

## *The Doubs Fish Data*

In an important doctoral thesis, Verneaux (1973; see also Verneaux et al. 2003) proposed to use fish species to characterize ecological zones along European rivers and streams. He showed that fish communities were good biological indicators of these water bodies. Starting from the source, Verneaux proposed a typology in four zones, and he named each one after a characteristic species: the trout zone (from the brown trout *Salmo trutta fario*), the grayling zone (from *Thymallus thymallus*), the barbel zone (from *Barbus barbus*) and the bream zone (from the common bream *Abramis brama*). The two upper zones are considered as the “Salmonid region” and the two lowermost ones constitute the “Cyprinid region”. The corresponding ecological conditions, with much variation among rivers, range from relatively pristine, well oxygenated and oligotrophic to eutrophic and oxygen-deprived waters.

The Doubs data set that is used in the present book consists of three matrices containing part of the data used by Verneaux for his studies. These data have been collected at 30 sites along the Doubs River, which runs near the France–Switzerland border in the Jura Mountains. The first matrix contains coded abundances of 27 fish species, the second matrix contains 11 environmental variables related to the hydrology, geomorphology and chemistry of the river, and the third matrix contains the geographical coordinates (Cartesian, X and Y) of the sites. These data have already served as test cases in the development of numerical techniques (Chessel et al. 1994).

Working with the environmental data available in the **R** package **ade4** (at the time of this writing, i.e. **ade4** version 1.4-14), we corrected a mistake in the `das` variable and restored the variables to their original units, which are presented in Table 1.1.

**Table 1.1** Environmental variables of the Doubs data set used in this book and their units

Variable	Code	Units
Distance from source	<code>das</code>	km
Altitude	<code>alt</code>	m a.s.l.
Slope	<code>pen</code>	‰
Mean minimum discharge	<code>deb</code>	m <sup>3</sup> s <sup>-1</sup>
pH of water	<code>pH</code>	–
Calcium concentration (hardness)	<code>dur</code>	mg L <sup>-1</sup>
Phosphate concentration	<code>pho</code>	mg L <sup>-1</sup>
Nitrate concentration	<code>nit</code>	mg L <sup>-1</sup>
Ammonium concentration	<code>amm</code>	mg L <sup>-1</sup>
Dissolved oxygen	<code>oxy</code>	mg L <sup>-1</sup>
Biological oxygen demand	<code>dbo</code>	mg L <sup>-1</sup>

From Borcard et al. (2011)