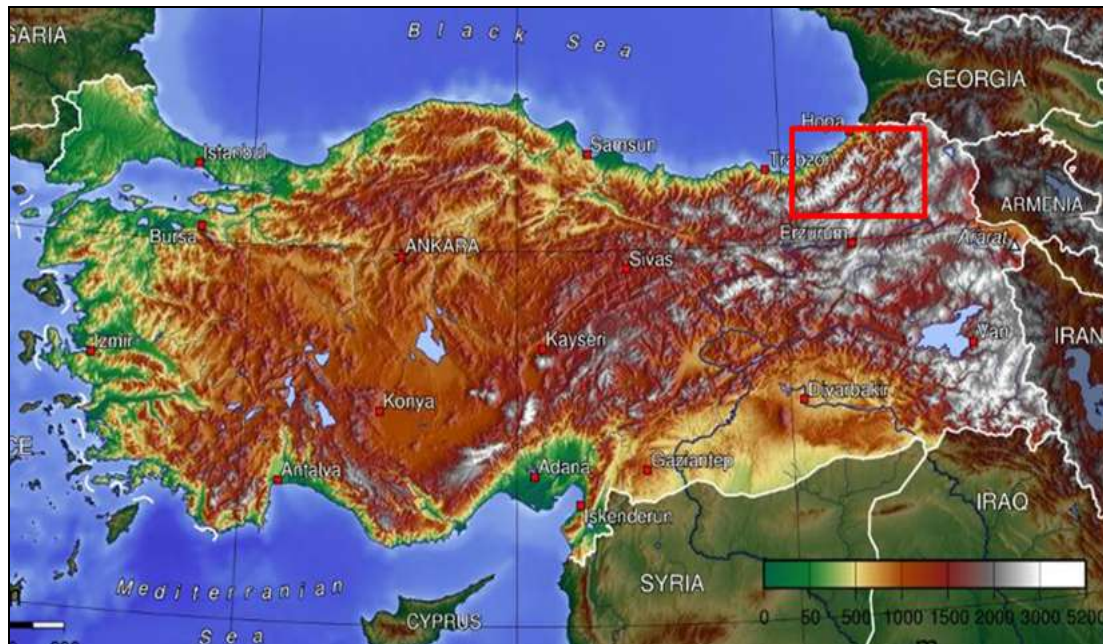


Figure 1. Map of the study area (indicated by rectangular).

to both selection criteria and field surveys.

RESULTS AND DISCUSSION

The study showed that Bear, wolf and Lynx had a good example for keystone species in the region due to the criteria; top predator or large carnivore/meso-carnivore and species having strong interactions with other species. These species are not important prey species or that provide key resources and species that transform landscapes or waterways. The species provide some food for other species and control the density of other species such as Wild goat, Chamois and Wild boar. Observations showed that these species could not transform landscapes but species abundance and richness were much related to the species. Ecological interactions are very complex and which species have much more keystone property may not be clear. Despite the prey species may be more useful as keystone species in the local scale, large carnivore, using large home ranges, having much more strong interactions for other species can be more useful as keystone specie.

The keystone role for specie can arise in several different ways. Payton et al. (2002) distinguish four types of organism (organism controlling potential dominants, resource providers, mutualists and ecosystems engineers) on the basis of their functional role as keystones. These groups are not mutually exclusive and individual keystone species may exhibit characteristics of more than one functional type (Payton et al., 2002). On the other hand, keystone species were evaluated in five diffe-

rent categories such as predator, prey, plant, link and modifier (Mills et al., 1993).

In a theoretical analysis that assumed no competitive interactions between prey species, Holt (1977; 1984) demonstrated that a preferred-prey species that is able to maintain its abundance in the face of predation can affect community structure by sustaining the density of a predator, thus reducing the density of other prey. Holt (1977) called such a predator-tolerant prey a keystone specie "in as much as its properties control the density of the predator and restrict the range of parameters open to other prey." As the term keystone prey species was used by Holt, removing the keystone prey species would increase and not decrease the overall species diversity in the community (Mills et al., 1993).

Keystone specie is often a dominant predator whose removal allows a prey population to explode and often decreases the overall diversity. Other kinds of keystone species are those, such as coral or beavers that significantly alter the habitat around them and thus affect large numbers of other organisms. The North American beaver (*Castor canadensis*) was described as a keystone species because its dams alter hydrology, biogeochemistry, and productivity on a wide scale (Naiman et al., 1986). Likewise, the Brazilian termite (*Cornitermes cumulans*) has been called a keystone species because loss of its large, abundant, and uniquely structured mounds would likely precipitate loss of obligate and possibly opportunistic users of the mounds (Redford, 1984).

It was suggested that ecosystem engineers will increase species richness at the landscape scale when-

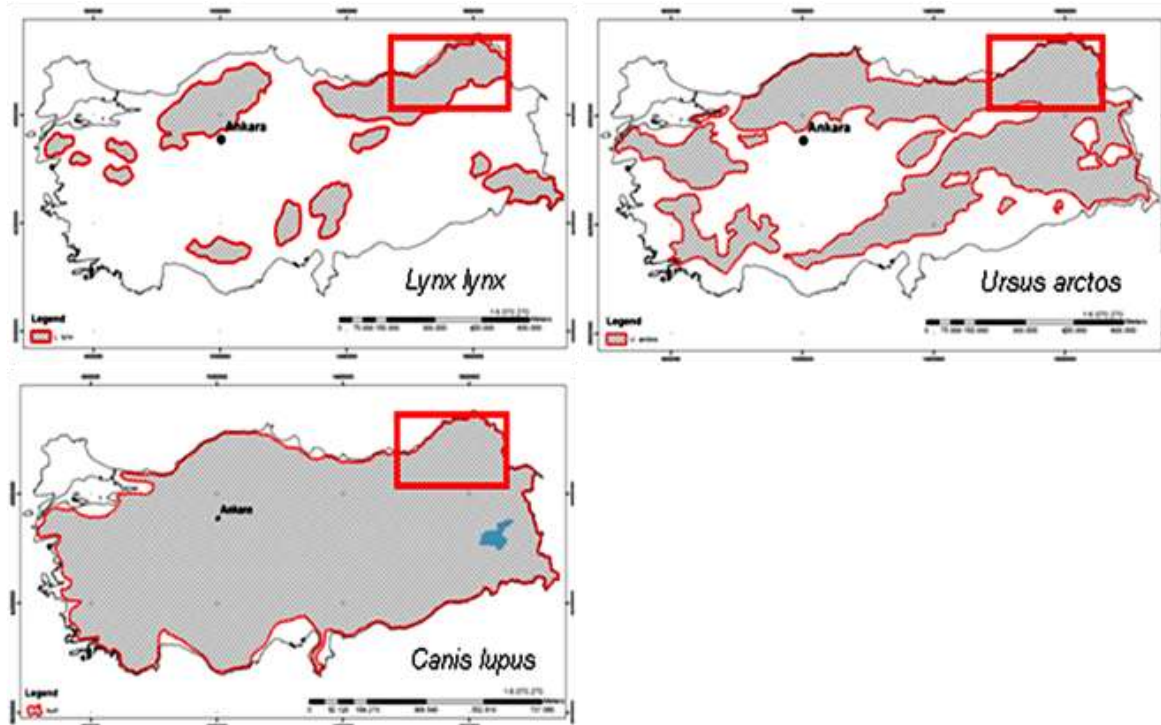


Figure 2. Distribution maps of Lynx, Bear and Wolf in Turkey (Modified after Turan, 1984). Population density of the three species was very low in the region. The region had very large distribution of the other species such as Wild goat (*Capra aegagrus*), Chamois (*Rupicapra rupicapra*) and Wild boar (*Sus scrofa*) and birds (Vulture, Eagles and Hawks, etc.).

ever there are species present in a landscape that are restricted to engineered habitats during at least some stages of their life cycle (Wright et al, 2002). In North America, the Grizzly Bear can be accepted as a keystone species considered as an ecosystem engineers.

Many species have been called keystone herbivores because their foraging causes drastic habitat modification. Based on the observation that large herbivores (more than 1000 kg) can readily convert closed thicket or forest into open grassy savanna, Owen-Smith (1987) posited a keystone-herbivore hypothesis to explain the late Pleistocene extinction of approximately half of the mammalian genera with body masses of 5-1000 kg. This theory posits that the elimination of large herbivores initiated vegetational changes that were deleterious to the fauna (Mills et al., 1993). For example, elephants appear to be keystone species in African grasslands. That is, without elephants, the grasslands actually cease to exist as grasslands. Take away the elephants, and the grasslands, which are overgrown with woody plants, will be converted to forests or to shrub-lands.

Large carnivores (such as Mountain Lions, Wolves, Bears and Coyotes) are the good examples for keystone species in North America. These species are also top predator and regulate large and small herbivore and also small carnivore. These species have the strong interactions with other species and large herbivore. On the other

hand, large herbivores are crucial to regulate the distributed areas vegetation. Because of this interaction, large carnivore serves as a keystone species for the distributed areas especially for large scale. In local scale, this interaction may not be observed as clearly.

Despite the ecosystems had very complex interactions, Ebenman and Jonsson (2005) suggested that the community viability analysis can also be used to identify fragile community structures and keystone species and, hence, to provide guidelines for conservation priorities. Also, Jordan (2009) discussed the role of network analysis and presented a new and simple approach to characterizing the interaction structures of each species in a complex network. Because the importance of some species may largely be the consequence of their rich interaction structure, one possible quantitative approach to identify the most influential species is to study their position in the network of interspecific interactions.

The effects of keystone species may not be observed in a short time but Brock and Kelt (2004) observed the Kangaroo rats (*Dipodomys*). This species have been argued to exert keystone effects because they interact strongly with other species, and their removal results in major changes in the community structure. The most common example of keystone species might be thought as Salmon. Salmon are keystone species in the rainforest. Not only are they a critical fall food source for

the Grizzly Bear, Wolves, Eagles and Otters, but they also act as fertilizer for the trees. In addition, because spawning is highly sensitive to stream temperature and sedimentation, salmon act as an indicator species for the overall health of the ecosystem.

A top predator will usually exert its role in a specific ecosystem, rather than over a whole heterogeneous region (Sergio et al., 2008). Thus, bear, wolf and lynx has crucial role in the region but one species can be more crucial role than others in some local areas. These species also served as a focal species in Yalnızcam forest Turkey (Ucarli, 2006). The observations showed that bear, wolf and lynx regulate the population density of Wild goat (*Capra aegagrus*), Chamois (*Rupicapra rupicapra*), Wild boar (*Sus scrofa*) and brown hare (*Lepus europaeus*).

Conclusion

This work suggested that large carnivore such as bear, wolf and lynx can serve as keystone species in Eastern Black Sea Region of Turkey. Large herbivore population can be regulated by large carnivore in many regions. Similarly, bear, wolf and lynx provide some food for some species and control the density of other species such as wild goat, Chamois and wild boar. Observations showed that these species could not transform landscapes but species abundance and richness were much related to these species. Large herbivore species may be the most important factor to regulate grassland and their habitats compositions. Large carnivore serves as a keystone species for the distributed areas especially for large scale but in local scale this interactions may not be observed clearly.

Many field surveys also showed that Wild goat, Chamois, wild boar, brown hare, red fox, golden jackal, vultures, eagles, hawks, ravens and other bird species were strictly related to bear, wolf and lynx in the Eastern Black Sea Region of Turkey.

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