# SURVEY AND HABITAT EVALUATION FOR A PERIPHERAL POPULATION OF THE EURASIAN OTTER IN ITALY

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**ABSTRACT:** The Eurasian otter has declined sharply in Italy in recent decades, now surviving only in the southern regions. Knowledge of the species' range and environmental factors affecting its distribution is limited. From 2000 to 2002, we conducted a field survey in the Molise region of Italy, an area of formerly known to be occupied by the Eurasian otter. The survey followed the "standard method" for monitoring otter presence used in other European countries. The area was searched for sign of otter, with 6 habitat structure parameters recorded at the 191 sites. Multivariate ordination and hierarchic classification were used to find environmental similarities between sites where otters were present or absent. Otter sign were detected at 22 sites, concentrated in the Volturno and Biferno River basins. Three habitat suitability classes were distinguished through hierarchic clusters derived from multivariate ordination, which are mostly influenced by elevation and vegetation cover on riverbanks. Through the analysis of the distribution of suitable sites in the study area we were able to define sites unoccupied by otters in the region that offer the best opportunity for recolonization.

**KEY WORDS**: Eurasian otter, GIS, habitat suitability, hierarchic clustering, Italy, *Lutra lutra*, natural expansion, standard survey.

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Once widespread in all major rivers, the Eurasian otter (*Lutra lutra* L.) is currently one of the most endangered mammals in Italy (Bulgarini et al. 1998). The species has experienced particularly sharp declines in the northern and central regions from which it went extinct during the 1990s (Spagnesi et al. 2000). A healthy population persists in the southern regions of Campania, Basilicata and Puglia (Prigioni et al. 1989, Reggiani and Ciucci 1994, Spagnesi et al. 2000). This population is completely isolated from other European populations (Foster-Turley et al. 1990, Spagnesi et al. 2000).

From 2000 to 2002, we conducted a field survey to assess the status and distribution of an otter sub-population in the Molise region, which is located northeast of the primary otter range in Italy (Fig. 1). Otters in this region were once common and

widespread in all the watercourses (Altobello 1921). The species' decline in this area was first documented by MacDonald and Mason (1983*a*), and later by Pellegrini and Febbo (1986). Outcomes of these surveys demonstrated that a few individuals persisted in the Volturno and Biferno Rivers.

Our goal was to verify the presence and distribution of otters in the Molise region following methodology prescribed in the "standard method" for conducting surveys for otters in Europe (Reuther 2000) and to use the habitat structure parameters from each site to develop a method to rapidly evaluate the suitability of habitat for otters. Habitat destruction was proposed as a main cause for the otters' decline in Europe (MacDonald and Mason 1994, Conroy et al. 2000), but there is a paucity of objective information that can be used to assess the range of environmental conditions suitable for sustaining a persistent otter population in Italy. A better understanding of the distribution of the otter in relation to environmental variables may provide more information concerning the influence of habitat quality and connectivity in shaping the dynamics of the species' range boundaries (Brown et al. 1996, Anderson et al. 2003, Barbosa et al. 2003).

## STUDY AREA

The Molise region lies in central-southern Italy, between the Adriatic Sea and the Apennines, occupying an area of 4,439 km$^2$. The territory is mostly mountainous or hilly, with flat ground limited to the lower valleys and along the Adriatic coast. The Molise border passes through the Apennine watershed, including the upper valley of the Volturno River. The Biferno River is the only river with its entire drainage within the Molise region. Substantial portions of the Trigno and Fortore Rivers occupy the region and, like the Biferno, flow into the Adriatic Sea. A small portion of the Sangro River (about 5 km) forms a portion of the border between the Molise and Abruzzo regions (Fig.1).

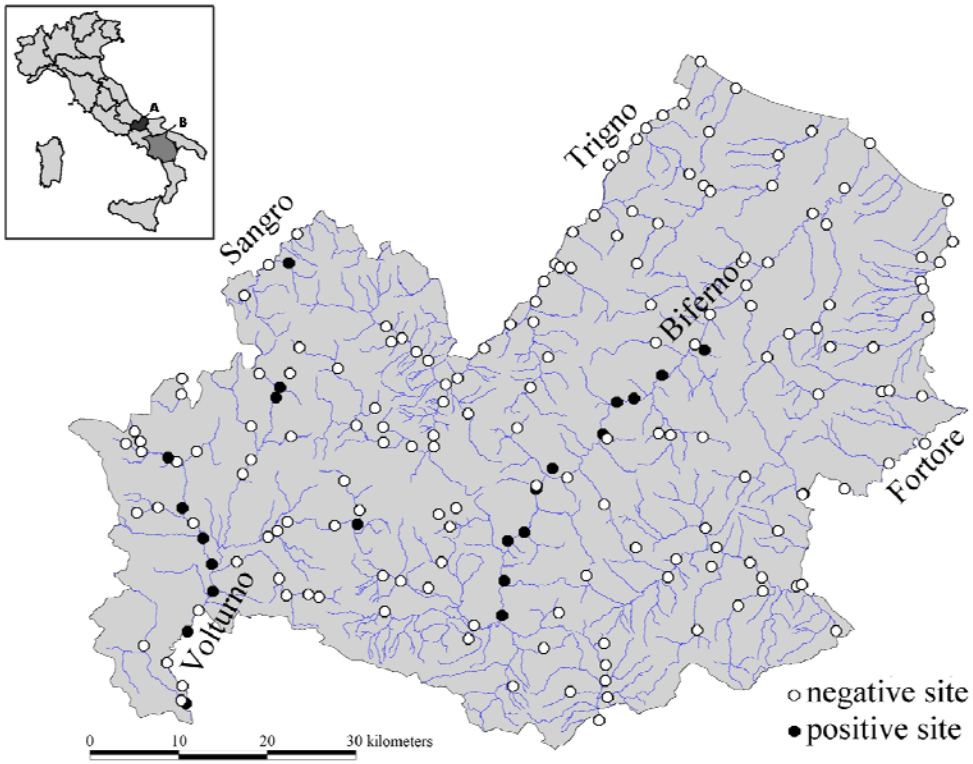


Fig. 1. Distribution of sites surveyed for otter sign in the Molise Region during 2000 -2002. Location of the Molise region (A) and Italian otter range (B) are shown on the top left of the map.

## METHODS

### Field survey

Our field survey was carried out during 2000-2002 following the standard method recommended by the IUCN Otter Specialist Group (Reuther 1995, Reuther et al. 2000). Four sample sites were randomly selected for each 10x10 km quadrant of the Universal Transverse Mercator (UTM) square grid laid over the regional topographic map (scale 1:50.000, Istituto Geografico Militare). A total of 191 sites were spaced at least 5 km apart and checked for sign of otters (either tracks or spraints) along 600 m of riverbank. Each site was classified as positive or negative based on the presence or absence of otter sign.

For each site, the UTM coordinates were recorded with structural habitat parameters (Reuther et al. 2000; Loy et al. 2002). Numerous other studies have indicated that vegetation cover along riverbanks, elevation and river-width are useful in predicting the likelihood of a river being occupied by otters (MacDonald and Mason 1983*b*, Prenda and Granado-Lorencio 1996, Madsen and Prang 2001, Barbosa et. al. 2003). Therefore the following 6 parameters were recorded at each site: elevation (m above sea level [ASL]), average width of riverbed (m), water level (low, normal, high), water turbidity (low, medium, high), riverbed substrate (mud, gravel, rock-gravel, rocks), and prevailing vegetation cover along the riverbank. Vegetation within a 500-m wide strip from the riverbed was recorded following the CORINE land cover categories at a $4^{th}$ level of detail for natural and forested areas (European Environment Agency 1997, 2000; Blasi 2003) (see Appendix A for details of classes recorded during the survey).

Habitat parameters were first transformed to an ordinal scale and tested for significant differences between positive and negative sites. Environmental gradients in the study area were investigated through Principal Component Analysis (PCA) based on Gower distances on the habitat parameters matrix (Gower 1971). Habitat similarities among sites were assessed through hierarchic clusters (average linkage) derived from PCA scores through the global optimization algorithm based on quantitative chord distance and suboptimal fusion for the resolution of tie breaks (SYN-TAX 2000 Package; Podani 2001). Clusters were inspected for the rate of positive and negative sites and used to establish 3 suitability classes for otters.

Positive and negative sites were mapped according to suitability classes in a GIS environment (Arc-View 3.2 ESRI 2000). Finally, the most likely potential area of connection between suitable occupied and vacant catchments was identified by visual inspection of the Digital Elevation Model, the 1:25,000 scale topographic map, hydrographic network, and recent (from 2000) high-resolution orthophotos.

## RESULTS

Otter sign was detected in 22 out of 191 sites (11% positive) (Fig. 1). The majority of positive sites (21) occurred on the Volturno and Biferno Rivers, with 1 positive site on the Sangro River. Positive and negative sites were significantly different for CORINE land cover ($\chi^2 = 10.615$; $P = 0.0139$) and riverbed structure ($\chi^2 = 19.261$; $P = 0.0074$).

We constructed a multivariate ordination biplot of surveyed sites based on habitat structure parameters (centered PCA on Gower's distance matrix; Fig. 2). Positive sites, concentrated on the upper left quadrant of the biplot were associated to Corine classes with high vegetation cover and to low medium elevation values. Hierarchic clustering derived from ordination axes defined 2 main groups (Fig. 3). A

high concentration of positive sites (10 out of 22) occurs in sub-group 2aa. Conversely, all other sub-clusters belonging to group 2 include only negative sites. Given this clear separation, these 2 extremes were used as a reference to rank the suitability of habitats for otters in the region. Sites included in cluster 2aa were considered as highly suitable, whereas all other sites included in cluster 2 were considered unsuitable. Sites included in cluster 1 were considered to be moderately suitable.

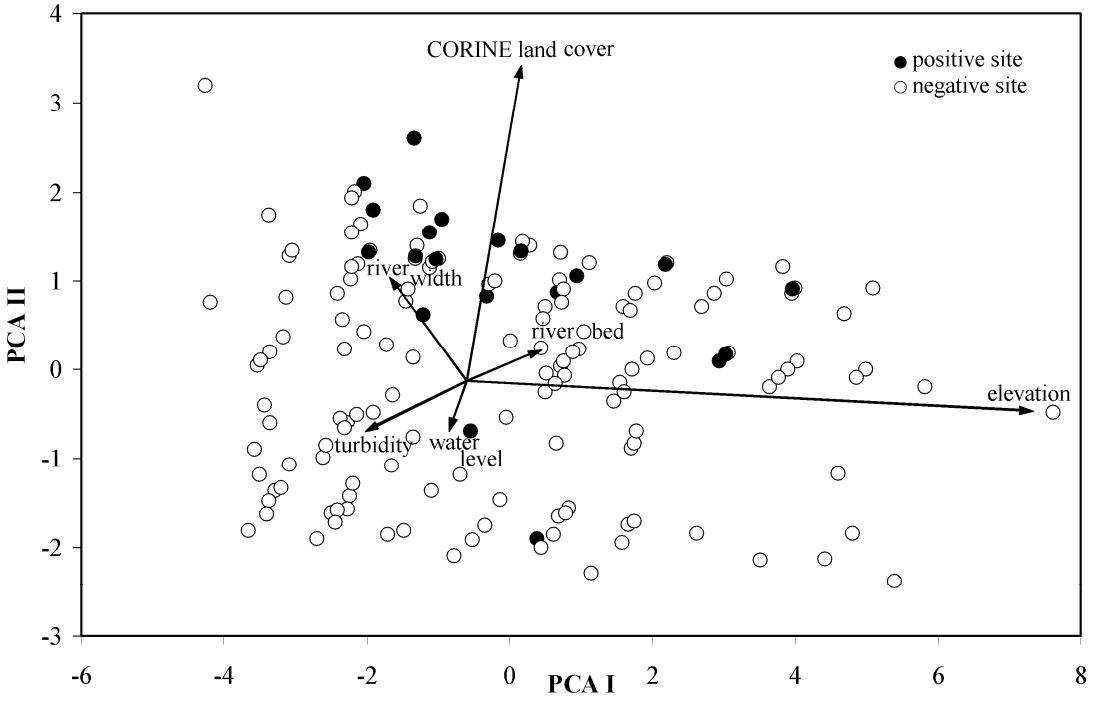


Fig. 2. Multivariate ordination biplot of surveyed sites based on habitat structure parameters (Centred PCA on Gower's distance matrix). First and 2nd principal components account for 61.01% and 14.02% of cumulative variance, respectively.

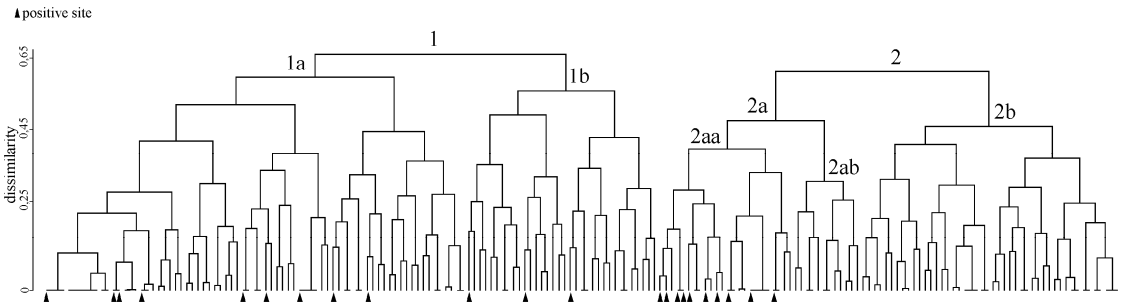


Fig. 3. Hierarchic clusters (average linkage) derived from PCA scores. Group 2aa shows a high concentration of positive sites (10 out of 22). All the sites included in this cluster were considered to be highly suitable habitats for otters.

Ranges for habitat structure parameters characterizing these 3 suitability classes (Table 1) revealed that the riparian vegetation of the most suitable sites exclusively consists of hygrophilous forests (CLC 3.1.1.6). Sites in this cluster also are characterized by rocks or rocks and gravel riverbeds, an elevation ranging between 80 and 300 m ASL, a medium or high water level, and a river width not exceeding 50 m (Table 1).

Table 1. Range of habitat structure parameters recorded at sites surveyed for otter signs in Molise during the years 2000-2002. Sites are grouped in habitat suitability classes defined through hierarchic clustering.

| Suitability class | Low ($n$ = 58) | Medium ($n$ = 109) | High ($n$ = 24) |
|---|---|---|---|
| Elevation (m) | 3-394 | 9-1160 | 82-300 |
| River width (m) | 1-60 | 1-80 | 2-50 |
| Water level (%) | low = 5.17<br>medium = 58.62<br>high = 36.21 | low = 7.34<br>medium = 71.56<br>high = 21.10 | medium = 87.50<br>high = 12.50 |
| River bed (%) | mud = 43.10<br>gravel = 10.34<br>rock-gravel = 46.55 | mud = 22.94<br>gravel = 11.93<br>rock-gravel = 40.37<br>rock = 24.77 | gravel = 4.17<br>rock-gravel = 95.83 |
| Vegetation cover (%) | open areas = 39.10<br>scrubs = 29.58<br>woods = 5.17<br>hygr for[a] = 15.52 | open areas = 18.34<br>scrubs = 10.79<br>woodlands = 35.68<br>hygr for = 34.86 | hygr for = 100 |
| Turbidity (%) | low = 5.17<br>medium = 36.21<br>high = 56.90<br>no water = 1.72 | low = 49.54<br>medium = 27.52<br>high = 22.02<br>no water = 0.92 | low = 25<br>medium = 50<br>high = 25 |

[a]hygrophilous forest.

The ranges of environmental variables and the distribution of sites according to suitability show a well-defined spatial pattern (Fig. 4). The most suitable sites typically are located in the mid-reaches of the rivers, whereas suitability tends to decrease both in the upper and lower reaches. Our model revealed a long stretch of high suitable habitat for otters along the Trigno River, where no evidence of otters were detected during the survey (Fig. 4). This area should be considered to be the best candidate for the potential future expansion of otters in the region.

One possible pathway overland connecting the Trigno with Biferno catchments was identified at Fonte Cannavina (770 m ASL, Long E 14° 33’ 08’’; N 41° 42’ 30’’). This is a 990 m trail that otters could cross to go from a tributary of the Biferno (Vallone delle Cese) to a tributary of the Trigno (Torrente Rivo) (Fig. 4).

## DISCUSSION

We detected otter sign primarily along the Biferno and Volturno Rivers, which was an outcome similar to a 1985 survey conducted by Pellegrini and Febbo (1986). These rivers form an isolated nucleus from the known range of otters in Italy (Spagnesi et al 2000). Consequently, otters occurring in the Molise region appear to be from the persistence of a remnant population and not the expansion of the “core” population, or the result of occasional “wandering” individuals as suggested by Pellegrini and Febbo (1986). This newly found peripheral population may be an important source of individuals for future recovery of the otter in central Italy.

The 13% of positive sites in Molise is considerably lower than percentages recently recorded in the core of the species’ distribution range in Italy, where otter occurrence was detected at about 70% of the sites surveyed using the same standard method (Marcelli et al. 2004). Although the results of these standard surveys do not demonstrate the number of otters, several studies have shown that they represent a general indicator of otter relative abundances (Reuther et al. 2000, Ruiz-Olmo et al.

2001). Therefore, outcomes of our study suggest that otters in the Molise region occur at lower densities than in the core area.

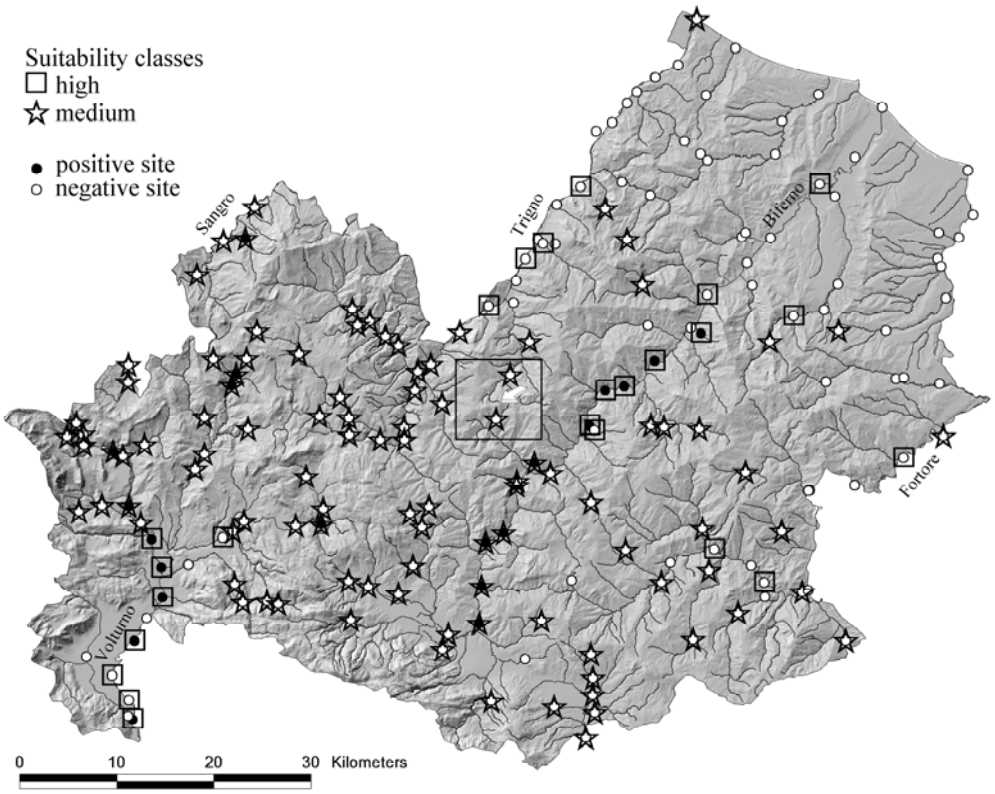


Fig. 4. Distribution of sites according the 3 habitat suitability classes derived from hierarchic clustering. Unsuitable sites are those not surrounded by a symbol. The DEM (Digital Elevation Map) layer has been overlaid on the regional map to allow a rapid detection of differences in elevation. The area with the highest concentration of most suitable sites where otters are currently absent occurs along the middle section of the Trigno River. The frame highlights the area containing the shortest and most suitable pathway joining this river basin and the Biferno; the white arrow indicates the narrowest portion of land joining 2 suitable water stretches belonging to the 2 river basins.

Isolation, limited distribution, and low numbers are all population factors currently posing a risk to the persistence of otters in the Molise region. In these circumstances individuals probably tend to occupy the areas that offer the most favorable environmental conditions (Ruiz-Olmo et al. 2001). Evidence of otters in the Molise region is associated with mid-reaches of rivers (80-300 m ASL) with extensive hygrophilous vegetation along riverbanks.

We are aware that more data are needed to define the habitat requirements of otters in Europe. Nevertheless, our results stress the importance developing habitat suitability models based on comparing habitat conditions associated with areas occupied or unoccupied by otters. This information can be used to improve the quality of habitat suitability models based on GIS data.

## MANAGEMENT IMPLICATIONS

Our study demonstrated the persistence of a small otter population in the Molise Region, primarily along portions of the Biferno and Volturno Rivers. The habitat modelling that we conducted indicates that these populations typically are associated with certain riverine and riparian habitat conditions and therefore provides a basis for identifying and protecting areas most likely to be occupied by otters. The small otter population in the Molise region should be regarded as vulnerable to extirpation.

Conservation efforts in the region should focus on protecting riverine and riparian habitats identified as important to otters through our initial modelling. Also, water quality and fish abundance must be maintained or enhanced throughout the entire drainage to ensure the persistence (and potential for expansion) of this small otter population (Conroy et al. 2000, Ruiz-Olmo et al. 2001). Specifically, goals of protection measures and habitat management, conservation activities and policies should be designed to maintain adequate riparian vegetative cover, an important factor associated with the distribution of otters in our study area and elsewhere in Europe (Prenda and Granado-Lorencio 1996, Madsen and Prang 2001). Vegetative cover may act directly in providing refuge (e.g., denning and resting sites), and secondarily by providing habitat for prey (primarily fish) (Prenda and Granado-Lorencio 1996, Prigioni et al. 2003).

We suspect expansion of the otter population to lower reaches of rivers and coastal areas currently may be limited by unfavourable environmental conditions. In Molise, as in most Italian regions, coastal lowlands typically support high concentrations of people and associated development. Consequently, water quality and hydrology may be particularly degraded or altered, and riparian vegetation often absent or reduced in lower reaches of rivers near the coast.

Our study suggests that habitat conditions potentially suitable for supporting an otter population exist elsewhere in the Molise region. The Trigno River could potentially be colonized by expansion of the existing population in the region. Conservation efforts should be made to identify and then protect or enhance potential corridors by which extant otter population could colonize other suitable areas. The re-colonization of the Trigno River, for example, would improve the chances of survival of otter populations in Molise region, and also enhance the potential for expansion of these populations into suitable habitats in Central Italy. A young female killed recently (December 2004) along a road between the Biferno and the Trigno Rivers indicates the potential for dispersing otters to travel overland between drainages. Also, our detection of a positive site along the Sangro River, which was not reported as being occupied by otters following the 1985 survey conducted by Pellegrini and Febbo (1986), serves as further indication of the potential for natural expansion of otter populations in the region. Any conservation activities that enhance the likelihood of the natural expansion of otters in and beyond the Molise region would contribute to a primary goal for otter conservation activities in Europe—enabling the re-colonization of otters to all adequate habitats throughout their historic range on the continent (Reuther 2004).

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## Appendix A

CORINE land cover classes recorded in the field. Classes are listed according to ordinal ranks used for multivariate analyses.

| *Ordinal class* | *CORINE class* | *Description* |
|---|---|---|
| 1 - Open areas | 2.1.1 | non-irrigated arable land |
| | 2.1.2 | permanently irrigated land |
| | 2.3.1 | permanent meadows |
| | 2.4.1 | annual crops associated with permanent crops |
| | 2.4.3 | land occupied principally by agriculture |
| | 3.2.1 | natural grasslands |
| 2 - Scrubs | 3.2.2 | moors and heathlands |
| | 3.2.4 | transitional woodland-scrub |
| | 3.3.3 | sparsely vegetated area |
| 3 - Woodlands | 3.1.2 | coniferous forest |
| | 3.1.3.1 | broad-leaved dominated mixed forest |
| | 3.1.3.2 | coniferous dominated mixed forest |
| | 3.1.1.2 | deciduous oak forests |
| | 3.1.1.3 | mesophilous broad-leaved forests |
| 4 - Hygrophilous forests | 3.1.1.6 | hygrophilous forests |