Summary

This dissertation develops a rationale of how to use fossil data in solving biogeographical and ecological problems. It is argued that large amounts of fossil data of high quality can be used to document the evolutionary processes (the origin, development, formation and dynamics) of Arealsystems, which can be divided into six stages in North America: the Refugium Stage (before 15,000 years ago: > 15 ka), the Dispersal Stage (from 8,000 to 15,000 year ago: 8.0 – 15 ka), the Developing Stage (from 3,000 to 8,000 years ago: 3.0 – 8.0 ka), the Transitional Stage (from 1,000 to 3,000 years ago: 1 – 3 ka), the Primitive Stage (from 5,00 to 1,000 years ago: 0.5 – 1 ka) and the Human Disturbing Stage (during the last 500 years: < 0.5 ka). The division into these six stages is based on geostatistical analysis of the FAUNMAP database that contains 43,851 fossil records collected from 1860 to 1994 in North America.

Fossil data are one of the best materials to test the glacial refugia theory. Glacial refugia represent areas where flora and fauna were preserved during the glacial period, characterized by richness in species and endemic species at present. This means that these (endemic) species should have distributed purely or primarily in these areas during the glacial period. The refugia can therefore be identified by fossil records of that period. If it is not the case, the richness in (endemic) species may not be the result of the glacial refugia. By exploring where mammals lived during the Refugium Stage (> 15 ka), seven refugia in North America can be identified: the California Refugium, the Mexico Refugium, the Florida Refugium, the Appalachia Refugium, the Great Basin Refugium, the Rocky Mountain Refugium and the Great Lake Refugium. The first five refugia coincide well with De Lattin's dispersal centers recognized by biogeographical methods using data on modern distributions.

The individuals of a species are not evenly distributed over its Arealsystem. Brown's Hot Spots Model shows that in most cases there is an enormous variation in abundance within an areal of a species: In a census, zero or only a very few individuals occur at most sample locations, but tens or hundreds are found at a few sample sites. Locations where only a few individuals can be sampled in a survey are called "cool spots", and sites where tens or hundreds of individuals can be observed in a survey are called "hot spots". Many areas within the areal are uninhabited, which are called "holes". This model has direct implications for analyzing fossil data: Hot spots have a much higher local population density than cool spots. The chances to discover fossil individuals of a species are much higher in sediments located in a "hot spot" area than in a "cool spot" area. Therefore much higher MNIs (Minimum Number of Individuals) of the species should be found in fossil localities located in the hot

spot than in the cool spot area. There are only a few hot spots but many cool spots within an areal of a single hypothetical species, consequently only a few fossil sites can provide with much high MNIs, whereas most other sites can only provide with very low MNIs. This prediction has been proved to be true by analysis of 70 species in FAUMAP containing over 100 fossil records. The temporal and spatial variation in abundance can be reconstructed from the temporospatial distribution of the MNIs of a species over its Arealsystem. Areas with no fossil records from the last thousands of years may be holes, and sites with much higher MNIs may be hot spots, while locations with low MNIs may be cool spots.

Although the hot spots of many species can remain unchanged in an area over thousands of years, our study shows that a large shift of hot spots occurred mainly around 1,500-1,000 years ago. There are three directions of movement: from the west side to the east side of the Rockies, from the East of the USA to the east side of the Rockies and from the west side of the Rockies to the Southwest of the USA. The first two directions of shift are called Lewis and Clark's pattern, which can be verified with the observations mad by Lewis and Clark during their expedition in 1805-1806. The historical process of this pattern may well explain the 200-year-old puzzle why big game then abundant on the east side were rare on the west side of the Rocky Mountains noted by modern ecologists and biogeographers. The third direction of shift is called Bayham's pattern. This pattern can be tested by the model of Late Holocene resource intensification first described by Frank E. Bayham. The historical process creating the Bayham pattern will challenge the classic explanation of the Late Holocene resource intensification.

An environmental change model has been proposed to account for the shift of hot spots. Implications of glacial refugia and hot spots areas for wildlife management and effective conservation are discussed. Suggestions for paleontologists and zooarchaeologists regarding how to provide more valuable information in their future excavation and research for other disciplines are given.