1.4 Watercourses

1.4.1 Location, size and density

Danish watercourses, including those in Odense River Basin, are typically lowland watercourses (terrain height under 200 m). In a European perspective, they are all very small (Figure 1.4.1). The largest watercourse in Odense River Basin is the River Odense (catchment 630 km^2), the main reach of which is just under 60 km long and up to 30 m wide. The density of open watercourses in the basin as a whole is approx. 1.0 km/km^2. The original (natural) density of the watercourse network was probably somewhat greater (up to 1.5-fold). However, the density is of the same magnitude as in the other Nordic countries and Great Britain (as well as in parts of the USA).

In Odense River Basin, the very small watercourses account for a considerable proportion of the watercourse network (Table 1.4.1). Even though the watercourse system is incomplete, the relative distribution of the watercourses in size categories does not differ very much from the expected natural distribution (Horton's laws of stream number and stream lengths; see Dodds & Rothman, 1999).

Due to resource constraints, the many small watercourses are relatively under-represented in the current monitoring (Table 1.4.1). They encompass both spring brooks, summer-dry (temporary) watercourses (which should be included as watercourses – and not as wetlands) and ditches established in connection with drainage of wetlands. Even though our knowledge of the small watercourses is generally less than that of the larger watercourses, the small watercourses are considered to be a very important part of the watercourse network. Thus the small watercourses together contain just as many species of macroinvertebrates as the larger watercourses (including also special spring species), just as many small watercourses are important spawning and nursery grounds for salmonids.

Given that the small watercourses are of such great significance, they, like the larger watercourses, should also be included when identifying water bodies (Section 1.4.3). As it is impracticable to investigate them all, it would be appropriate to aggregate them into groups. Aggregation could be carried out for each type (Section 1.4.2) according to the main threats/pressures. The monitoring and subsequent reporting could thereafter be restricted to a representative fraction of the water bodies within each group. It is believed that it will hereafter remain necessary to operate with several levels of monitoring in order to achieve a sufficiently adequate description of watercourse status to enable prioritization of environmental initiatives and the selection of the most appropriate measures to improve watercourse environmental quality.

1.4.2 Typology

According to the WFD, the watercourses have to be differentiated into types in order to establish relatively uniform groupings for which the natural reference conditions are relatively homogenous. Annex II of the WFD provides two typology systems for differentiating the watercourses, namely System A and System B. As Danish watercourses are so small, the use of System A in its present form is inappropriate. Two other systems for differentiating Danish watercourses have therefore been tested.

One of the systems in principle resembles System A, but contains elements of System B (Table 1.4.2). This typology, which has been developed by the National Environmental Research Institute, has so far only been notified nationally. According to this system, Danish watercourses are differentiated according to location east or west of the line formed by the Weichsel ice front

Width	≤2 m	2–10 m	>10 m
Watercourse length (km)	730	330	42
Percentage of total length	66	30	4
No. of monitoring stations	101	192	15
Percentage of stations	33	62	5

Table 1.4.1 Size distribution of watercourses and monitoring stations in Odense River Basin.

Type	1	2	3
Stream order (Strahler system)	1–2	3–4	>5
Catchment area (km^2)	<10	10–100	>100
Width (m)	0–2	>2–10	>10
Distance to source (km)	<2	2–40	>40

Table 1.4.2 Typology of Danish watercourses proposed by the National Environmental Research Institute (M.L. Pedersen, personal communication). The watercourses in Odense River Basin lie east of the line formed by the Weichsel ice front.

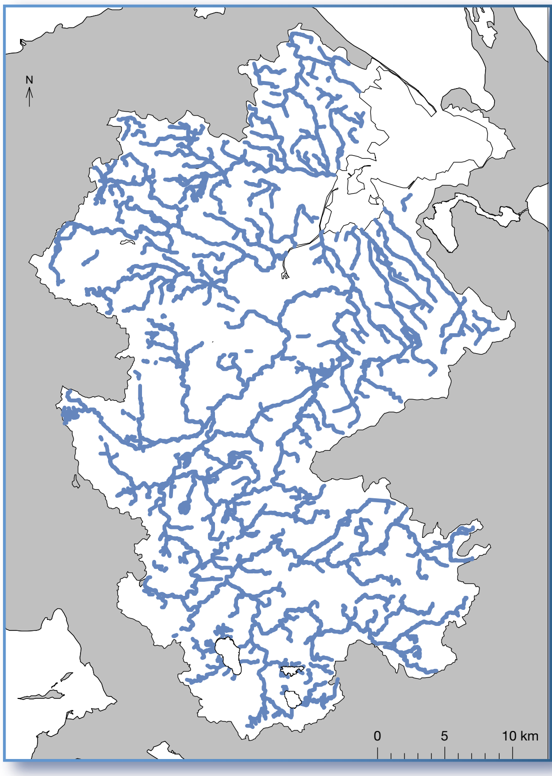


Figure 1.4.1 Map of Odense River Basin showing the complete watercourse network.

and thereafter according to size. The typology of each individual locality is assessed from four appropriate (and mutually positively correlated) size components. A locality is assigned a type in accordance with the dominance principle. In cases of equal distribution between two types, the size of the catchment area is the decisive determinant of type. This principle is employed to ensure that the system can be used throughout Denmark irrespective of regional or local differences in topography. The method has been tested in part of Odense River Basin (Figure 1.4.2) and is fully practicable when appropriate calculation methods are used to define catchment boundaries and to determine watercourse length. Watercourse width (if possible the winter width of the water surface, otherwise the summer width of the water surface) and the catchment area are the parameters that are easiest to work with. That stream order and distance to source are more difficult to work with is due to the fact that it can be difficult to locate the source (often piped) and to differentiate artificial reaches from natural reaches in the upper parts of the watercourse systems. For Danish watercourses, it has been shown that the composition of the plants, macroinvertebrates and fish is closely correlated with watercourse size (Fyn County, 2000a; WaterFrame, 2003). The macroinvertebrate fauna also correlates with the watercourse slope, which in turn is negatively correlated with watercourse size (Wiberg-Larsen et al., 2000).

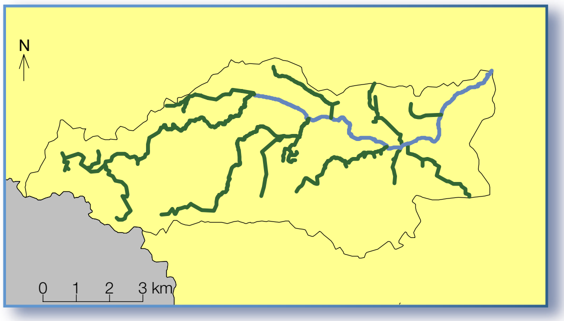
The second system (Table 1.4.3) is based in part on theoretical considerations, according to which the magnitude and variation of water flow and the watercourse slope considerably influence conditions for the flora and fauna. Thus many reaches can more or less regularly dry out in summer, especially the very small watercourses and the upper reaches of the larger watercourses. Furthermore, the slope is decisive for flow rate and the composition of the bottom substrate. Runoff is described from the median minimum value. For Fyn County as a whole this is determined with an average density of 1 location per 5 km². For Odense River Basin, the corresponding density is 1 location per 4.4 km². The project partner, DDH, has tested this method in the Lunde Stream system and concluded that the selected parameters can be accurately determined, and that the method is easy to use and not very time-consuming (DDH, 2003). The relationship to the biological conditions still remains to be tested, though. There is no doubt, however, that at least the naturally summer-dry watercourse reaches have reference conditions that differs markedly

Table 1.4.3 An alternative typology of Danish watercourses proposed by DDH (2003). In this system the three variables should be considered independently of each other.

Alternative type	1	2	3
Catchment area (km^2)	<10	10–100	>100
Runoff, median min (l/s • km^2)	<0.2	0.2–2,0	>2.0
Slope (m/km)	<0.25	0.25–0.75	>0.75

Table 1.4.4 Physical modifications initially examined in the Ryds Stream catchment and the main course of the River Odense.

Physical pressure	Specification of extent
Piped reaches	km (and pipe diameter)
Other regulation (straightening, deepening)	Grade 0–3
Bank stabilization (stones/fascines)	+/-
Maintenance (weed cutting/dredging)	Grade 0–3
Obstructions for fish	Number (height and upstream damming effect)
Stormwater discharges (hydraulic stress)	Number (and frequency)
Sand transport	Grade 0–3
Drainage (flood plain)	Grade 0–3



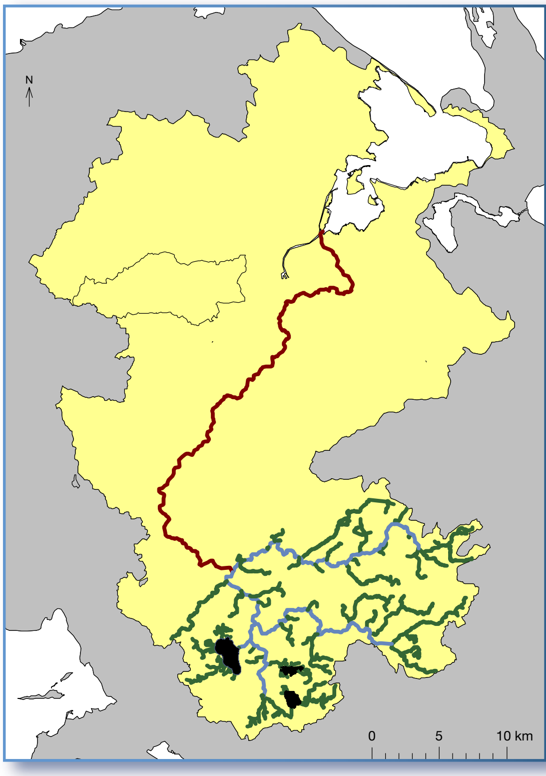


Figure 1.4.2
Map indicating the watercourse typology for the Ryds Stream catchment and the upper parts of the River Odense system.

Type 1
Type 2
Type 3
Basin

from that of permanently flowing watercourse reaches. Moreover, the reference conditions of watercourse reaches with a naturally very gentle slope can be expected to differ markedly from that of those with a steeper slope.

1.4.3 Delineation of watercourse reaches

The complete method for delineating watercourse reaches was initially tested on the Ryds Stream catchment (area 46 km^2) and the main course of the River Odense (length 60 km) calculated from the source of Rislebæk Brook to the outlet in Odense Fjord (Figure 1.4.3). In addition, part of the identification process (excluding assessment of physical modification) has been tested in the Lunde Stream catchment (area 70 km^2) (DDH, 2003). Applying the criteria in the EU horizontal guidance "Identification of water bodies" to these three test areas together with the criteria for identifying heavily modified water bodies (Section 1.4.4) yields 13, 16 and 14 water bodies, respectively, i.e. an average of 1 water body per 4 km of watercourse. The individual water bodies vary in length from 1 to 12 km. If the present level of detail is maintained, an estimated 280 water bodies should be identifiable in Odense River Basin solely from the watercourse systems. This figure is preliminary and could be revised as experience with the pilot project progresses. Furthermore, aggregation of the smaller watercourse reaches in particular is being considered.

To facilitate the identification of the water bodies, watercourse physical conditions have been charted on the basis of information from the watercourse regulations (only county and municipal watercourses), preliminary investigations in connection with wetland projects and monitoring results (see also Section 1.4.4). The whole process of assessing the physical conditions is very time-consuming, among other reasons because much of the data is usually only available in paper form or has to be collected from the municipal authorities. When information on the physical conditions is available it is compared with the results of the biological monitoring. In addition, the presence of different forms of national and regional protection is incorporated in the assessments. Delineation of water bodies has thus primarily been based on knowledge of the watercourses' current status assessed from the existing knowledge about the physical and biological quality. It should be noted that the biological status is primarily described from the existing Danish assessment system, whereby macroinvertebrates are utilized as "indicators" for the biological conditions in general (Danish Stream Fauna Index; Skriver et al., 2000). The status is measured as fauna classes on a scale from 1 (poorest) to 7 (best). According to the guidelines, the riparian zone is counted as a biological quality element. No decision has been made as to how this zone should be delineated from wetlands along the watercourses, though, and consequently the zone has not been included as an element in their identification.

1.4.4 Physical modification

An analysis of large watercourses in Fyn County (county watercourses) reveals that approx. 46% are regulated, and have thereby been shortened by 5–10%. The extent to which the minor watercourses have been regulated is unclear, among

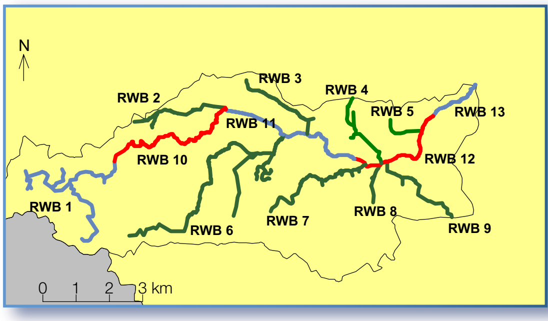
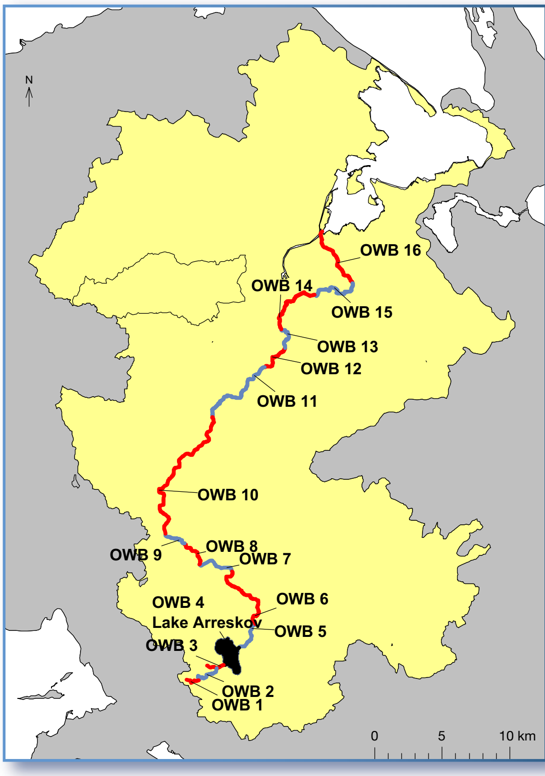


Figure 1.4.3
Map indicating the water bodies in the Ryds Stream catchment and the main course of the River Odense.



other reasons because many changes of course and length were made long ago (before 1850). A general phenomenon, though, is that the upper sections of the watercourses are more heavily modified than the lower sections. In many places, the upper sections are piped, often including the natural source. An analysis of known piped sections in the whole of Odense River Basin shows that approx. 25% of the total watercourse network is piped, although the real figure is undoubtedly significantly higher. Of the remaining open watercourses in Odense River Basin, 60% are estimated to be regulated. All in all, the majority of the watercourses are therefore modified by man to some extent. At the same time, though, it is clear that some of these modifications are very old such that the environmental quality of at least some reaches have considerably improved in the course of time through "natural re-establishment" (Brookes, 1984), and hence can no longer be considered as heavily modified.

The procedure for the provisional identification of heavily modified water bodies (Guidance Document 2.2) has in the first instance been tested on the Ryds Stream catchment and the main course of the River Odense (see also Section 1.4.3). For use in assessing the degree of physical modification, an analysis has been made of the main physical pressures affecting a number of sub-reaches (Table 1.4.4). It should be noted that it has not been possible to identify actual artificial reaches in the areas tested with certainty, even among the smaller, upper ends of watercourses. Different forms of artificially established bypasses through which part of the watercourse water passes, for example at dams and weirs in the main course, are thus included as part of a modified water body.

Table 1.4.4 is based on work with two test localities. It is not complete with regard to either

Table 1.4.5
Water bodies (WB) in the main course of the River Odense indicating the occurrence of heavy modification (HM), biological status (FC = fauna class) assessed from the macroinvertebrates (Danish Stream Fauna Index), and remarks concerning physical potential.

WB No.	HM	FC	Remarks
1	+	4	Regulated, restoration planned, mean slopes 1.2–2.9 m/km
2	-	7	Unregulated, sinuous, mean slopes 2.8–6.9 m/km
3	+	?	Regulated, mean slopes 0.1–4.6 m/km
4	-	-	Lake Arreskov
5	+	3–4	Regulated, affected by fluctuation in water level (periodic outflow of water from the lake)
6	-	5–6	Regulated, but with a rather varied bottom substrate
7	-	5–6 (pre)	Under restoration (remeandering)
8	+	?	Regulated, affected by damming, technical structures
9	-	5–7	Unregulated, sinuous
10	-	5–7	Regulated, but with a rather varied bottom, restoration planned
11	-	5–7	Unregulated, sinuous
12	+	3–4	Affected by damming, technical structures
13	-	5–6	Regulated, but with a rather varied bottom substrate
14	+	3–5	Regulated, several technical structures
15	-	4–6	Slightly regulated
16	+	4	Affected by salt water, cooling water and impoundment

watercourses in Fyn County or in Denmark as a whole. For example, it lacks groundwater abstraction, which in some cases can considerably affect watercourse flow and hence also hydromorphology (especially in the watercourses of eastern Denmark, to which those of Fyn County belong, and which are affected by water abstraction to supply the major towns). In general, though, the analysis is a good tool for use in the subsequent design of restoration scenarios and for prioritization of efforts to improve the status of the water bodies. During the work process it transpired that information about drainage of the floodplain is difficult to obtain, and only sporadic information is available about sand transport and bank stabilization. In addition, it is characteristic that the data material is best for the major watercourses, whereas knowledge about the small watercourses is more limited. With two of the tributaries of Ryds Stream catchment it has been necessary to make a field inspection. In these cases it will be necessary to clarify the degree of detail to be recorded, and to draw up unambiguous operational methods for assessing the extent of physical modification at the national level.

The most extensive physical modifications are piping and straightening/deepening, where the form of the watercourse and drainage status of the surroundings are radically altered, and where efforts are subsequently made to maintain this status through intensive watercourse maintenance (frequent weed cutting and dredging of bottom substrate). The establishment of major dams, weirs, etc. that cause significant impoundment of the water or the formation of upstream lakes are also a major physical modification. In the main course of the River Odense, 7 out of 15 reaches corresponding to 33% of the main course (20 km) have thus been provisionally designated as heavily modified (Table 1.4.5). The main course also contains other reaches that have been severely regulated over the years, but where most of them have a fauna class >5 (i.e. good status or better) and a relatively varied bottom substrate. It has been decided not to designate these reaches as heavily modified water bodies.

While subdivision of the main course is in principle "quite simple", this is not the case with the minor watercourses due to the fact that they are often very fragmented by piped sections/dams or other forms of regulation (straightening/deepening). Subdivision into sub-reaches according to physical status might therefore result in an enormous number of water bodies, which is naturally undesirable. Conversely, merging of too many sub-reaches into a single water body entails that it will be possible to designate them all as heavily modified irrespective of the fact that some sub-reaches could have a very good status as assessed from fauna class and physical conditions. There is therefore a general need to draw up more exact criteria for what is meant by "heavily modified".

The water bodies in the Ryds Stream catchment have provisionally been designated as heavily modified according to the criteria in Table

Physical pressure	Extent (percentage of reach length)
Piped reaches	>50
Regulation (grade 2–3)	>75
Piped reaches and regulation (grade 2–3)	>75
Maintenance (grade 3)	>50
Hydraulic stress (considerable pressure)	>50

Table 1.4.6
Criteria for preliminary identification of heavily modified water bodies.

WB No.	HM	FC	Remarks
1	+	4	Upper parts piped, mean slopes 4.4–5.6 m/km
2	+	5	Partially piped, with spring, mean slopes 6.4–20 m/km
3	+	?	Highly regulated, lower part piped, mean slope 0.9 m/km
4	+	-	Completely piped
5	+	-	Completely piped
6	+	4–5	Several piped/regulated sections, lower part sinuous, mean slopes 5.4–11 m/km
7	-	4–6	Upper parts piped, remainder sinuous, many small obstructions, mean slope 10 m/km
8	+	4–5	Upper parts piped, with springs, mean slope 9.2–13 m/km
9	+	?	Upper parts piped, mean slopes 1.5–3.2 m/km
10	-	5	Unregulated, sinuous, mean slope 9.0 m/km
11	-	5–7	Unregulated, slightly sinuous, mean slope 2.4 m/km
12	-	6–7	Regulated, but sinuous, mean slopes 1.2–1.8 m/km
13	+	4	Unregulated, sinuous, very affected by hydraulic stress, mean slope 3.8 m/km

Table 1.4.7
Water bodies (WB) in the Ryds Stream catchment indicating the occurrence of heavy modification (HM), biological status (FC) assessed from the macroinvertebrates (Danish Stream Fauna Index) in the open part of the watercourse, and remarks concerning "physical potential".

1.4.6. As a consequence, 9 out of 13 water bodies can be considered to be heavily modified (Table 1.4.7), corresponding to 65% of the total watercourse network in the catchment. It is emphasized that the criteria established are provisional, and that changes can occur as the pilot project progresses.

No attempt has been made to identify heavily physically modified watercourse reaches in the Lunde Stream system.

Based on experience to date, and applying the criteria in Table 1.4.6, it must be presumed that around 60% of the total watercourse network in Odense River Basin will be provisionally designated as heavily modified.

1.4.5 Reference conditions

Under the provisions of the WFD, reference conditions must be established for each type of watercourse (Guidance Document 2.3) corresponding to the expected conditions if undisturbed by human activity. For each watercourse reach of known type, an assessment has to be made of the extent to which the current status deviates from the "natural background conditions". There are several possibilities for describing the reference conditions, namely using current data from virtually undisturbed Danish watercourses or comparable foreign watercourses, historical and palaeolimnological data, or, if necessary, data from expert judgements.

Assessment of the extent to which suitable reference stations exist is primarily based on the macroinvertebrate fauna, for which the data material is generally greatest. For natural reasons (cf. the island biogeographic principles on spatial extinction and immigration), there are clear differences between the macroinvertebrate fauna in Jutland, Fyn + Zealand, and Bornholm. In addition, man has enhanced this difference in various ways.

Table 1.4.8
Stations assessed as being suitable as reference stations for biological conditions in watercourses in Fyn County. The data in question primarily concern macroinvertebrates and are included in the analysis shown in Figure 1.4.4.

Data series	Watercourse	Locality	Type	No. of data sets (yr)
Historical	Lindved	Main road A1	2	4 (1947–1950)
	Stavis	Upstream of Lærkehus	2	4 (1951–1952)
	Stavis	Lake Langesø forest	2	1 (1952)
	Stavis	Morud forest	2	1 (1947) (3 outliers excluded)
	Stokkebæk	Mullerup forest	2	1 (1945)
	Stokkebæk	Skrams Vænge	2	1 (1945)
	Odense	Lykkensprøve	3	5 (1942–1955)
	Rislebæk	Sollerup	1	Several (2001 selected)
Present-day	Stamperenden	Idyllendal	1	Several (2001 selected)
	Ørredbæk	Forest road	1	Several (2001 selected)
	Brende	Tanderup	2	Several (2001 selected)
	Hattebæk	Upstream of fish farm	2	3 (1996–1998)
	Hattebæk	Faldsled–Jordløse road	2	Several (2001 selected)
	Hågerup	Downstream of Hågerup	2	Several (2001 selected)
	Kongshøj	Ågård	2	Several (2001 selected)
	Lindved	Main road A1	2	Several (2001 selected)
	Stokkebæk	Dyregård	2	Several (2001 selected)
	Tange	Downstream of Skovmøllen	2	Several (2001 selected)
	Traunskov-afløb	Vissenbjerg–Morud road	2	Several (2001 selected)
	Vindinge	Rønninge	2	Several (2001 selected)
	Odense	Vibæk	3	Several (2001 selected)

Table 1.4.9
Existing system of objectives used in Fyn County and the requirements stipulated for fulfilment of the objective.

Objective	Classification (Danish EPA, 1983a)	Required FC
Reference area for scientific studies	A (Areas of special scientific interest)	>5
Salmonid spawning and nursery waters	B_1 and B_2 (Salmonid waters)	>5
Fish waters for angling/fishery	B_3 (Cyprinid waters)	>5
Aesthetically satisfactory, etc.	C–F (Eased objectives)	>4

The first step taken was to examine which regional data could be used to describe the reference conditions for watercourses in Fyn County (Table 1.4.8). As is apparent, the data material is generally rather sparse (7 old and 14 new stations). Comparison of the macroinvertebrate fauna by multidimensional scaling (MDS) on the basis of the Bray Curtis similarity shows that there is a clear difference between old (historical) and new data sets (Figure 1.4.4). In making the analysis, attempts were made to compensate for the fact that the methods employed earlier in time differ from those currently employed (quantitative data have been normalized, a few species have been aggregated; in addition, species composition was tested for alone, with the same result.) Overall, the results indicate that it is not possible – even using the best stations currently available – to find a macroinvertebrate fauna quite resembling that which previously existed (certain species have become extinct, and with others immigration can be expected to take a very long time). The same undoubtedly applies to plants, for which the data material is even smaller (e.g. Riis et al., 1999).

As impoverishment of the watercourse flora and fauna due to human activities has been considerable, especially over the past 100 years (e.g. Riis & Sand-Jensen, 2001; Jensen & Jensen, 1980), the lack of suitable reference data is expected to apply to large parts of the country. There is thus a need to establish a suitable network of reference stations in Danish watercourses, and it will probably also be necessary to utilize data from reference stations abroad (southern Sweden, northern Germany, southern Baltic countries, northern Poland). There is a particular lack of data for all relevant biological quality elements (plants, macroinvertebrates and fish), and knowledge of the hydromorphological quality elements under reference conditions also needs to be improved. For comparative purposes, consideration should be given to the use of independent expert judgement for selected quality elements, for example for part of the macroinvertebrate fauna (regional species lists) and flora (regional species lists).

Finally, it is possible to gain an impression of the composition of the macroinvertebrate fauna and flora in watercourses of the past – before the impact of human activities became extensive – by employing palaeolimnological methods. Investigations of subfossil insect remains in "old" watercourse sediments have thus been successfully utilized to describe the macroinvertebrate fauna in the lower part of the Rhine (Germany/Holland) and the River Avon (England) for 100–250 and 3 000 years ago, respectively (Klink, 1989; Wilkinson, 1987). Such studies are also feasible in Denmark, for example in the floodplain of the River Odense. The method has already been tested on 10 300 year-old watercourse sediments from the Great Belt (Wiberg-Larsen et al., 2001).

A good initial suggestion for the reference conditions for watercourses in Fyn County is reaches with a natural course, good hydraulic contact with the surroundings, no or very extensive utilization of the surrounding land, generally varied physical conditions in and around the watercourses, clean water with a low nutrient content and a naturally varied flora and fauna both in and around the watercourses. These conditions will be close to that described as high ecological status in Section 1.4.6.

MDS for stream macroinvertebrates

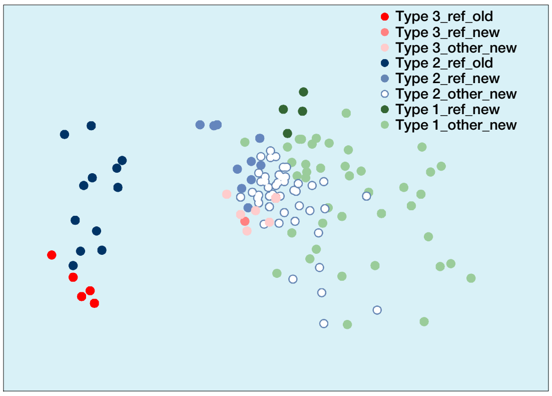


Figure 1.4.4 Multidimensional scaling (MDS) for macroinvertebrates in the watercourses of Fyn. The data derive partly from new (new) and historical (old) reference stations (ref, see Table 1.4.8), and partly from remaining (other) new watercourse stations where the composition and density of macroinvertebrates have been comprehensively investigated. The distance between the points reflects the difference in the fauna between the individual stations. The stress of the ordination is 0.14 (i.e. a useful 2-dimensional picture).

1.4.6 Provisional establishment of objectives

Fyn County's current Regional Plan stipulates a quality objective stating the use for which each watercourse should be suitable (Table 1.4.9). Whether a watercourse fulfils its quality objective is determined biologically from the fauna class (Danish Stream Fauna Index). Since the fauna class at a given location can vary from year

Ecological status	Required FC (slope >0.1 m/km)	Requried FC (slope 0–0.1 m/km)
High	6–7	5 (if possible)
Good	5	4
Moderate	4	3
Poor	3	2
Bad	1–2	1

Table 1.4.10 Summary of how the fauna class (cf. DSFI) can initially be used to assess watercourse ecological status. It should be noted that a greater number of quality elements will be included in the assessment in future.

Table 1.4.11
Variables included in the data analysis for 103 monitoring stations in watercourses in Fyn County. The physical index is currently calculated as a modified Aarhus Index (after Kaarup, 1999; but with plants, cf. the unpublished proposal drawn up by the Physical Index Working Group), and the fish index is calculated according to WaterFrame (2003).

Surroundings	Size	Water chemistry	Physical conditions	Biology
Percentage of farmland in catchment Woodland, nearest 25 m Trees/bushes, nearest 2 m High (>0.5 m) herbaceous plants, nearest 2 m Herbaceous plant diversity, nearest 2 m	Catchment area Winter width Max depth	NH_x-N, mean NO_x-N, mean PO_4-P, mean BOD_5, mean	Degree of shading Percentage stone+gravel Degree of sinuousity Pools + riffles Roots Degree of regulation Physical index	No. of species/taxa: Macrophytes Macroinvertebrates Fish Coverage: All macrophytes Submerged macrophytes Fauna class (DSFI) Fish index

Table 1.4.12
Summary of how different variables can be used to assess the ecological status of watercourses. It should be noted that these considerations are only preliminary. The basis for the classification is as follows: Physical index: Kaarup (1999); Fish Index: WaterFrame (2003); Water chemistry: Preliminary data and for high status among others Kristensen & Hansen (1994).

Status	Physical index	DSFI	Fish index	BOD_5 mg/l	NH_x-N (mg/l)	NO_x-N (mg/l)	PO_4-P (mg/l)
High	>33	6–7	55–60	<0.5	<0.05	<0.8	<0.020
Good	25–33	5	47–54	0.5–2.0	0.05–1.0	0.8–2.0	0.020–0.040
Moderate	17–24	4	38–46	2.1–3.5	1.1–2.5	2.1–5.0	0.041–0.090
Poor	8–16	3	24–37	3.6–5.0	2.6–5.0	5.1–7.5	0.091–0.170
Bad	<8	1–2	12–23	>5.0	>5.0	>7.5	>0.170

to year, among other reasons due to differences in precipitation and hence runoff, the objective is only considered to be fulfilled in regional environmental administration if the minimum fauna class requirement has been met for at least five consecutive years.

Under the provisions of the WFD, watercourses have henceforth to be subdivided into five classes of ecological status. The objective here is that all water bodies should achieve good ecological status by 2015 at the latest, while at the same time preventing deterioration in the existing status. A simple and manageable means of converting to the new system is to initially continue to employ the macroinvertebrate fauna to assess fulfilment of the objective (Table 1.4.10). This is not without problems, though, as the DSFI employs a 7-step scale and the WFD a 5-step scale. Moreover, the WFD prescribes the use of considerably more quality elements, including both physico-chemical elements and other biological elements (Guidance Document 2.3).

In order to determine what consequences this can have, a more detailed analysis has been made of data from 103 monitoring stations in Fyn County for which more detailed information is available, for example on land use and physico-chemical and biological conditions. As regards size and fauna class, the stations turned out to be reasonably representative for the whole regional station network, as well as for the station network in Odense River Basin, although, as mentioned earlier, the smallest watercourses are under-represented in the monitoring (Section 1.4.1). The analysis encompassed an initial selection of the strongest descriptive variables in the data set (Table 1.4.11) and subsequent statistical analysis of these variables (see Annex 1.4). From this it is apparent that there is a positive correlation between the selected biological variables and watercourse size, the presence of natural, varied physical conditions in the watercourse and the presence of woodland around the watercourse, respectively. Correspondingly, there is a negative correlation to the degree of anthropogenic pressure described by land use for agriculture, watercourse regulation and input of easily metabolizable organic matter (BOD_5) and nutrients

Table 1.4.13
Watercourse total N and total P concentrations for different ecological status classes. This also gives the requirements that watercourses will have to meet in order to attain high and good ecological status in lakes and coastal waters, respectively.

Ecological status	Total N (mg/l)	Total P (mg/l)
High	<1.0	<0.030
Good	1-0–2.5	0.030–0.060
Moderate	2.6–6.0	0.061–0.125
Poor	6.1–9.0	0.126–0.250
Bad	>9.0	>0.250

from the surroundings, respectively. It should be noted that even though BOD_5 is of relatively minor significance in this data set (Annex 1.4), an analysis of small watercourses alone would show that its significance for biological conditions is considerably greater (Fyn County, 2001c).

When the indices employed for the 103 monitoring stations are distributed according to ecological status classes it is seen that the status is generally assessed as being poorer for fish and physical conditions than for macroinvertebrates (Figure 1.4.5; Table 1.4.12). That the fish index indicates a relatively greater share of watercourses with bad status than the physical index is in part attributable to the fact that certain forms of physical disturbances – for example dams, weirs and drying-out – are not included in the physical index (just over 40% of all the stations rated by the fish index as having bad status are affected by one or more of these). At the same time it is emphasized that speedy completion of the final physical index is vital, and that the development of a suitable index for plants is highly desirable.

Attempts have also been made on a trial basis to subdivide into status classes for the water chemistry variables that were included in the statistical analysis (Figure 1.4.5; Table 1.4.12; Annex 1.4). It should be noted that even though nitrogen and phosphorus are usually input to the flowing water in such large amounts that the watercourse plants are not limited by them, and the macroinvertebrates and fish are hardly likely to be affected either (Section 4.2), the input of these substances is of great significance for the status of other categories of water body (lakes, coastal waters, etc.) fed by the watercourses. In many cases it will therefore be necessary – out of consideration for these water bodies – to include nitrogen and phosphorus as an important part of the assessment of watercourse status. A suggestion for the distribution of the total content of these substances across the status classes is shown in Table 1.4.13. Apart from the above-mentioned methods, the status of Danish watercourses can be assessed from other variables such as maximum temperature and pH, as well as the content of oxygen, ochre (especially in Jutland) and various hazardous substances, and the necessary amount of water (see also Figure 4.2.1). In any event, it will be necessary to decide how these variables should be weighted against each other in the final system for determining the ecological status of the watercourses.

Part of the River Odense system, including large parts of the main course and the tributaries Hågerup, Sallinge and Lindved Streams, are

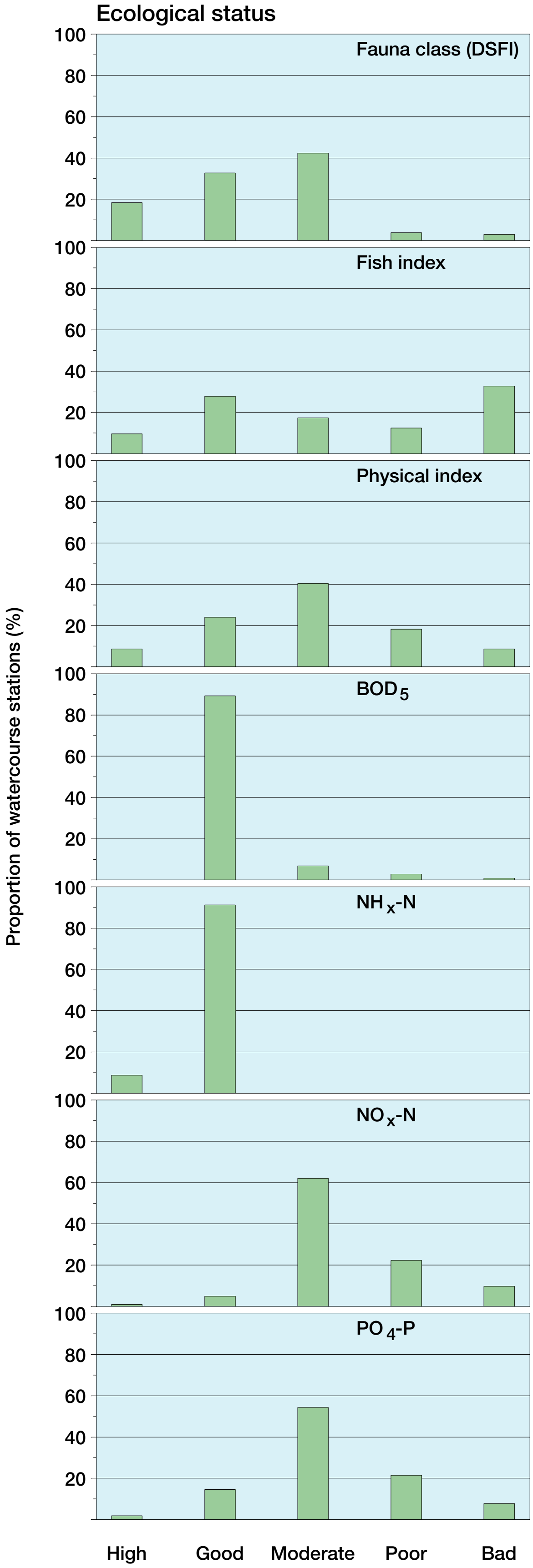
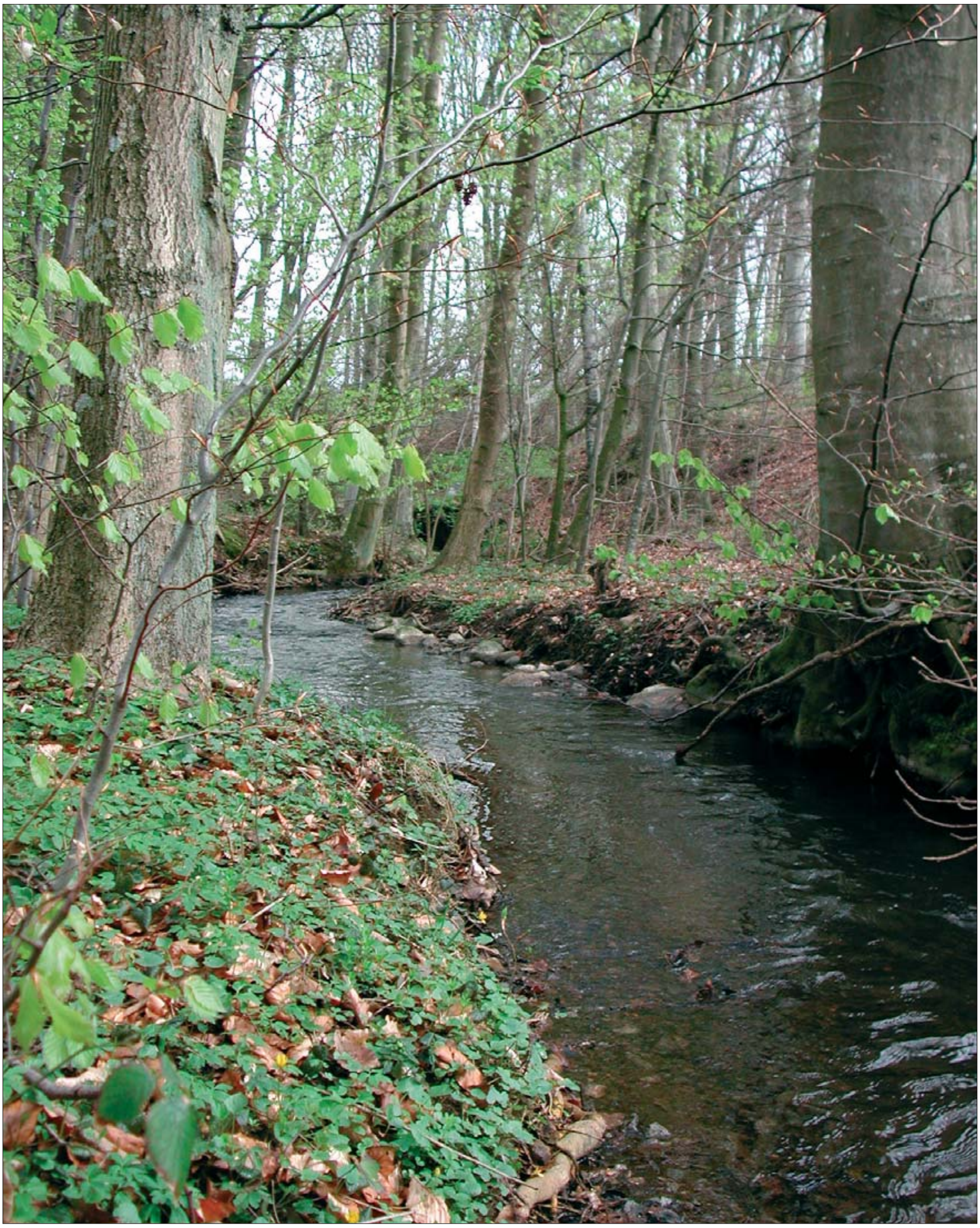


Figure 1.4.5 Distribution of 103 watercourse stations according to ecological status classes for the physical, chemical and biological variables listed in Table 1.4.12. These variables were selected on the basis of the statistical analysis described in Annex 1.4.



Ryds Stream – a reach surrounded by woodland.

Photo: Bjarne Andresen, Fyn County

encompassed by the Habitats Directive. It is therefore important that there is a good correlation between the two ways of assessing status that accompany the two Directives. Thus high and good status pursuant to the WFD should correspond to the designation "favourable conservation status" pursuant to the Habitats Directive. However, it is presently uncertain whether consideration for special habitat species can lead to requirements different from those that they would otherwise have to fulfil in order to achieve good watercourse ecological status.

Concrete suggestions for the provisional establishment of objectives for the watercourse reaches in the two test areas – Ryds Stream catchment and the main course of the River Odense – are given in Section 4.2.3, together with an assessment of the likelihood that the environmental quality objectives will not be achieved by 2015.