02.08 Fish Fauna (Edition 2004)

Overview

Berlin's waterscape was formed during the second, the so-called Brandenburg Stage of the Vistulian Glaciation, which ended about 10,300 years ago. The **Berlin glacial spillway** is part of the Glogau-Baruth glacial spillway, which extends along the Vistulian end moraines of the Brandenburg Stage. It starts at the mouth of the Prosna, where that river empties into the Warta in western Poland, and proceeds along the Obra to the Oder, along the Oder from Nowa Sól to the Bobr and the Neisse, and then from Forst across to the Spree around Lübben, across to Luckenwalde and Tangermünde, and finally to Brandenburg-on-the-Havel and down the lower Havel to the Elbe.

At the end of Vistulian Glaciation, the waters of the Vistula, Warta and Oder, flowing northward from periglacial areas, were dammed by the inland ice and drained away toward the west, to where the Oder is today, and further toward the Havel and Elbe. Moreover, at all inland-ice advances up to the Ruhr District, there were connections between the Rhine, Weser and Elbe systems which were passable for aquatic organisms (Hantke 1993).

This postglacial waterway network made it possible for three lamprey species and 33 fish species to populate the bodies of water of what is today the state of Berlin (Wolter et al. 2003). These species are considered the original or **indigenous fish fauna of Berlin**.

Due to their low gradient, the lowland rivers were early the object of **hydraulic engineering impairments** such as dams, weirs or canal connections between different river watersheds, which reached an initial climax during the Middle Ages. Once, the hydrodynamics of the Spree and the Havel characterized Berlin's water network; later, these rivers were increasingly dammed and regulated. The **construction of dam facilities** along river and creek courses began during the early days of the Askanian dynasty, which took possession of the Markgravate of Brandenburg in the 10th century (Driescher 1969). In Berlin, dam construction for the operation of mills can be traced back at least to the 13th century. The first documentary mention of a mill dam is in 1261 at Spandau. In 1285, there was a water-mill in Berlin, and the Berlin Mühlendamm (Uhlemann 1994) is certified for October 28th 1298. However, a 1232 document indicates that a dam facility already existed in Spandau at that time (Natzschka 1971, Driescher 1974).

Many dam facilities are moreover probably considerably older than their first documentary mention would have us suspect. In 1180 for example, Spandau Castle and its castle town were moved about 1.5 km up the Havel, to today's Old Town Island, due to a disastrous rise in the water level of the Havel caused by a mill dam at the city of Brandenburg, which already existed earlier than 1180 (Müller 1995).

In addition to mill dams, other dam facilities for the regulation of the water level and the promotion of navigation were also built. The **straightening of single river sections** already began during the 17th century. The lower Havel - for fish, the main colonization pathway into the Berlin waters - was regulated comprehensively for the first time between 1875 and 1881. In the context of the "Melioration of Receiving-Stream and Navigation Conditions on the Lower Havel" of 1907-1913, not only new breakthroughs and cross-section enlargements, but also three additional dam facilities were built at Grütz, Gartz (both 1911) and Bahnitz (1912).

By 1914, the **Havel was fully channelized as far as Spandau**, with a channel depth of at least 2 m ensured, even at low water levels. This regulation led to a dramatic **collapse of the fish populations**, and thus almost to the death of the Havel fishing industry. At that time, 1,100 fishermen lost their livelihoods on an 80-km stretch of the Havel, and sued for compensation (Kotzde 1914). It was now no longer possible for migrating fish to overcome the weirs, even at high water levels, and to reach the Berlin area. The dam facilities not only interrupted vitally necessary migration routes, but also destroyed valuable habitat structures in the streams, as well as the flooding areas necessary for many fish species. The flow speed was cut, so that fine-grained material was deposited in the sediment, causing the coarse-grained sediments to be overlain with mud. Oxygen-consuming degradation processes in the stream-beds became predominant. For fish species which prefer a gravelly substratum rich in oxygen, there were no longer suitable spawning grounds and habitats, and no possibility of carrying out compensatory migration, so that e.g. the barbel, a typical river fish which had formerly been the dominant fish species, became extinct in the lower and middle Spree. By the end of the 19th century, waters of the **Spree** in Berlin changed their character from that of a **classic barbel area** to that of a **bream area** (Wolter et al. 2002).

In addition to these permanent impairments caused by waterway melioration, immissions of all kinds had an effect on long-term aquatic conditions. Even before the turn of the century, the pollution of the Spree and the Havel by industrial and municipal wastes and from excrement was so heavy that fish death was common, and fishing was seriously impaired. For instance, due to the poor oxygen supply of the water, it became impossible to transport living fish to Berlin (i.e., today's central Berlin) in the water from the Lower Havel in so-called drebels, i.e. boats with open, flow-through fish boxes; they died on the way. The establishment of city sewage farms provided only limited remedy of the water quality situation. Pollution was particularly dramatic in the Spree, which received so much sewage immission on its way through Berlin that all animal life on the river bed was eliminated below the Charlottenburg sluice (Lehmann 1925). These anthropogenic effects caused additional impoverishment of the Berlin fish fauna. In addition to the migrating lampreys and fish species and the barbel, other species which required fast-flowing and oxygen-rich water, such as the pond lamprey and loach, died out in Berlin waters. The eutrophication caused or promoted by nutrient immissions favored euryecoid (environmentally tolerant) fish species, whose increase often concealed the decline of more demanding species.

These effects of the historical impairment of the bodies of water in Berlin on the fish fauna were summarizing in 1993 in the first complete Berlin edition of the Environmental Atlas (edition 1993), and in supplementary booklets (Vilcinskas & Wolter 1993, 1994).

The purpose of this edition, in addition to updating and completing the verified results, is to present the development of the fish association and its changes over the past ten years.

Tab 1: Occurrences, Development and Endangerment of verified Fish Species (bold: Species listed in Appendix II of the Habitat Directive).				
Fish Species		Occurrences 2002 (waters)	Change from 1993	Berlin Red Data Endangerment
Rainbow trout	Oncorhynchus mykiss (Walbaum, 1792)	4	-13	Neozoan
Smelt	Osmerus eperlanus (Linnaeus, 1758)	10	-3	endangered
Pike	Esox lucius Linnaeus, 1758	98	14	stocked / engangered
Ide	Leuciscus idus (Linnaeus, 1758)	43	11	
Bitterling	**Rhodeus amarus (Bloch, 1782)**	2	-8	Threatened by extinction
Bream	Abramis brama (Linnaeus, 1758)	96	8	
Chub	Leuciscus cephalus (Linnaeus, 1758)	7	-8	very endangered
Gibel carp	Carassius gibelio (Bloch, 1782)	66	3	
Goldfisch	Carassius auratus (Linnaeus, 1758)	9	-1	Neozoan
Grass carp	Ctenopharyngodon idella (Valenciennes, 1844)	6	-12	Neozoan
Gudgeon	Gobio gobio (Linnaeus, 1758)	47	-1	endangered
White bream	Abramis bjoerkna (Linnaeus, 1758)	79	5	
Dace	Leuciscus leuciscus (Linnaeus, 1758)	12	0	endangered
Crucian	Carassius carassius (Linnaeus, 1758)	69	-16	very endangered
Carp	Cyprinus carpio Linnaeus, 1758	77	2	
Marble carp	Hypophthalmichthys nobilis (Richardson, 1845)	4	4	Neozoan
Moderlieschen	Leucaspius delineatus (Heckel, 1843)	47	6	endangered
Roach	Rutilus rutilus (Linnaeus, 1758)	116	14	
Asp	**Aspius aspius (Linnaeus, 1758)**	36	2	
Rudd	Scardinius erythrophthalmus (Linnaeus, 1758)	93	15	
Tench	Tinca tinca (Linnaeus, 1758)	95	15	
Silver carp	Hypophthalmichthys molitrix (Valenciennes, 1844)	7	-8	Neozoan
Bleak	Alburnus alburnus (Linnaeus, 1758)	75	14	
Weatherfish	**Misgurnus fossilis (Linnaeus, 1758)**	5	-3	threatened by extinction
Loach	**Cobitis taenia Linnaeus, 1758**	10	7	endangered
Catfish	Silurus glanis Linnaeus, 1758	28	10	endangered
Bullhead	Ameiurus nebulosus (LeSueur, 1819)	3	0	Neozoan
Burbot	Lota lota (Linnaeus, 1758)	21	1	very endangered
Brusque	Perca fluviatilis Linnaeus, 1758	115	15	
Ruffe	Gymnocephalus cernuus (Linnaeus, 1758)	72	12	
Pike-perch	Sander lucioperca (Linnaeus, 1758)	60	0	
Three-spined	Gasterosteus aculeatus Linnaeus, 1758	59	1	
Nine-spined stickleback	Pungitius pungitius (Linnaeus, 1758)	19	0	very endangered
Eel	Anguilla anguilla (Linnaeus, 1758)	100	14	stocked / engangered

Tab. 1: Occurences, Development and Endangerment of verified Fish Species in Berlin

Furthermore, the current implementation of Directives of the Council of the European Union places new, in some cases very far-reaching requirements on the quality of fish stock data and recording, which are also to be met with this updated edition of the Environmental Atlas. Thus for example, Council Directive 92/43/EEC of May 21st 1992 Concerning the Preservation of Natural Habitats as well as Wild Fauna and Natural Flora (Abl. L 206) - the " **Habitat Directive**," for short - includes an Appendix II "Animal and Plant Species of Community Interest, for the Preservation of which Special Reserves Must Be Certified" (as amended by Directive 97/62/EC of October 27th 1997). This Appendix II of the EC Directive also lists four of the species of fish currently occurring in Berlin: the **bitterling, asp, weatherfish and loach**.

With the European Water Framework Directive (EC-WFD) of October 23rd 2000, fish fauna for the first time were adopted into the European statutory framework as a biological quality component for the ecological condition of bodies of water. On the basis of the **species inventory, frequency (abundance) and age structure of the fish fauna**, as well as of the existence of type- specifically disturbance-sensitive species of fish, the ecological condition lakes and streams is to be assessed. The goal of the EC-WFD is to achieve a **good ecological condition** in all surface bodies of water, and of good ecological potential in all artificial and strongly anthropogenically affected bodies of water, by 2015.

Statistical Base

The present map shows an overview of the current state of knowledge of the fish populations of the Berlin bodies of water through **December 2002**. After 1993 (02.08 edition 1993), the recording process of the fish population continued consistently in the Berlin waters. Between 1994 and 2002, numerous recording data were updated and new bodies of water examined(Carstensen & Kropf 1994, Wolter & Vilcinskas 1996, 1997, 2000, Minow 1999, Wolter 1999, Doetinchem 2000, Wolter et al. 2000, 2002, 2003, Doetinchem & Wolter 2003, Fredrich & Wolter unpublished, Minow unpublished, Vilcinskas unpublished).

For the presentation of the current stock situation of the Berlin fish fauna, catch data were evaluated from **170 bodies of water**. The stock-taking is **representative**, since it contains all major streams and lakes in Berlin, as well as more than fifty of a wide variety of smaller bodies of water.

During the recording time period through **December 2002**, each smaller body of water was fished at least once, and each major one repeatedly, in some cases annually, in some cases at different seasons. All bodies of water were electrically fished. In addition, in the larger bodies of water, fixed nets, fish traps, dragline nets and trawl nets were also used. By means of the combined use of different types of equipment, individual catch selectivity is compensated, which increases the recording precision of the fish population. Particularly in canals and in places with artificial bank reinforcements, the combination of electro-fishing and stationary nets has proven itself; in lake-like river widenings and in areas with unspoiled shore structures, trawl nets are most useful (Doetinchem & Wolter 2003). The Berlin Fisheries Office also made its fishing statistics available for the evaluation.

The **fishing procedure** has been carried out according to the usual good practice. Wadable trenches and small bodies of water were fished with a portable DC-powered impulse device, while for larger and deeper bodies of water, a boat with a DC-power unit is used. Some 300-800 m of shoreline were sampled in each case, depending on the breadth of the body of water, the structural variety and the catch success, with the goal of verifying the species spectrum as completely as possible. **Electric fishing** is the most efficient of all catch methods, especially for bed substrata such as large rocks, rocky deposits or plant formations. Used correctly, it is also the **least disruptive method** for recording the fish population, since the fish have the least contact with net material, etc., and thus show hardly any injuries to their scales or mucous membranes. With the aid of a DC-power unit, an electrical field is produced in the water. Fish situated within it receive various voltages, depending on their length and position relative to the lines of force. Depending on the voltage they receive, their reactions range from flight through positive electrotaxis (swimming toward the anode) to electronarcosis. The effective radius of the catch electrode is approx. 2 m, so that pelagic (free-water-living) species and large, shy individuals of all species are under-represented in the catch, due to their greater flight distance. Moreover, the selectivity of electric fishing is altogether far lower than that of other methods, given comparable work and time expenditure.

For the **catch evaluation**, the species were determined and the individuals counted and measured, and also weighed on a sample basis. Fish larvae and young fish of the same age are for the most part not considered in determining species frequencies, since they were not included representatively using the chosen fishing methods and the sample size. However, they were registered for species and reproduction verification.

Methodology

Fish are comparatively long-living, mobile organisms which represents several trophic levels (levels in the food chain) and are dependent on various, different water habitats in the course of their development or their life cycle. Due to their distinctive habitat requirements, fish have been included in the EC-WFD as **biological indicators for the structural variety of the surface bodies of water**. **High diversity of indigenous (local) species** of fish typical for the body of water indicates the **good ecological quality** of that water, according to the **EC-WFD**, i.e. the intactness of a water ecosystem and thus also its value for species and biotope protection. It must be taken into account that only with the verification of **natural reproduction** is the existence of a population verified. As a rule, the proof of a **high number of species** of fish is the basis for a positive assessment, since this - provided it is not caused by stocking measures - indicates the existence of a variety of available habitats and resources, and hence of great structural variety.

The existence of stable populations of **endangered species** of fish is also the basis for a positive assessment. As a rule, they have the greatest demands upon their habitats, and therefore are affected most strongly by negative influences. As a result, the **endangerment level of a species** in the current Red Data Book is suitable as an indicator for the protection-worthiness of a habitat.

The stated information on ichthyologic water assessment was processed for cartographic representation as follows, analogously to the first complete Berlin Environmental Atlas:

For any body of water to be examined, the species of fish present and the population of the species can be directly taken from the map, and the proven species have been represented in color code,

a) by **level of endangerment**, according to the current Berlin Red Data Book and (cf. Tab. 1, Wolter et al. 2003);

b) by their relative **frequency** in the body of water.

In order not to overload the color design, species frequency was represented in **three classes**: rare species are those verified only irregularly and as individuals, after repeated sampling; while frequent species are those present at all fish samplings in greater quantities. The third group includes those species which were caught regularly, but only in relatively low numbers. Their stock was assessed as stable; their frequency as low or moderate.

Also retained was a **body-of-water-type-specific assessment** of the bodies of water examined, with regard to numbers of fish species. In the first version, **nine types** had been established (Wolter & Vilcinskas 1993), based on the factors genesis, surface-area, networking, type and continuity of water supply, and settlement possibilities for fish species, and since these have proven useful, they have been retained. They are:

- streams
- river lakes
- natural inland lakes
- artificial inland lakes
- retention basins
- canals
- trenches
- sewage-treatment plant discharge channels

Artificial lakes and rain retention basins constitute an ichtheologically independent type of body of water, since their fish occurrences is at least initially, and as a rule continually, based on stocking, so that their fish associations reflect neither a settlement history nor a body-of-water specific population development.

Sewage-treatment-plant discharge channels and rain retention basins are the bodies of water, flowing and standing respectively, with the highest level of melioration. Moreover, the former differ from the other types by a water level which remains relatively constant over the course of the year, while comparable creeks and trenches regularly dry out.

The category of **small bodies of water** includes all standing ponds, tarns, meres, kettle-holes and the like with an area of up to one hectare. All other categories are self-explanatory.

From the current catch data, the **mean average** value for the number of indigenous (local) species of fish was calculated for every type of body of water. Neozoans were not taken into account for purposes of conservation and species protection, to prevent stocked, non-indigenous species of fish from compensating for a possible impairment-caused lack of local species. A deviation above or below by this mean average value by one fish species was allowed, and the resulting range was defined as the **mean fish-species inventory** of the respective type of body of water to be **expected in Berlin**. The type- specific range limits are shown in the map legend.

As explained above, a high number of fish species implies a variously structured, ecologically valuable habitat, so that a count of fish species above the type-specific average was judged as positive, and one below it as negative.

Since the average of the attested number of fish species was determined and assessed **separately** for each type of body of water, the map also contains e.g. positively assessed sewage-treatment-plant discharge channels, provided that they contain more species of fish than other ones. This apparent absurdity of a positive evaluation for an extremely degenerated body of water arises from the comparison of bodies of water exclusively within each type category.

On the one hand, this shows that the type-specific mean average value method selected is **unsuitable** as an instrument for the assessment of the overall ecological integrity of bodies of water or their ecological condition, in accordance with the EC-WFD. It would be really absurd to apply a mean average value in this context.

On the other hand, the ichthyologic comparison of bodies of water as implemented enables the development of body-of-water-type-specific ichthyo-ecological potentials, which are required for the implementation of the EC-WFD.

For artificial or anthropogenically degraded bodies of water, the Water Framework Directive requires the definition of the best ecological potential, i.e. the best fish species association attainable under the available conditions of use and quality of the given body of water. Using the optimum condition as the point of departure, a **good ecological potential** is to be attained by 2015.

This is the advantage of the average number of fish species per body-of-water-type model, as represented on the map. Within the category of artificial and degraded bodies of water (rain retention basins, sewage-treatment-plant discharge channels, canals and artificial lakes), positive references can identified which refer to the possible ichthyologic potential of the respective body-of-water type.

However, the implementation of the EC-WFD will require further examinations to underpin these species figures with information on **dominance and age structures** of fish species, and to develop reference cenoses.

Map Description

During the recording period of 1993-2002, **34 species of fish** were verified in the state of Berlin, including six non-local species. Compared with 1993, the species inventory was expanded by one non-indigenous fish species, the **marble carp**, a cyprinide originating in China, which was stocked, particularly during the 1980s, for economic reasons. Moreover, a second bullhead species has now been verified in Berlin, the **black bullhead** (*Ameiurus melas*). This species was already described by Doering & Ludwig (1992) for the bodies of water in the Great Tiergarten; however, it could not be taken into account in the current map representation either, since the living catch reports do not distinguish between the two species, so that their occurrences cannot be delimited clearly from one another (Wolter et al. 2003).

Since 1993, order has brought to the taxonomic chaos previously prevailing in the systematics of European freshwater fish, particularly due to the basic work of Kottelat (1997). As a result, the scientific species names of several fish species have been changed, by comparison with the last edition of the map. Besides this editorial change, the view of a species as not local (non-indigenous, neozoans) has been fundamentally changed. As the result of an international working group on Neozoans/ Neophytes, **the year 1492**, the official discovery of the "New World" by Columbus, has been established as the threshold year for the determination of a **species as non-indigenous**, since after this, the exchange processes of goods, commodities and also biota increased immensely between the continents. Species of fish naturalized after 1492 are regarded as non-indigenous, not local (Kinzelbach 1996, Kowarik 2003).

In glaring contradiction to this, the new **Berlin State Fishing Regulation** (LFischO, GVbl Berlin 57, No. 54 of December 22nd 2001) has, for purposes of simplification of economic stocking measures of the fish industry (abolition of approval requirements), established all species of fish naturalized since **1900** as local. However, this administrative simplification of stocking regulations is of marginal importance for the ichtheofauna, since the neozoans in terms of the stricter definition which still remain in Berlin waters are economically insignificant and hence, despite unrestricted stocking possibilities, in permanent decline (cf. Tab. 1).

The species carp and gibel carp, which are economically significant in Berlin, particularly for fishermen, are no longer viewed as non-indigenous, as they were in the edition 1993, since they demonstrably settled the Elbe watershed area, including the Havel and Spree, between 530 and 1100 (Hoffmann 1994).

Tab. 2: Number of Berlin Bodies of Water with Verified Occurrences of Fish Species											
Nr. on map	Fish Species	Body-of-Water Type									all
		River-lakes	Inland lakes		Retention basins	Small standing bodies of water	Streams	Canals	Trenches	Sewage plant discharges	
			Natrl.	Artif.							
		Number of sampled bodies of water									
		19	31	16	6	49	11	16	16	6	170
01	weatherfish	3	1	0	0	0	1	0	0	0	5
02	spined loach	4	0	0	0	0	5	1	0	0	10
03	burbot	10	0	0	0	0	6	5	0	0	21
04	nine-spined stickleback	0	0	0	2	3	0	0	10	4	19
05	sheat-fish, wels, catfish	7	9	3	1	3	2	2	1	0	28
06	three-spined stickleback	7	3	4	3	21	4	5	7	5	59
07	ruffe	18	12	8	2	4	9	15	2	2	72
08	smelt	9	1	0	0	0	0	0	0	0	10
09	pike	18	27	13	2	13	11	8	5	1	98
10	eel	19	26	11	1	10	11	16	4	2	100
11	perch	19	27	13	5	14	11	16	7	3	115
12	zander	18	13	6	1	6	7	9	0	0	60
13	bitterling	0	2	0	0	0	0	0	0	0	2
14	chub	3	0	0	0	0	2	2	0	0	7
15	dace	2	0	0	0	0	5	4	0	1	12
16	ide	15	1	0	0	0	11	15	1	1	44
17	gudgeon	14	8	1	2	4	9	8	0	1	47
18	moderlieschen	5	16	3	3	13	3	1	0	3	47
19	roach	19	29	14	5	16	11	16	3	3	116
20	rudd	17	23	11	5	12	10	10	3	2	93
21	asp	16	3	0	0	2	7	8	0	0	36
22	bleak	16	17	5	2	7	9	16	2	1	75
23	bream	19	24	10	3	9	11	16	3	1	96
24	white bream	18	17	7	1	6	10	16	3	1	79
25	tench	14	26	13	1	18	9	5	6	3	95
26	crucian carp	8	13	7	5	24	5	0	5	2	69
27	rainbow trout	1	1	0	0	0	2	0	0	0	4
28	grass carp	2	0	0	0	4	0	0	0	0	6
29	gibel carp	8	9	6	3	27	4	3	3	3	66
30	goldfish	0	0	3	1	5	0	0	0	0	9
31	carp	14	21	11	3	14	6	3	2	3	77
32	silver carp	4	1	0	0	0	2	0	0	0	7
33	brown bullheat	0	1	1	0	1	0	0	0	0	3
34	marble carp	1	1	0	0	1	1	0	0	0	4
total number of species		31	27	20	21	24	28	23	17	19	34
average number of species		16 - 18	10 - 12	8 - 10	7 - 9	4 - 6	15 - 17	11 - 13	3 - 5	6 - 8	x

x = statement not meaningful

Nr. 01 - 26, 29, 31 = autochtonic fish species
Nr. 27, 28, 30, 32 - 34 = allochtonic fish species

Tab. 2: Number of Berlin Bodies of Water with Verified Presence of Fish Species

The **most frequent species of fish** in Berlin bodies of water are still the **roach and the perch**, followed closely by **eel, pike, bream, tench and rudd**, which are all on the increase (Tab. 1).

The most dramatic population decline affected the **crucian**, with 16 eliminations within the last ten years, for which reason this species is classified as severely endangered in the current Red Data Book.
The **bitterling**, a so-called "Habitat-Directive species," the preservation of which requires special attention, lost 80 % of the occurrences which had existed in 1993. Today, only two reproductive populations exists (Wolter et al. 2003).

The decline in occurrences of the neozoans **rainbow trout and grass and silver carp** was comparably dramatic, albeit from a conservationist viewpoint, not undesirable. These species cannot reproduce naturally in Berlin waters, and due to the above-mentioned lack of economic significance, or in the case of the rainbow trout, to a lack of suitable bodies of water, are no longer being stocked.

Another Habitat-Directive species, the **loach**, showed a strong increase in Berlin. The positive development of the populations of other typical species of river fish, such as **the ide and the asp**, has proceeded analogously.

Since Berlin's bodies of water have hardly changed at all structurally - the degradation of the Spree has even increased in the government district construction area -- the **increase in river fish species** can only be explained by an **improvement in water quality**. One reflection of this is the relatively high number of species moved to **less-threatened categories in the Red Data Book**, and also that the "mass fish problem," widely discussed in 1993, is now a thing of the past. Today, the so-called white fish show good to very good individual growth.

Here the use of phosphate-free detergents, the full-scale introduction of phosphate elimination or precipitation in sewage treatment plants, as well as reduced agricultural fertilizer use in the Spree and Havel watershed areas have had a positive effect on the **reduction of the nutrient burden** in the bodies of water. How considerably the phosphate load has been reduced can e.g. be seen from the fact that the estimation of per capita daily use has been corrected from 4.2 g of phosphorus per day (g P/d) to 1.8 g P/d, as a result of the widespread availability of phosphate-free detergents and efficient phosphate elimination in sewage-treatment plants (Behrendt et al. 1999).

Moreover, the ongoing measures for the reconstruction of the Berlin **mixed-water sewage system** discharge the bodies of water furthermore. Mixed-water overflows, during which untreated sewage water and polluted rain water during heavy rainfalls flows directly into the bodies of water, may led to fish kills. In the water, bacteria immediately decompose the organic material, consuming oxygen in the process. During heavy rainfall and caused by this, massive mixed-water overflows, the consuming of oxygen is so high that whole sections of waters are free of oxygen. **Fish kills** are unavoidable. By extensive measures during the last years the mixed-water overflows could already be reduced obvious, therefore situations critical for fish are clearly more unusual compared to the past. The reconstruction measures will last until 2020. Furthermore, the Berlin Senate runs several **aerating plants and an aerating ship**, which provide artificial input, if oxygen values drop during the summer. The regular supervision of summertime oxygen conditions are carried out by 10 **stationary online-measuring probes supplemented by longeron ways during critical weather periods**.

In addition to these direct measures for the improvement of water quality and oxygen conditions, the fish also profited from the Berlin **reed-bed protection program**, the efforts to **plant pike-spawning meadows**, e.g. in the Tiefwerder meadows, from the certification of **spawning protection areas**, and the eel and pike **stocking measures** financed by all licensed fishing people through the sale of fishing tickets.

What is still especially striking is the relatively **large number of species in the smaller bodies of water**. They are often home to considerably more species of fish than would be expected under natural conditions. The majority of the stocked species is not capable of reproduction under the given conditions of the bodies of water, and is continually restocked. A total of 24 of the species of fish verified in Berlin were found in small bodies of water (see Tab. 2), while the fish fauna characteristic for this body-of-water type contains only eight species: carp, gibel carp, crucian, moderlieschen, rudd, tench and, to a limited degree, pike and perch.

Only **rivers, canals, river lakes and inland lakes greater than 10 hectares** are relevant for the assessment under the **Water Framework Directive**. For these body-of-water types, the map provides valuable information about potential species inventory; the good ecological potential must in every case be set above the observed species average (see map legend). However, for an initial classification of the bodies of water through 2006 on the basis of the valuation procedures according to the Water Framework Directive, further stock verification and scientific examinations on the ecological potential of urban bodies of water will be required.

Brief Characteristics of Selected Berlin Bodies of Water

River Lakes

Some 30 km of the **Havel** and its lake-like expansions are located in the Berlin municipal area. The Spandau barrage weir, which has existed since before 1232, separated the **upper Havel**, including Niederneuendorf and Tegel Lakes, from the **lower Havel**, including the Scharfe Lanke, Stössen Lake, Jungfern Lake and Great Wannsee.

The **little Wannsee chain** lies in an ancillary ice-age spillway, and includes the Little Wannsee and Pohle and Stölpchen Lakes. These bodies of water are similar both morphologically and hydrologically and can be viewed as outflow or river lakes. The total area of the Havel lakes is more than 2000 hectares, with Pohle and Stölpchen Lakes the smallest with 10 hectares each, and Tegel Lake the largest with about 400 hectares. All bodies of water mentioned were tested in the course of the Berlin fish fauna survey, with the exception of Niederneuendorf Lake. The Havel lakes are among the **Berlin bodies of water with the highest number of species of fish**; the maximum of species was in Tegel Lake, with 24, and there were **30 fish species altogether**.

The large range of species of fish in the river lakes has several **causes**. On the one hand, as mentioned above, there are **both flowing and still water areas**, so that in addition to the ubiquitously present eurytopic species, both lentic species (preferring still water) and lotic species (preferring flowing water) can find suitable living conditions. Moreover, despite major anthropogenic impairments, relatively **variegated shore structures** can still be found. Apart from widespread structures of every kind (bung walls, footbridges, moorings etc.), there are also flat, weeded bays and reed-beds, which serve the fish as spawning grounds and their brood as growth areas.

In addition, eel, pike and catfish are regularly **stocked**. The Havel waters are a **waterway of the first order**, i.e. they are used by professional navigation. Moreover, they are heavily used by professional and sports fishermen as well as by water-sports enthusiasts and relaxation seekers.

In addition to the Havel, the **Spree and Dahme** also have lake-like expansions. Along the Dahme are the **Langer and Zeuthen Lakes and the Great Krampe**. Seddin Lake is fed with Spree water through the Gosen Canal; the Spree flows through all the other bodies of water examined (**Rummelsburg Lake, the Great and Little Müggel Lakes and Dämeritz Lake as well as the Bänke**). The last-named lakes occupy an area of 952 hectares together, with their size ranging between 15.8 hectares (**Little Müggel Lake**) and 770 hectares (**Great Müggel Lake**). A total of **28 species of fish** have been verified; the single bodies of water ranged from 12 species (Little Müggel Lake) to 24 species (Dämeritz Lake).

The **bitterling** has disappeared from these bodies of water. The strong occurrences of the Habitat-Directive species **loach and asp** in the Great Müggel Lake particularly deserve mention. For both species, the **Great Müggel Lake is the main spawning area** in Berlin. These species are particularly numerous here, and from here they also settle other inner-city bodies of water, such as the Spree. The river lakes located at the southeastern edge of the city stand out for their variegated habitats. They still have extensive non-reinforced, near-natural shorelines (the southern and western shores of the Great Müggel Lake) as well as relatively extensive reed-bed belts (eastern shore of the Seddin lakes), and extensive floating foliate plant zones (the Bänke). The uses of these bodies of water is analogous to that of the Havel lakes, although the burden due to sports boats is considerably lower. The Dahme is part and the Spree-Oder waterway, and is used by professional navigation.

The **species-poorest river lake of all was the Jungfern Lake**, where only seven species of fish were verified.

Inland Lakes

The category of **inland lakes** includes closed, standing bodies of water with areas greater than one hectare. Depending on their type of genesis, the distinction is made between natural lakes (created by the Vistulian Glaciation), and artificial lakes (pits, gravel or clay quarries, peat cuts, etc.).

Natural Lakes

Thirty-one of the sampled lakes were assigned to this category. Their sizes ranged from 1.2 hectares (Möwen Lake) to 70 hectares (Gross-Glienicke Lake). A total of **27 species of fish** were verified in them, with the number of species per lake ranging from one (Schwarzwasser Lake) and 16 (Heiligen Lake).

The land-forming, flat, polytrophic **Bogen Lake** in the Buch Forest has an extensive reed-bed belt. The sewage-farm operation near the lake, which continued into the mid-'80s, led to heavy nutrient immissions, causing it to silt up. In summer, the oxygen content of the water often reaches values critical for fish. From the south shore of the lake, there is a pipe connection to the Buch ponds. The lake appears very unspoiled.

The **Grunewald, Hundekehl, Nikolas and Schlachten Lakes and the Krumme Lanke** form the **Great Grunewald lakes.** They are located in an ancillary postglacial spillway off the Havel lakes. The shores of these long bodies of water are overgrown with trees almost throughout their entire length. With the exception of Nikolas Lake, which has extensive herbaceous areas of flat water and reed-beds, the mentioned bodies of water have scanty reed-beds in only a few places. Nikolas Lake is one of the two remaining bodies of water with a bitterling population.

The **Little Grunewald lakes** include the **Hertha, Halen, Diana, Hubertus and Koenig Lakes**. Like the Great Grunewald lakes, they are located in an ancillary postglacial spillway off the Havel lakes. Their shores are lined with bushes and trees, and to some extent reinforced with wooden fascines. These bodies of water all have reed-beds and flat herbaceous areas. Their shores are accessible to the public only at a few locations. Like most Berlin lakes, they are also fishing areas, and as such are regularly restocked with fish.

With an area of 70 hectares, **Gross-Glienicke Lake** is Berlin's biggest inland lake. It is a stratified, eutrophic to hypertrophic lake. Its earlier, temporary connection to Sacrow Lake no longer exists, so that migration of fish via this path has ceased. Fish-stocking is carried out mainly with pike, tench, carp and eel; a total of seven species of fish have been verified. Due to a chemical phosphate precipitation project carried out in 1992-'93, the summertime view depth has improved considerably in the lake, which has also favored the settlement of sub-aquatic plants and led to a rise of the structural variety of the lake.

Heiligen Lake is indeed connected to the upper Havel by a channel, but its theoretical water dwell time is so high that it is not counted as a river lakes (water dwell time < 30 days). The northern lakeside appears near-natural, is covered with reed-beds and certified as a spawn- protection area. The other shores are grass-covered or obstructed by footbridges. The Heiligen Lake is used for fishing. Due to the connection to the upper Havel, which makes fish migration into the lake possible, it is the **inland lake with the largest number of fish species** in Berlin, with **16 verified species**.

The long-drawn **Hermsdorf Lake** is located in the north of Berlin. It is drained by Tegel Creek. Like Heiligen Lake, its flow is too slight for it to count as a river lake. Its shore vegetation is variously structured; some areas are overgrown with reed-beds, others with bushes and trees. Flat, herbaceous areas which can serve the fish and their brood as spawning grounds and shelters are found in the water. The lakebed is muddy.

The hypertrophic **Malchow Lake** is located in the north of Berlin. It is used for fishing. Its maximum depth is only 1.5 m; its view depth is only a few centimeters. The lakeside is partly lined with thick willow bushes (eastern shore) and trees (northern and northwestern shores). Higher aquatic plants are largely lacking, due to the nutrient entry from the surrounding area; the western part of the lake is particularly strongly silted. Here, thick mud deposits extend to just below the water surface (10-20 cm). No fish kills have been observed during the past ten years, as had repeatedly been the case between 1974 and 1988. The lake is managed and stocked with fish by the Berlin State Fishermen's Association which belongs to the German Fishermen's Association e.V (DAV). They have stocked catfish successfully, as could be impressively seen, among other things, by the catch of a 1.20 m long fish in the summer of 2003. However, only **eleven species of fish** were verified recently, compared with 14 to 1993.

The hypertrophic **Ober Lake** in Hohenschönhausen is a park lake. The lake structure is poor except for an island, with monotonous concrete shorelines which offer fish neither shelter nor spawning grounds. The sewer is an additional burden; it discharges mixed waste and rain water overflows into the lake during strong rainfalls, particularly in winter. The lake is also managed by the Berlin State Fishermen's Association. The fish population has changed considerably compared with the period before 1993. At that time, crucian, gibel carp, tench and carp were frequent; today, perch and moderlieschen predominate, of which the perch have a much lower tolerance for oxygen scarcity than the cyprinides mentioned above. The number of fish species has **declined to ten**, compared with 14 in 1993.

Neighboring eutrophic **Oranke Lake** is also a park lake used for fishing; on its northern shore, there is also a heavily frequented public swimming area. The lakesides are reinforced with steel bung walls and concrete honeycomb plates. They therefore no longer have their original, richly variegated structure.

Extensive curltop growth, which provides the fish with spawning grounds and shelter, is still found in the lake, while the bathing beach provides sand-spawning (psammophilic) species of fish like the gudgeon with a suitable spawning refuge. The lake is fed from a submerged spring, is considerably less silted than neighboring Ober Lake, and has a better water quality despite heavier frequentation by bathers.

The bitterling has disappeared in the course of the shore reinforcement measures at the lakeside.

Plötzen Lake in Wedding is also used for public swimming. The lake is also used for fishing, and is managed by the German Association of Sports Fishermen (VDSF). Tests of rainbow trout stocking failed in 1998; the species was already no longer verifiable in the subsequent year.

The Plötzen Lake has predominantly non-reinforced shores; the tree stands reach the water. The only non-wooded shore is in the area of the public bathing area. Every year, large quantities of leaves from the shore vegetation fall into the water, causing nutrients to be released and oxygen deficiency to appear in the hypolimnion. At the time of the full circulation in October 2000, an **eel kill** occurred, so that in the fall of the same year, **chemical methods** were used intensively for **nutrient verification in the sediment**. An examination of the consequences for the ichtheofauna carried out in subsequent year verified a total of **15 fish species** (Fredrich & Wolter, not published), as opposed to 10 species to 1993.

The occasional asps found were apparently from the neighboring Westhaven Canal (individual transfer by fishermen).

Before the termination of fishing in the **Müggelheim Teufel Lake**, it was stocked with fish by the German Fishermen's Association. The species of fish verifiable at present can primarily be explained by that. Like Plötzen Lake, the shores are largely tree-lined. The leaf entry caused by this has led to the polytrophic lake having a mud floor, with an up to 20 m thick layer of fine sediment.

The **Wilmersdorf Teufel Lake** is located in a nature reserve. Its shores are lined with trees and to some extent with reeds. The result is a variegated structure and a near-natural appearance. Although the stock development of the **bitterling** was assessed as declining in 1993, this species has maintained itself in this body of water to this day, one of the **last two reproductive populations of this species** in Berlin waters, together with Nikolas Lake.

The shores of the **Hermsdorf Wald Lake** have thick stands of trees. There are flat herbaceous areas which are suitable habitats for broods and young fish and spawning grounds for fish which require aquatic vegetation. The lake appears very natural. A total of 12 fish species were found.

The **Zehlendorf Wald Lake** is not open to the public and also seems quite natural. The shores are thick with trees, with stabilized walkways in some places. Submerged aquatic vegetation is rich. Compared with 11 fish species in 1993, **only 8** were now verified (Minow, unpublished).

The hypertrophic **Weisse Lake** is a park lake managed by recreational fishers. The shoreline of old facines is monotonous and has few structures. Cyprinide species (carp) have hardly any spawning substrate, because strong eutrophication hinders higher water plants. The lake bottom is very muddy, except for the bathing area on the east shore. The water fountain in the middle of the lake introduces much oxygen in the summer months and is thus evaluated positively. After numerous fish kills between 1993 and 1996, **only 7 fish species** have now been verified, compared with 18 in 1993.

The **drop in the numbers of species compared with 1993** in many inland lakes, seemingly so dramatic, can often be explained by the fact that the users, **mostly fishing organizations**, today apparently plan and carry out **fish-stocking measures more responsibly**. The species which are now missing in the lakes are almost exclusively those which were stocked in the past, although they were unsuitable for the body-of-water type. These included primarily rainbow trout, but also pike-perch, asp, chub etc., and which are now disappearing once again, since the stocking measures have evidently been terminated.

Artificial Lakes

This category **includes 16 of the lakes sampled**. Their size varies between 0.5 hectares (Körner Lake) and 30 hectares (Airport Lake). In them, a total of **20 species of fish** were verified, **six fewer** than in 1993; each lake had at least 3 (Elsengrund Basin, Elsengrund Lake and Dreieck Lake), and at most 15 (Airport Lake). The high numbers of fish species can be explained by **stocking**.

A representative of this category is **Arkenberg Lake**, a former gravel pit located in northern Berlin (Blankenfelde). The lake, which is today eutrophic, was created in 1979 in the course of freeway construction, and has since then been managed for fishing by the Berlin State Fishermen's Association. A construction rubble dump is operated on the west shore of the lake. A further source of anthropogenic water pollution is the extremely heavy summertime bathing use. The shoreline of this artificial lake is very structurally poor and monotonous; an extensive growth of submersed makrophytes deserves mention, however. All 13 species of fish occurring were caused by stocking; however, today they **predominantly reproduce naturally**, with the exception of catfish and carp.

The so-called **BUGA bodies of water** on the terrain of the former Federal Horticultural Exhibition (BUGA) were created for the scenic design of the park. They are artificially fed. Their water is relatively low in nutrients, and clear. Parts of the shore region have been near-naturally designed and planted, and are home to a large number of plant species. Thick growths of submersed makrophytes grow in the water. Although numerous species of fish, including bitterlings, were stocked in these bodies of water, **only seven** could now be verified. The bitterlings have not taken hold.

The **Airport Lake**, over 30 m deep, is the deepest body of water in Berlin. It was created as a gravel quarry for the construction of Tegel Airport, and is today managed by fishermen. Near-natural shore vegetation is found in places not frequented by bathers. Some of the reed-bed stands are endangered by the drop in the ground-water level. The herbaceous bays at the southern part of the lake serve fish as spawning areas, and their brood as growth shelter. **Only 15 species** of fish have currently been verified, 4 fewer than in 1993.

In the **Great Tiergarten**, there are a number of **park bodies** of water which are in some cases interconnected by trenches, of which two, Faule Lake and Neue Lake, are classed as artificial lakes due to their area. Their water is supplied from the Spree, but this connection is not passable for fish, so that the very high number of fish species, **15** compared with 18 to 1993, **is still largely due to stocking**. Wolter & Vilcinskas in 1993 proposed a connection passable for fish from these bodies of water to the Spree, but it has not been realized to date.

The **Kaulsdorf Lakes**, located in the borough of Hellersdorf, are a very recently created recreation area containing 5 manmade lakes, of which **Butz and Habermann Lakes** are the two oldest. The latter was created in connection with the construction of the German National Railways Wuhlheide detour track in 1942. The Kies ("gravel") Lake was excavated in 1970; since 1980, gravel has been quarried at **Elsengrund Lake**. As former quarries, these bodies of water have a gravelly sediment. Only in the Elsengrund Basin was foul sludge determined, connected with hydrogen sulfide formation.

All lakes are heavily fished, and also extremely heavily frequented by bathers in the summer, numbering up to 30,000 in a day. The strong bathing use in summer and the wintertime frequentation of the frozen surfaces have led to considerable shore erosion and an almost complete disappearance of the once extensive reed-bed stands. Only in those shore sections where trees and bushes prevent sun-bathing has near-natural preservation-worthy shore vegetation developed. Other valuable structural elements include the various species of submersed aquatic plant growing in all the lakes except the Elsengrund basin.

Altogether, **14 species of fish** were found in the Kaulsdorf lakes; between three and eleven (Kies Lake) in individual lakes. **Pike** still find suitable conditions for natural reproduction in the lakes. Since, as a result of the loss of spawning grounds and thus restricted possibilities of the survival of the species, this species of fish is predominantly present in Berlin due to stocking, so that the few remaining spawning grounds are particularly protection-worthy.

The former gravel pit in the **Lasszins meadows** is a near-natural body of water, protected and fenced in due to its significance for birdlife. The shore structure consists of a broad reed-bed belt and trees. A thick growth of submersed makrophytes exists in the clear, relatively low-nutrient water. Pike find particularly suitable living and reproduction conditions here, too.

Retention Basins

Retention basins are artificially created bodies of water. As their name implies, they serve as catchment, collection and sedimentation basins for rain and surface water. The run-off from roofs, courts, streets and other sources collected in these basins is **heavily contaminated by nutrients and pollutants**, particularly PCBs. The toxic sediments washed in do not reach the open bodies of water, so that rain retention basins contribute to the reduction of the diffuse nutrient and pollutant immission often required of other surface bodies of water; they have been conceived and designed for this purpose.

Due to the pollution of the water and the sediments which accumulate in the fish, these bodies of water **may not be fished**. Since retention basins can of course not be settled by fish either, they should actually be fish-free. The opposite is the case. None of the six rain retention basins examined was home to less than two fish species (Dahlwitzer Landstrasse retention basin). On average, **8 species** were verified, the maximum was 14 (Wuhle basin).

The **Wuhle basin** in Marzahn is structurally an exception, however, since the Wuhle sewage-treatment plant discharge channel flows through it. Both bodies of water are also managed by the DAV. With the closure this year of the Falkenberg sewage-treatment plant, which has fed the Wuhle and the Wuhle basin, future changes in the water course and flow are to be expected, which will also have a medium-term effect on the fish-species association.

The **Klötz basin** is located in the Lübars neighborhood. It was built in 1968, as part of the planning of an industrial area. The shores are monotonous, and overgrown with grass only above their reinforcement. Submersed makrophytes and other structures which could be used by fish as a spawning ground or shelter are largely lacking. The verified **9 species of fish** are the result of stocking. Except for the three-spined stickleback, there seems to be no natural reproduction of fish species present.

The **Osdorfer Straße rain retention basin** is completely fenced in. The shores are thickly covered with bushes and trees. A thick growth of cow-lilies is found in shallow places. As was already suspected in 1993, the bitterlings have disappeared from the basin, since the species of mussel essential for their successful reproduction is lacking.

The 1.8-hectare **Seggeluch basin** is in the Märkische Viertel. Its shores are artificially reinforced and largely vegetation-free. The verified **11 species** are stocked. It would appear an unsuitable habitat for so many fish species, because of its small size and lack of structures.

Unlike the other retention basins, the **Rahnsdorf basin** was built as a survival pit for the fish from the Fredersdorf Mill stream, the lower stretches of which periodically dry out. More than 14,000 fish from 11 species were counted in the mass fishing of approx. 250 sqm area survival pit carried out a 1999 (Fredrich & Wolter. unpublished). This included one single stocked catfish, for which both the basin and the stream itself are completely unsuitable as a habitat.

Small Bodies of Water (ponds, tarns, meres, kettle-holes and the like)

Ponds are artificial, dischargeable bodies of water. The other bodies of water were usually naturally created as a result of landscape processes during the Ice Age, including "dead-ice" lakes, and kettle-holes, or as abandoned clay or gravel quarries, or peat cuts. These bodies of water are different from ponds due to the fact that in principle, they are not drainable. Since no pond management is carried out in Berlin and therefore the ponds are drained only in the course of rehabilitation work, both forms have been categorized together. No further distinctions of the small bodies of water are required, either, from an ichtheologic point of view in the examination area.

Their quality of inflow waters, anthropogenic impairments (mainly by fish stocking), and their areas (usually less than 1 ha) are all similar and make them comparable. A total of **49 Berlin small bodies of water** were verified as home to a total of **24 species of fish**, 20 of them indigenous. The average number of species per small body of water is 5, which is very high, considering their small areas. Only a few **examples of these bodies of water** are to be introduced briefly in the following:

The **Buch ponds**, three interconnected ponds in the midst of sewage farms which operated until the mid-eighties, are located in the north of Berlin. The fisheries management is carried out by the DAV. While Pond III is still completely surrounded by trees, Pond I lacks them almost entirely. The latter is surrounded principally by great sedge reed. Pond II represents the transitional form between the other two. Pond I is fished considerably less than the other two, which are heavily frequented. This is primarily evidenced by the uninterrupted shore vegetation. The shores of Ponds II and III are trodden and eroded in the accessible places. All three ponds are strongly silted. Altogether, **11 species of fish** have been verified in the Buch ponds.

Eckern pond is in the middle of a park in Tempelhof. Its shore structures are a monotonous, regularly-formed reinforcements. Five species of fish were verified here, all euryecoid species.

The **Erlengraben pond** is connected with the upper Havel by a trench. Its shores, overgrown by reeds and trees, make it seem relatively near-natural. The fish population results largely from stocking and consists of **12 species**.

The polytrophic **Faule Lake** is located in the protected area of the same name in Weissensee. Originally, it had no outflow; in the last century it was connected by a trench to the Panke water system. This caused the water-level of the lake to sink by more than one meter. The lake floor is heavily silted. Today, the area around the Faule Lake is primarily significant as an inner-city rest and refuge area for birds. **Two species of fish** have stable populations.

Hufeisen pond is located in Britz in the middle of a housing development. Its shores are reinforced partly by concrete plates. Aquatic plants are also lacking, as is shore vegetation. The pond is excessively anthropogenically overformed and non-natural. Notwithstanding, the pond has a **stable crucian carp stock**.

The **Karow ponds** are four hypertrophic, former fish ponds in the fields of the discontinued Buch sewage farms. The ponds, interconnected by pipes, were used for fishing until 1990, and are a nature protection area today. Their very unspoiled shores are lined with extensive reed-bed stands.

The **Charlottenburg Palace carp pond** is connected by trenches with the Spree. No migration of fish is to expect from this side, however, since the weir at the confluence of the Spree is not passable for fish. Nevertheless, **18 species of fish** were verified in these bodies of water. Their value for the Berlin fish fauna could be increased considerably if the weir were fitted with a fish-passage aid.

Unfortunately, no such compensation measure was provided for the developments of the **Spree Bend**. The **carp ponds and the trenches** would be an important structural element which the fish in the now even more reinforced and monotonous inner-city Spree could use as a retreat and reproduction refuge.

Altogether nine little ponds and meres are located in the **Malchow flood-plain meadow** north of the lake of the same name. The shores have broad reed belts or are lined by alder-marsh woods. Almost all ponds accommodate rich stocks of submerged aquatic plants and seem natural. Five ponds regularly dry out in summer and have no fish. The remaining 4 ponds accommodate both stickleback species and gibel carp, along with roach, tench, crucian and carp in one pond. As one of the few remained habitats for sticklebacks, the Malchow meadow is protection-worthy. Furthermore the wetland is of great importance for the reproduction of local amphibian species.

The **Roete pool** in the borough of Neukölln appears relatively near-natural. It has thick reed-bed and sub-aquatic plant formations and is also especially significant as an amphibian spawning area.

Even after ten years, no fish have been verified in the **Rosenthal ponds** west of the Blankenfelder Chaussee, indicating that the annual drying out of the ponds, which lasts for several months, is continuing.

The **Rückert Pond** is located on the campus of the Free University of Berlin, surrounded by grassy areas, low reed-bed stands and some trees. Its floor is muddy, however, and has a low stock of submersed makrophytes. In addition to tench, crucian and gibel carp, the goldfish stocked in 1990 have survived to this day.

The **pond in the Steglitz Municipal Park** is one of the few that show a fish settlement typical for its body-of-water category. In addition to moderlieschen, which appear sporadically in masses, crucian and gibel carp also occur.

The **Südende pond** resembles the Steglitz park pond. The shores are largely reinforced and accordingly monotonous, here too. The bushes and trees of the shoreline cannot serve the water species as shelter, spawning, or feeding areas. **Only two species**, crucian and gibel carp, have been verified.

The shores of the **Tempelhof Turkish Pool** are lined with bushes and trees; the water itself is clogged with trash. Notwithstanding this, 4 species still survive in the pond.

One of the bodies of water newly fished in recent years in the **Riemeisterfenn**. This former bog area was fed with nutritious Havel water through the Fenn Trench from 1958 to 1995 to safeguard the groundwater supply in the area. With the termination of groundwater charging in 1995, the nutrient enrichment to the Fenn was to terminate, and the area permitted to redevelop into a mesotrophic mire again. For this reason, the connection to the Fenn Trench was interrupted in the late summer of 1998. However, this dam also prevents the access of fish from the Grunewald lakes to spawning areas in the Fenn. The **fish association of 12 species** even today provides evidence for the successful spawning of these species in the Fenn. It includes bream and white bream, which were isolated in the Riemeisterfenn, but are atypical there.

Streams

This category covers **11 bodies of water** in Berlin, including the **upper Spree**, **small tributaries of the Havel and Spree**, and the **tributaries of the large lakes**. All still show at least rudimentarily the near-natural habitat structures characteristic for streams, such as **pools, meanders, back currents, turbulences, and various bottom sediments**. Particularly overflow areas, coarse-grained sediment and meanders, all near-natural structural elements, have been removed almost everywhere by hydrological construction measures. This has led to a major elimination of those stream-dwellers which were tied to these structures. The strict protection of still-existing stream habitats as well as the restoration of some of those destroyed would constitute a very valuable contribution to fish-species protection. Other streams have changed markedly in their character, and have been heavily polluted by the discharges of sewage treatment plants. They are described under the category sewage-treatment plant discharge channels.

The **Fredersdorf Mill stream** arises northeast of Berlin on the Barnim plateau, and has a catchment area of about 230 sq.km. After flowing through Kessel, Fänger and Bötz lakes, it starts its actual 27.6 km long course, which leads to Müggel Lake. The last 3 km or so are within Berlin, in the borough of Köpenick. The Rahnsdorf weir, on Berlin territory, stops any migration of fish from Müggel Lake. Moreover, the biotic association in the Fredersdorf stream above the dam facility is extremely anthropogenically impaired by **drinking water discharge**. Since Well Gallery B of the Friedrichshagen waterworks was brought into operation in 1983, large stretches regularly fall dry during the summer, which is the reason for the above-mentioned **survival pit in the Rahnsdorf basin**. Currently, **16 species of fish** have been verified in the Fredersdorf Mill stream, including Habitat-Directive species such as the **weatherfish**, but ever less frequently. Since the Fredersdorf Mill stream was reported as a **protected area under "Natura 2000"**, this population development of Habitat-Directive species is extremely alarming. Without the year-round water supply already demanded in 1993, and the elimination of the existing obstacles to fish migration, the stocks in the stream can hardly sustain themselves in the long run.

The **Western Drainage Trench** branches off from the weir of the Spandau citadel trench and empties into the Havel below the Spandau sluice. Immediately below the weir, there is a relatively strong flow, and the sediment is sandy to gravelly. Here, lotic (flow-loving) species of fish find suitable habitats; **chub and dace** have been verified. Further downstream, in areas with a lower flow, the bed is muddy. The shores seem near-natural, and are tree-lined almost on their entire length. A total of **16 species of fish** have been verified. The Western Drainage Trench is undoubtedly an important spawning area for the fish of the Havel, particularly for the lotic species.

Canals

Canals are **artificial waterways** with monotonous, reinforced shores (ripraps, concrete or steel bung walls), largely constant breadth and depth as well as a mostly trapezoidal profile. **Berlin has more than 100 km of canals**, if the canal-like structures of the Spree River in the inner city areas are included. Fish make only seasonal visits or **migrations**, because of the **lack of structures** important for fish, such as spawning, shelter and feed areas. The number of fish species present is thus dependent on the fauna of still bodies of water with which they are connected. As a comparative analysis of the fish population of 27 waterways of the northeastern German lowlands has confirmed, the typical federal waterway cenosis shows nine characteristic and nine typical associate species of fish (Wolter & Vilcinskas 2000). Thus, the **good ecological potential of a canal according to the EC-WFD would lead one to expect the presence of 18 typical fish species**. Currently, an average of **only 12 species** are verified in the Berlin canals.

The **Gosen Canal**, completed in 1936, is today managed for fisheries by the DAV, and connects Dämeritz Lake and Seddin Lake. Its shores consist largely of ripraps. Its mean depth is 3 m, its width 35 m; aquatic plants are very rare in the canal, shore reinforcement measures as well as the breaking of the waves caused by navigation are the necessary reason for that. Currently, **16 species of fish** are verified in the Gosen Canal.

The canals in the **city center**, such as the **Landwehr Canal and the Kupfergraben**, have been developed even more monotonously. For reasons of space, the shores are perpendicular here, and are solidly sealed. Thus, unlike the ripraps of other canals, they are not even usable as spawning substrata by hard-substrate spawners like the perch or the ruffe. A total of 23 species of fish were verified in the canals; the canal with the **largest number of species** was the **Teltow Canal**, the **southern connection between the Spree and the Havel**, which showed **19 fish species**.

Trenches, Melioration Trenches

This category consists of small, hardly structured, largely straight **artificial streams**. They were mainly built as **inflow and outflow trenches for the sewage farms**, but also for **drainage**, e.g. of the Gosen meadows in Köpenick. Their profile is trapezoidal or rectangular. While the outflow channels of the sewage farms are heavily contaminated by nutrients and pollutants, the pure melioration trenches, i.e. the irrigation or drainage trenches, are typically only polluted if their surrounding countryside is or was intensively agriculturally used. The abandonment of sewage dissemination and the drop of the ground-water table caused **many of the trenches in the north of Berlin (the former Buch sewage farms) to dry out**.

The **Great Sprint Trench** is a strongly weed-clogged melioration trench connected with the Lübars pond. Both species of stickleback were verified in it. With regard to ichthyologic value and protection, it should be treated as equivalent to the sewage-farm trenches (see below). Maintenance measures may be necessary to prevent the overgrowth and hence the disappearance of this trench.

The feeding of mechanically cleaned Havel water made the re-settlement of submersed makrophytes such as featherfoil, starwort, and water yarrow possible in the **Kuhlake**. The plant stocks, very thick in some places, support the growth of **rudd** and **pike**. The source of the Lietzen Trench is west of the village of Schönow, near Bernau in Brandenburg.

The **Lietzen Trench** drains the sewage farms at Hobrechtsfelde, flows to the west past the Bogen Lakes, and into the Panke at the Karow ponds. Besides the two **stickleback species**, **crucian and gibel carp** were verified.

The **Prisen trench** which is extremely monotonous and straight, largely drains parts of the Hobrechtsfeld sewage farms into the Lietzen Trench. Makrophytes and other structural elements are completely lacking. Within the last few years, the trench frequently dried out, which is why **no fish** were verified.

There are many **discharge trenches** around the discontinued **Buch sewage farms**, remainders of 100 years of such use. They are today dry during the summer because of the lowering of the groundwater table. Both **stickleback species** were found in almost all sewage farm trenches. They are the species most adapted to this kind of extreme biotope and find their last refuge areas here. Since the remained small trenches have been preserved, the populations of sticklebacks has during the last few years stabilized at a level which is low in comparison with the habitat supply prior to the extensive groundwater lowering, for which reason the endangerment level of both species has been **reduced in the current Red Data Book** (Wolter et al. 2003). Little trenches are typically only settled by **two or three fish species**. This number can, however, increase considerably if the **trenches are connected with rivers or lakes** and are used as spawning and breeding areas by the species inhabiting the latter. Thus e.g. 12 species of fish from the above-mentioned Riemeisterfenn and Grunewald lakes regularly migrate to the connected Fenn Trench.

Sewage-Treatment-Plant Discharge Channels

To safely discharge the considerable volumes of cleaned sewage emitted every day from the **major Berlin sewage-treatment plants**, small creeks were improved to increase their drainage capacity, redirected (Panke), straightened, clear out and reinforced with ripraps or concrete plates. Examples are the Panke, the Wuhle and the Neuenhagen mill stream. In the course of this development, **monotonous, fish-hostile gutters** whose water is considerably contaminated with waste heat, nitrates and various salts were created.

The "**Silent Don**" is an approx. 5-meter wide additional runoff channel for sewage peaks of the North Sewage-Treatment Plant in Schönerlinde. Its cross-section is trapezoidal, its shores are reinforced with stone packets. No fish have been verified in ten years. The reason, in addition to the lack of migration possibilities from the surrounding bodies of water, is also temporary sewage waves. The degree of organic burden is not preclusive of fish settlement.

To the north of the Heinersdorf ponds, the **North Trench** branches off from the Panke, flows through the north of Berlin and empties into Tegel Lake. Its artificial bank reinforcement, its straight course and its **structural poverty** makes this body of water appear very non-natural. **Only three thorny sticklebacks** were verified, although the North Trench is theoretically accessible to other fish species as well (e.g. from the Steinberg Lake). Probably, **temporary strongly salt-contaminated sewage waves** limit fish settlement in this body of water as well. Three-spined sticklebacks, of which anadromous populations also exist in coastal areas, tolerate higher salt content than other freshwater fish species.

From its source south of the city of Bernau, the **Panke** flows through the north of Berlin to empty into the Spree. The original mouth and the entire stream course in the borough of Mitte have been piped since 1987, and have fallen dry for at least 15 years. Even in the rest of the river's course, nothing recalls the time when the only certain verifications of occurrences of trout, creek lamprey and loach in bodies of water now part of Berlin were found here. In the past, a popular destination for outings, only the spring areas and the section flowing through the Pankow Public Park recall the original stream today.

The **Wuhle** flows through the boroughs of Hellersdorf and Marzahn at the edge of the city, to flow into the Spree at Köpenick. The body of water today marked on road maps as the Wuhle flows parallel to the original "Urwuhle," and is a fully developed drainage channel with a trapezoidal profile, partly graveled, partly sealed in concrete. The Wuhle is used for fishing from the retention basin in Biesdorf to its mouth into the Spree. During the last few years, it has shown thick, extensive sub-aquatic plant formations, with *Kammlaichkraut*, predominating. The Wuhle is divided by the **Wuhle basin** into **two different ichthyologic sections** by dam facilities which cannot be overcome by fish. Fish migration is possible from the Spree into the **lower portion**, so that **15 species**, which also represent the species spectrum of the Spree, were verified here. Since 1993, the number of fish species in the Wuhle **above the basin** has dropped to **8**. At present, the future development of the Wuhle and its fish population is not foreseeable, since the watercourse and draining conditions will change fundamentally, due to the above-mentioned closing of the Falkenberg sewage-treatment plant.

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