

Effects of rural agriculture and plantation forestry on high Andean biodiversity

Thor Hjarsen

Centre for Research on the Cultural and Biological Diversity of Andean
Rainforests

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THjarsen@zmuc.ku.dk

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The Endangered Forests in the Andes

One of South America's most endangered forest ecosystems is the *Polylepis* forests (los bosques de kehuña) in the Andean highlands. In Bolivia only about 650 km² of *Polylepis* is left - down from an estimated potential distribution of 40.000 km². The highland forests serves as important water catchment areas by "combing" humidity out of clouds and fog, and by accumulating precipitation.

The water generated by the highland forests is of vital importance for Andean biodiversity and human settlements. A yet unpublished study of Jon Fjeldså and Carsten Rabeck at Zoological Museum, Copenhagen, has shown a high correlation in areas in the Andes between local concentrations of bird species and both historic and recent human settlements. The authors propose that both biodiversity and human settlement relies on the same major factor: A predictable and stable water resource.

For such reasons any measure that can protect and regenerate the highland forests in the Andes are important.

Endangered Species Concentrate in Certain Areas

Jon Fjeldså has earlier identified specific areas along the Andean mountain range which hold a high amount of species with very restricted ranges (so-called endemics) and furthermore, a high proportion of evolutionary young species. Such centres are probably very active species evolution centres.

Some of the rarest birds on the continent are occurring in such evolutionary centres and are furthermore associated with the *Polylepis* or other highland forest ecosystems. Such concentration of species with very restricted ranges

has made it possible for BirdLife International to identify the exact location of high priority areas for conservation in the book Key-areas for threatened birds in the Neotropics.

One example of a rare bird is the Cochabamba Mountain-Finch that is now classified as endangered by IUCN. The species only occurs at 3000-4000 m in Northern-central Bolivia around the town Cochabamba. And BirdLife's book identifies the most important valleys and ravines where this bird occurs.

Human Impact on the Forests

The main reason for the lack of forests in the Andes today is the unsustainable use of natural resources employed by the Andean farmers. The techniques used today were forced upon the native Indians by the Spanish conquistadores and replaced ancient land management traditions developed by high cultures such as the Incas.

One major problem threatening the highland forests are yearly grass burning to provide livestock with fresh pasture. Such burning inhibits growth of tree seedlings and regeneration of forests. The Inca culture obtained much higher crop production per area by relying on terraced fields, but today this technique is replaced by sloping fields. Thus fertile topsoil is washed away in heavy rains and several slopes erode. Thus the farmers clear more forests to obtain fertile soils.

The problems of erosion and scarce water resources are recognised by several international donors working in the Andes. Regeneration of forest cover has high attention in several projects but most often such projects rely on exotic trees, mainly *Eucalyptus globulus* and *Pinus radiata*. Use of native species (*Polylepis* spp., *Alnus acuminata* etc.) is often not seriously considered by foresters responsible for implementation.

In recent years several biological expeditions in the Bolivian Andes have reported establishment of exotic plantations inside native forests and some have also discussed whether the plantations caused any threats to the endangered biodiversity.

Human Effects on Endangered Andean Bird Fauna Exclusion of humans from nature to protect endangered species or ecosystems is not a rational solution anymore; certainly not when it comes to poor peoples' land as in Bolivia. Instead, ecologically and economically sustainable land management techniques must be employed. Thus a five-month field study was initiated in 1996 to investigate the impact on the endangered avifauna and vegetation from: 1) Andean farmer's traditional agriculture and use of forest resources, and 2) Modern exotic plantation forestry as introduced by various forestry projects operating in the Cochabamba area.

The results (see also table 1) shows that the endangered and endemic bird species never were recorded in the exotic plantations. By analysing the feeding habits of the avifauna recorded, we found that insect-, nectar- and fruit eaters occurred at lowest abundance in the exotic plantations. Opposite, seed eating species with large range sizes and broad habitat selection were relatively more abundant in the plantations. Only the natural forest ecosystems had all bird groups present. Considering all bird records in relation to the 4 habitat groups, 77% of all records were made in natural forest ecosystems and 23% in the plantation habitats.

Another important finding was that various degrees of land-use techniques employed by the local farmers did not cause any significant threats to the endangered bird species. In fact the highest abundance of the most threatened birds was found in areas with many fields and pastures. The condition though was that some native woodland was left. Such results call upon development of ecologically sustainable and socially acceptable land management policies in the areas. The findings did not support the idea of creating more national parks or reserves that exclude already marginalised the rural populations.

Exotics versus Native Species in Forestry

Exotic afforestation activities in the Andes can ultimately limit water resources and agricultural output. Native trees are most suitable in interception of precipitation, because of higher leaf area indices and more epiphytes on the branches. This important "water catching function" of the natural forests is essential to biodiversity, agriculture and human settlements. Today, loss of high mountain forest is considered as the major cause for water scarcity in many parts of the Andes.

We experienced that exotic plantations did not always remove logging pressure on the natural forests. High market price for exotic plantation timber caused farmers to protect the exotics against early logging and instead they continued to utilise the natural forests for domestic purposes.

During the last 13 years a forestry project: "Programa de Repoblamiento Forestal" (PROFOR), has planted more than 15 million trees in the Andean zone in Cochabamba. About 80 per cent of the trees are *Eucalyptus globulus* and *Pinus radiata*. This important project has largely neglected to acknowledge the role of native tree species for erosion control and preservation of ecosystems and water catchments. Little attention has also been given to the fact that the indigenous communities also rely on the non-timber resources offered by the *Polylepis* forests such as medicine plants, game and wild tuber plants.

Fast growing exotics should only be used when a rapid supply of firewood and construction timber is needed and - with great care - for urgent erosion control. Long-term ecological, hydrological and rural socio-economical goals

require instead protection and regeneration of the endangered *Polylepis* forests by true reforestation, and zonation of different land-uses.

Table 1: Indicators of the impact on avifauna of exotic plantations compared with natural forests habitats in the High Andes of Bolivia (averages of 52 areas - area of each habitat: 3 ha.).

Plantations	<i>Pinus</i> plantations	<i>Polylepis</i> forest habitats	Other natural forest habitats	
Average bird species number	6,2	6,7	18,0	20,4
Average number of bird individuals	14,8	14,9	56,1	65,0
Diversity index for birds (a diversity)	6.7	9.3	16,3	18,8
Bird Rarity Score *)	0,27	0,26	1,23	1,52

*) The Bird Rarity Score (here average of each habitat category) is calculated by summing the inverse range size of all recorded bird species. This has been done for all study areas of each habitat category. Species' range sizes are established by calculating the 1° geographical grids where each species occur in a WorldMap database. Bird species with small range sizes (includes the endemic and endangered species) thus gets high scores. A study area with many such restricted range birds will then get a high Bird Rarity Score.

Notes to readers

The author may be reached at:

Centre for Research on the Cultural and Biological Diversity of Andean Rainforests (DIVA)
 The Danish Environmental Research Programme
 Zoological Museum
 University of Copenhagen
 Universitetsparken 15
 2100 Copenhagen
 Denmark