02.08 Fish Fauna (Edition 1993)

Overview

Berlin's lakes and running waters were formed about 10,000 years ago with the melting of the Weichselian ice age glaciers that had covered the area. These waters are young from a geological perspective. The autochtone (native) fresh water fish fauna at that time comprised 56 species, according to Thienemann (1925). Migratory fish which visit fresh water only for spawning are not included in this number. Of these 56 species of fish, 31 populated the waters of what is today Berlin. They are viewed as the original, or autochtonic fish fauna of Berlin. They were and are subject to diverse changes.

The dynamic of the Spree and Havel rivers was once the prime dominant of the Berlin bodies of water system, but **still waters** and **dammed-up waters** have become the primary factors. The construction of dams to drive mill wheels can be traced back to the 13th century. Other water-stemming projects as well as locks for canal navigation were established. The straightening of single river sections began in the 17th century. Canal construction reached a high point in the middle of the 19th century. After this time it was no longer possible for migratory fish to overcome the high obstacles, even at high water levels, to reach the Berlin urban area. The use of stemmed waters caused the loss of valuable lotic (running water) habitats and the loss of flood areas needed by many fish species. Flow velocities slowed and sedimentation processes led to the overlaying of mud onto coarse-grain sediments. Oxygen-consuming decomposition processes predominated at bodies of water bottoms. Fish species preferring gravelly, oxygen-rich substrate had to leave. They lacked suitable spawning and habitat conditions as well as possibilities of compensatory migrations. This is why the earlier primary fish species, the barbel, became extinct. Bodies of water characteristics changed from those of a classical **barbel fish region** to those of a **bream fish region**.

Beyond the continuing negative effects brought by **the engineering of bodies of water**, **inputs** of every kind had an important role. Even before the turn of the century ,the Spree and Havel rivers were so strongly contaminated by industrial waste water, sewage effluents and feces, that fish-kills occurred frequently and commercial fishing was seriously harmed. At that time, for example, fishing boats transported their live catch in cages (Drebeln) towed through the water. Poor oxygen conditions at the surface of the water made it impossible for boats to bring their fish in these Drebeln boxes from the Lower Havel to Berlin (today the inner city). The fish died on the way. Even the urban sewage farms gave only a certain measure of relief for the quality of bodies of water.

These anthropogeneous influences led to an impoverishment of Berlin fish fauna. The barbel and other lotic species of fish requiring stronger currents and oxygen-rich water, including the pond lamprey and schmerle, died off in Berlin.

The already strongly damaged rivers and lakes received in more recent times a new - but not better - quality of waste water. Large sewage treatment plants prevented the input of coarse organic materials (feces, etc.), but the freight of dissolved nutrients remained high. The parallel intensification of agriculture and increasing industrialization amplified discharges of dung fertilizers, plant protection agents, toxic metals and other toxins. Industrial waste water polluted waters with **cooling water discharges.**

Eutrophication caused by excessive nutrient input favored the growth of euryöke (euryeco = ecologically tolerant) fish, whose expansion of population often concealed the dwindling of more sensitive species.

These are doubtless the most important factors. But that does not exhaust the range of anthropogenic damages to fish stocks. The **recreational use** of bodies of water is a large, continually increasing factor. Wave impact caused by motorboats and swimming promote the erosion of shores and damage the protective belt of vegetation.

Recreational fishing must be differentiated. Damages and pollution to shores and bodies of water caused by recreational fishers in bodies of water already burdened by a multiplicity of uses (fishing, swimming, recreational boating, etc.) are relatively small in comparison to the countless other visitors and users. Fishers influence surface water eco-systems mainly by interventions in the biocoenosis in the form of **fish removals** and **fish stocking.** Economically valuable fish or those of interest to fishers are disproportionately promoted. An imbalance of autochthonic fish fauna occurs when species not indigenous to the area are introduced, such as rainbow trout and brown bullhead. They can be competitors for

nutrients, egg-predators and predators. Indigenous fish may not be able to adjust. The species have specialized in the course of their development and adapted optimally to their habitat space to avoid competitive relationships. This process results in an eco-system in which most species have a relatively limited range, an ecological niche, which only they can optimally use. The effect of introducing allochtonic (non-autochtonic) species, into this ecosystem cannot be estimated. Indigenous species can be displaced. Lost with them are genetically coded specializations and adaptations to contemporary bodies of water conditions won in the course of evolution.

The **overfeeding** commonly found in heavily-fished bodies of water represents a nutrient impact which is not negligible.

The first inventories of fish fauna in Berlin bodies of water were made about 100 years ago and offer historically valuable starting points for estimating effects on the constellation of fish species and their changes in time. Individual bodies of water, primarily in southeast Berlin, were investigated again in the 50's. Fish stock inventories later could only be conducted separately in divided Berlin, because of the political situation. Red Data Books were separately prepared in East and West Berlin (cf. Tab. 1). Divergent classifications of endangerment to individual species are mostly due to different bodies of water conditions in the two parts of the city. Large river lakes dominate in West Berlin, while East Berlin has more running waters. There are thus considerable differences in the number of species, as well as population sizes of flowing water fish and river fish. This led to different estimations of endangerment.

Tab. 1: Endangered Categories of Autochthonic Species of Fish According to the Red Data Book of Berlin and the Federal Government

No. on Map	Fish Species	Degree of Endangerment			
		West Berlin 1991 1)	East Berlin 1992 2)	Berlin 1992 3)	Germany 1992 4)
01	weatherfish	1	1	1	2
02	spined loach	1	1	2	2
03	burbot	1	1	1	3
04	nine-spined stickleback	1	1	1	
05	sheat-fish, wels, catfish	2	1	2	3
06	three-spined stickleback	3	3	3	
07	ruffe	3		3	
08	smelt	1	1	3	3
09	pike	3	P	B	
10	eel	3	P	B	
11	perch				
12	zander				
13	bitterling	1	1	1	2
14	chub	1	2	2	
15	dace	1	1	3	
16	ide	3	3	3	3
17	gudgeon	3	3	3	
18	moderlieschen	3	2	3	3
19	roach				
20	rudd				
21	asp	3	3		3
22	bleak		3		
23	bream				
24	white bream				
25	tench	3	P		
26	crucian carp				3

1) Vilcinskas 1991a – 2) Brehme, Geißler and Sedlaczek 1992 – 3) Wolter, Vilcinskas and Geißler, in preparation – 4) Bless, Lelek und Waterstraat, outline on 10 july 1992
1 = threatened by extinction, 2 = strongly endangered, 3 = endangered, P = potentially endangered, B = natural population strongly endangered, population based mainly on restocking, empty space = not endangered at this time

Tab. 1: Endangered Categories of Autochthonic Species of Fish According to the Red Data Book of Berlin and the Federal Government

After it became possible to prepare one **Red Data Book** for all Berlin, previously collected data on fish populations was coordinated and uniform standards of evaluation were developed. The somewhat smaller number of entries in the endangered classification in Table 1 are not due to improvements in habitat, but rather to a larger investigative area and a greater number of samples. Almost twice as many bodies of water were sampled as in previous studies. This led to the discovery of new populations of a larger number of fish species. A new, annotated Red Data Book for Berlin was prepared on this basis (Wolter et al., in preparation).

There are more than 250 bodies of water in Berlin, all with fish fauna strongly influenced by humans.

The essential prerequisites for well-directed biotope protection measures are knowledge of the current distribution and frequency of fish fauna, and the most important factors endangering their existence.

The investigation of fish populations is an aid for evaluating bodies of water. It enables an estimation of complex factors and their long-term effects on higher aquatic organisms without having to study each one singly. The prevailing fish fauna is an index for the ecological condition of a body of water. The determination of a large number of species of fish is thus to be judged positively, because this ecological elaboration indicates the existence of many different habitats, and thus a great structural diversity. The possibility that a given population survey may be distorted by restocking must be kept in mind.

The existence of endangered species of fish in a body of water can have a fundamentally positive significance for the evaluation of the water, because these endangered species are usually more sensitive to water quality and habitat structural diversity than euryöke species of fish.

Statistical Base

The map gives an overview of current knowledge about fish populations in Berlin bodies of water. Studies made more than 5 years ago were not used. The fishing samples in various waters occurred between 1987 and 1992 in the course of:

- preparation of a Red Data Book for fish and cyclostromata in West Berlin (Vilcinskas 1991a)
- fishing samples of bodies of water leased by the Landesverbandes Berlin e.V. im Deutschen Anglerverband (DAV e.V.) (= Berlin State Chapter of the German Fisher Association, non-profit organization) were taken in the course of operational measures (fish stock control, etc.).
- fauna study for the Naturschutz- und Grünflächenämter (= Nature Protection and Green Spaces Offices) of the Hohenschönhausen and Hellersdorf boroughs, and Berlin forests (Vilcinskas 1991b, Vilcinskas and Wolter 1992a, 1992b)
- Fischartenkartierung der Berliner Arbeitsgruppe "Wildfische" (= Fish Species Cartography of the Berlin Workgroup "Wild Fish")
- echo depth sounder studies of selected Berlin lakes (Wolter 1991).

Supplementary fish samples were necessary in order to sufficiently represent the entire area of investigation for the updating of the Fish Fauna Map.

The registration of all species of fish in a body of water requires at least 2 fishing samples a year because the activity radius of an individual species of fish in a body of water varies in the course of the year, thus affecting possibilities for detecting them. Various catching methods are employed. Electrofishing was possible in structurally diverse water sections with shelters and projections. Electrofishing, when properly used, is the most sparing method of capture because fish hardly come into contact with the capture mechanism. Mucous membranes and scales remain relatively uninjured. Fixed nets, dragline nets, and traps were used in flowing waters. Fixed nets, however, were only employed when fish were taken for residue analysis. This method of capture often injures fish and they cannot usually be returned undamaged. A combination of various capture methods is necessary in many waters in order to register the entire spectrum of species. Long-term investigations are advantageous. Species which are relatively difficult to capture, such as burbot, sheat fish, wels, and catfish, may not be detectable in a given year. Natural oscillations in population size, which are quite large among smelt and moderliesche, can be determined and the actual endangerment of this species more correctly estimated. In cases where it was not possible to conduct an adequate number of fish samplings, recreational, commercial and lease fishers were questioned, and their catch and restocking statistics were evaluated.

Methodology

Data from 151 sampled waters were evaluated for updating the Berlin Environmental Atlas. In order to use this data for evaluation, it is necessary to develop an idea of which fish fauna are capable of surviving under given conditions, and can thus be expected to be found. The difference between the **potential** and **actual** number of existing species can serve as a starting point for the evaluation of how near a body of water is to natural conditions. A wide variety of scientific publications deal with the theoretical and practical range of fish species which can be expected to be found in a body of water, from geological, geomorphological, fauna and fishing points of view. Common to all of these viewpoints is that the number of fish species depends on the structural diversity of the habitat, and thus directly on the **type of body of water.** Lakes with outflow, for example, have both running as well as still water areas. They offer suitable habitat conditions for both lotic, rheophillic (preferring strong currents) and lentic limnophillic (still water) fish species. River lake lowlands accommodate a diverse spectrum of fish species. Only lentic, limnophillic species find optimal habitat conditions in still lakes. In rivers, usually only lotic, rheophillic species. The number of fish species expected in stillwater types is thus less than in river-fed lakes.

Nine categories were made for the comparison of Berlin bodies of water:

- running waters
- river lakes
- natural lakes
- manmade lakes
- retention basins
- small bodies of water
- canals
- trenches
- sewage treatment plant discharges.

It was necessary to divide lakes into natural and manmade categories because the former can be naturally populated and fish stocks in the latter are due to stocking. Retention basins and sewage treatment plant discharges as manmade small bodies of water, whether still or flowing, were also given their own category, for they usually prove to have the highest constructed condition. The number of sampled bodies of water for each category is given in Table 2.

Tab. 2: Number of Berlin Bodies of Water with Verified Presence of Fish Species											
No. on Map	Fish Species	Bodies of Water Type									Total
		River Lakes	Lakes		Retention Basin	Small Bodies of Water	Running Waters	Canals	Trenches	Sewage Treatment Discharges	
			natural	artificial							
		Number of Sampled Bodies of Water									
		17	30	16	5	43	7	16	11	6	151
01	weatherfish	5	1	0	0	0	1	1	0	0	8
02	spined loach	1	0	0	0	0	2	0	0	0	3
03	burbot	11	0	0	0	0	2	7	0	0	20
04	nine-spined stickleback	0	1	0	2	2	2	0	8	4	19
05	sheat-fish, wels, catfish	8	6	2	0	2	0	0	0	0	18
06	three-spined stickleback	6	7	4	3	18	5	5	5	5	58
07	ruffe	17	15	6	0	3	6	12	0	1	60
08	smelt	10	1	1	0	0	0	1	0	0	13
09	pike	17	26	12	1	10	7	9	1	1	84
10	eel	17	26	11	1	8	7	13	1	2	86
11	perch	17	27	13	4	11	7	16	2	3	100
12	zander	17	18	8	1	4	4	8	0	0	60
13	bitterling	1	5	1	1	1	1	0	0	0	10
14	chub	8	1	0	0	0	2	4	0	0	15
15	dace	2	1	0	0	0	5	4	0	0	12
16	ide	13	1	0	0	0	6	12	0	0	32
17	gudgeon	11	16	6	1	4	5	5	0	0	48
18	moderlieschen	4	19	3	1	12	1	1	0	0	41
19	roach	17	28	14	4	12	7	16	1	3	102
20	rudd	15	22	10	3	9	7	10	1	1	78
21	asp	16	3	1	0	2	2	10	0	0	34
22	bleak	15	16	8	1	4	4	12	0	1	61
23	bream	17	25	12	2	6	7	16	1	2	88
24	white bream	17	20	11	1	3	7	13	1	1	74
25	tench	12	25	11	1	17	5	6	2	1	80
26	crucian carp	12	23	11	4	23	3	5	1	3	85
27	rainbow trout	1	4	6	0	0	1	4	0	1	17
28	grass carp	3	4	2	0	8	0	1	0	0	18
29	gibel carp	10	10	6	2	24	3	4	2	2	63
30	goldfish	0	0	3	1	5	0	1	0	0	10
31	carp	13	20	11	3	14	4	7	1	2	75
32	silver carp	8	2	1	0	1	1	2	0	0	15
33	brown bullheat	0	1	1	0	1	0	0	0	0	3
total number of species		30	30	26	19	25	28	28	13	16	33
average number of species		18 – 20	11 – 13	10 – 12	6 – 8	4 – 6	15 – 17	12 – 14	1 – 3	5 – 7	x
x = statement not meaningful No. 01 - 26 = autochtonic fish species No. 27 - 33 = allochtonic fish species											

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

The average of fish species detected was computed for all bodies of water of a type. This took into account species clearly stocked, in as far as they are considered to be indigenous or not. This value ±1 was set as the range for **average number of fish species for this type of bodies of water** in Berlin (cf. Tab. 2). Because a large number of fish species may usually be inferred as indicating a diversely structured and thus ecologically valuable habitat, deviations from the average were evaluated as positive when the number was greater, and as negative when the number was lesser.

The average value is only an aid for comparison of Berlin bodies of water to each other. It is not a scientifically based, generally valid evaluation. It should be basically noted that a body of water with relatively few fish species (compared to waters of the same type) is not necessarily to be estimated as poor. It can be a very valuable biotope (for fish too) anyway. On the other hand, the existence of relatively many fish species could be due to restocking measures, so this bodies of water cannot simply be

evaluated as good without reservations. But the map does show which bodies of water within a group **in reference to their fish fauna** are richer in fish species and thus usually more diverse.

Sewage farm trenches were assigned their own category and positively evaluated bodies of water are to be found here too, based on the number of fish species. This should not conceal the fact that this category consists of unnatural waters detrimental to fish. These waters are little deserving of protection in this condition. An example is the Panke. Eighty years ago the course of the Panke was a richly sectioned stream accommodating pond lamprey. The Panke was then reformed into a straight conduit with a trapezoid cross-section. It has been damaged by human intervention, regardless of the number of fish species which can be found there today.

The map gives information about the number of verified fish species, their relative frequency, and their degree of endangerment, in each investigated body of water. The existence of a fish species which was observed only irregularly and as an individual specimen in the course of several samplings of a body of water was classified as seldom. A species regularly captured, but only in relatively small numbers, was classified as low. Many species were found to be present in larger quantities in all samples.

The degree of endangerment of an individual species of fish was estimated according to the newly prepared Red Data Book (cf. Tab. 1). The existence of endangered fish species was evaluated as positive. The order of verified species in fish symbols was arranged so that the degree of endangerment increases from right to left.

Map Description

Thirty-three species of fish were found in 151 bodies of water in Berlin in the period of this survey. Seven of them belong to the non-indigenous category. The frequency of the recording of an individual species within each type of body of water is found in Table 2. The most frequently recorded species of fish is the roach, found in 102 bodies of water. Perch was found 100 times. Pike, bream, crucian carp and eels were recorded in more than 80 of the sampled bodies of water. Carp populate every second body of water sampled. They are the most frequently appearing non-indigenous species of fish, explained by their importance for commercial and sport fishing. The least number of verifications were for spined loach and brown bullhead, each with 3.

No fish at all were found in 6 sampled bodies of water. Only one species was found in 11 waters. As expected, the lake-like lowlands of the Havel and Spree rivers are the Berlin bodies of water most rich in fish species. The great wealth of fish species in small bodies of water is conspicuous. They usually accommodate more species of fish than would be expected under natural conditions. The majority of imported species are not capable of reproducing under prevailing conditions. Their stock is constantly renewed.

The number of tested bodies of water is almost 3 times the number in the Environmental Atlas of 1985, due to the expansion of the area to be investigated. The number of rivers and lakes investigated increased especially. Thirteen bodies of water of this category were tested in 1985. This time 63 were tested. This is probably why roach and perch - typical lake fish - are the most frequent species found. The crucian carp is a typical small bodies of water fish and occupies fifth place. It was the most frequently found fish species in the surveys of 1985. More small bodies of water were investigated at that time, in relation to other bodies of water categories. The results of 1985 and 1993 cannot be directly compared with each other for this reason.

Two new species, rainbow trout and goldfish, were included in the current survey map because their population sizes and frequency of appearances have increased over the last 5 years.

Brief Characteristics of Selected Berlin Bodies of Water

River Lakes

About 30 km of the **Havel river** and its lake-like broadenings run through Berlin. Beginning at the Spandau locks, the Havel can be divided into the Upper Havel, including Niederneuendorfer and Tegeler See (see = lake); and the Lower Havel, including Scharfe Lanke, Stößensee, Jungfernsee and Großer Wannsee. The Kleine Wannseekette (Lesser Wannsee chain of lakes) flows through an ice age channel and is comprised of Kleiner Wannsee, Pohlesee, and Stölpchensee. These bodies of water are similar both in morphology and hydrology, and can be termed lakes with outflows or river lakes. The entire area of the Havel lakes is

more than 2,000 ha. Pohle and Stölpchen are the smallest with 10 ha; and Tegeler See is the largest with about 400 ha. All bodies of water mentioned were tested in the course of the Berlin fish fauna survey, with the exception of Jungfernsee and Niederneuendorfer.

The Havel lakes are among the Berlin bodies of water with the highest number of species of fish. Each was found to have more than 20; the maximum was 25 species. Griebnitzsee is connected to the bodies of water system of the Havel but was found to contain only 14 species. This is due to the influence of the Teltow canal waters, but all the species living in it were probably not found.

Eleven of the fish species are Red Data Book Species. Two of them are endangered by extinction in Berlin. The large spectrum of species of fish has several causes. For one, there are both still water and running water areas, so that both lentic and lotic fish species find suitable habitats. For another, relatively diverse structures are to be found, despite strong anthropogenic damages. There are large-area constructions of every type (sheet-pile retaining walls, gangways, docks, etc.) and also flat, herbaceous bays and reed areas, which fish use as spawning areas and the brood as shelter during growth. There are also regular restockings with eel, pike, and wels.

The barbel was once widely-distributed and the characteristic fish of this flowing water region. The use of dammed-up bodies of water led to its extinction in the middle of the century in spite of diverse habitat conditions. Euryöke fish prevail today.

Havel bodies of water are first class navigation waters which are used for shipping. They are also used by commercial and sport fishers and heavily frequented by water sport and recreational visitors.

There are also river lakes along the **Spree** and **Dahme**. Langer See, Zeuthener See and Große Krampe are located along the course of the Dahme. Seddinsee is supplied with Spree water by way of the Gosener Canal. The Spree flows through all other investigated bodies of water (Rummelsburger See, Großer and Kleiner Wannsee, Dämeritzsee, and Die Bänke). These latter lakes together comprise an area of 952 ha. They range from the 15,8 ha Kleiner Müggelsee to the 770 ha Großer Müggelsee.

A total of 27 species of fish were detected, 13 of them Red Data Book Species. Three of them, bitterling, weatherfish, and burbot, are threatened in Berlin with extinction.

Eleven (Rummelsburger See) to 22 (Seddinsee) species were found in individual bodies of water. It is very probable that other small fish species exist in the Dahme lakes and will be documented, but the relative impoverishment of species in Rummelsburger See can be traced to strong anthropogenic effects. The increasing pollution of the urban Spree is responsible for this lack of more critical species of fish, and the unnatural structural condition of the shoreline, which is detrimental for fish. Rummelsburger See is almost completely closed with retaining walls, mostly of steel. This leads to a further lack of higher water plants and an extremely monotonous shore structure. It can be assumed that the lake serves the existing species solely as a feeding or retreat area.

River lakes located more to the east at the edge of the city demonstrate diverse habitats. Long zones of floating aquatic plants (Die Bänke) and even larger, non-built-up, natural shores exist (south and west shore of Großer Müggelsee), as well as relatively long belts of reeds (east shore of Seddinsee).

These bodies of water are used like the Havel lakes, but the impact of sport boats is clearly smaller. The Dahme is strongly frequented by river navigation (the Spree-Oder-River navigation channel).

Lakes

This group is defined as still bodies of water without currents, with an area usually more than one ha. These lakes are differentiated between natural lakes, resulting from the Weichselian ice age, and manmade lakes; excavations, sand pits, clay or peat removals, etc.

Natural Lakes

Thirty of the sampled lakes were classified in this category. Their sizes range from the 1.2 ha Möwensee to the 70 ha Groß Glienicker See. A total of 30 fish species were verified in them. The number of species in individual lakes varied from 1 in Schwarzwassersee to 23 in Heiligensee. All the endangered species of fish in Berlin were found there, except for burbot and spined loach. The appearance of dace and chub, as rheoic species (flowing water), in Heiligensee must be characterized as atypical.

The flat, polytrophic **Bogensee** in Bucher forest has a long belt of reeds. Sewage farms operated around the lake until the mid-80's. They led to strong nutrient impacts which resulted in mud sedimentation of the

lake. Oxygen levels in summer often reach a critical value for fish, resulting in fish-kills, as in the summer of '92. There is a pipeline connection from the south shore of the lake to Bucher Teichen. The lake appears very natural. It has been provisionally secured as a nature reserve. Four species of fish were verified. One of them, the three-spined stickleback, is endangered in Berlin.

The Grunewald, Hundekehle, Nikolas, Schlachtensee, and Krumme Lanke lakes are part of the **Große Grunewaldseenkette** (Greater Grunewald chain of lakes). They are located in a side channel of the Havel lakes, created by post-glacial meltwater. Almost the entire length of the long, stretched-out shores are lined with trees. The small bodies of water have only a few, small reed beds, with the exception of Nikolassee, which has a long, herbaceous shallow water area with reed beds. Fish which spawn in herbaceous areas find insufficient conditions for reproduction. Plantings of reed beds might help, as has been practiced since 1991 along sections of shore at Schlachtensee lake. Further protective and preservative measures include removal of sludge and mud (Hundekehle and Grunewald lakes), and introduction of de-phosphorized water to sink nutrient levels and maintain water levels.

A total of 19 fish species were surveyed in these lakes. Seven of them belong to species endangered in Berlin. The number of species in individual lakes ranges between 11 and 14. Bitterlings were only captured in Nikolassee, and asp only in Krumme Lanke. The asp is not a typical still water (lentic) fish and most probably entered the lake in restocking programs. Its long-term viability seems at least questionable. Regular restocking measures are conducted to maintain fish stock levels of species interesting for fishers, such as eel, pike, tench, zander and wels.

The **Groß-Glienicker See** (Greater Glienicke Lake) is the largest Berlin lake with an area of 70 ha. It is a stratified, eurotrophic to hypertrophic lake, whose outflow is temporarily connected to Sacrower See. This would theoretically provide at least temporary possibilities for fish migrations. There are no submerged macrophytes. The lake deepwater is without oxygen in summer, fish-toxic hydrogen-sulfides form. That prevents the bodies of water bottom (profundal zone) from being used by fish as a feeding area.

The Berlin portion of the lake is commercially fished by its owners. Restocking measures are mainly pike, tench, carp and eel.

A total of 10 fish species were verified by fishing samples, three of them endangered. Species verified in 1948 could no longer be found, such as bleak, spined loach and wels. Bleak and spined loach are native to Sacrower See, so their presence, even temporary, would be possible in Groß Glienicker Lake. It remains to be seen how the bodies of water ecosystem reacts to the chemical dephosphorizing begun in December 1992. The expected increase in water transparency could support a populating of underwater plants and thus to an increased structural diversity of the lake.

Heiligensee is connected to the upper Havel by a lock outlet. This minimizes water exchange to the extent that Heiligensee cannot be considered part of the river-lakes. The north shore is very near-natural, with reeds and is a spawning protection area. The remaining shoreline has grass or is stabilized with planks. Heiligensee is used for recreational fishing.

The link to the upper Havel makes Heiligensee one of the richest in fish species. A total of 23 species were verified here, including dace and chub. Ten are endangered species in Berlin. It should be noted that dace and chub are fish fauna of the upper Havel. As pure river fish, their presence in the lake is not typical and is limited to the lock outlet area. It would thus be expected that ide and burbot would be at least sometimes present. This supposition could not be verified by captures.

The long **Hermsdorfer See** is the northernmost lake in Berlin. It is fed by Tegeler Fließ. But this flow is too small to class it as a river lake. Its shore vegetation has a variety of structures: there are reed areas, and other with bushes and trees. There are flat, herbaceous areas in the water which serve fish and their broods use as spawning areas and shelter. The bodies of water bottom is muddy.

The lake was verified to have 14 species of fish, four of them endangered. The presence of other, small fish species is very probable, especially endangered species.

The **Kleine Grunewaldseenkette** (Lesser Grunewald chain of lakes) includes Herthasee, Halensee, Dianasee, Hubertussee, and Koenigsee lakes. Like the lakes of the Greater Grunewald lake chain, they are located in a side channel of the Havel lakes, formed by meltwater in the post-glacial period. Their shores are filled with bushes and trees, and sometimes with wooden fascine works. All areas also have flat, herbaceous areas and reed growths. The shores are accessible to the public only at a few locations, for they are mainly private property. They are used for recreational fishing, like most Berlin lakes, and as such are regularly restocked. The number of fish species varies between 13 at Herthasee and 15 at

Koenigsee (among others). These differences should not be too heavily weighed, for the lakes are connected with each other. Six species are endangered in Berlin. Of them, the moderlieschen is especially frequently found in these lakes.

Köppchensee is at the northern periphery of Berlin, in Blankenfelde, and eutrophic. It makes a very natural impression. But pollution has probably percolated from the waste disposal site operated until 1967, as well as the massive use of herbicides along the border between the GDR and West Berlin. There was a fish-kill in April and May, 1991. The causes are unknown. The lake was found to contain 12 species of fish, one of them, the spined loach, is very endangered.

Lietzensee is located in the middle of a park in the Charlottenburg borough. The lake consists of two connected basins. The shore of the northern basin is artificially reinforced, or built-up with houses. The southern shore has a few reed beds and trees. The lake has 13 fish species, 4 of them endangered. Almost all the fish come from stocking measures.

The hypertrophic **Malchow See** is in northeast Berlin. It is managed by recreational fishers. Its maximum depth is 1.5m, the water transparency only a few centimeters. The east lake shore is partially lined with thick willow bushes, and there are trees on the north and northwest shoreline. Few water plants grow here due to nutrient inputs from the surrounding area. The western part of the lake is muddied. There are thick mud deposits almost to the surface of the water, 10-20 cm below it. Oxygen loss and the formation of hydrogen-sulfides led repeatedly to fish-kills between 1974 and 1988.

A total of 14 fish species were found, 5 of them endangered in Berlin. The observed drop of gudgeon in the lake is alarming. A lack of spawning substrate is assumed to be the reason. A successful reproduction could only be verified for perch and moderlieschen.

Möwensee is located in the Lange Fenn in the Wedding borough, and it also has trees on the shore. The yearly input of leaves forms a thick layer of mud on the lake bottom. Lack of oxygen and fish-kills in summer result from the decomposition of these organic substances. Such extreme situations are only tolerated by fish who have low oxygen demands. This lake is almost only populated by crucian carp. How long the other verified species, brown bullhead and three-spined stickleback, have lived in the bodies of water could not be determined, nor how their populations are produced.

The hypertrophic **Obersee** in the Hohenschönhausen borough is a park lake. It is a lake poor in structures, except for an island. It is lined by a monotonous concrete bank which offers fish neither shelter nor spawning habitats. The sewer is an additional burden. It discharges mixed waste and rain water overflows during strong rainfalls.

The lake was strongly herbaceous previously, but there are no macrophytes today due to the bank structure and stocking of grass carp in 1986. Nevertheless, 14 species of fish have been verified from 1978 to today, among them 4 endangered species. More than half the fish have been stocked by recreational fishers. Grass carp and carp are regularly stocked, also zander, roach, bream, tench, and, previously, often eels.

Several fish-kills, poor reproduction conditions, and an imbalanced stocking of carp allow larger populations only of crucian carp, gibel carp, tench, and carp to be found today. The decline of gudgeon is alarming. Pike and bream are seldom found. Pike, bream, and zander do not reproduce naturally in this lake because of the lack of spawning refuges.

The eutrophic **Orankesee** is also in a park in the Hohenschönhausen borough which is managed by fishers. The lake shores are reinforced with steel sheet piling and honeycombed concrete plates. It no longer possesses its original, richly-divided structures. The lake still has long water curltop stocks, which afford fish spawning areas and shelter. Another area biologically valuable for fish is the bathing beach at the north shore of the lake. Its sandy sediments also serve as a spawning refuge. The lake is fed by a deep well and is clearly less muddied that the neighboring Obersee. It also has better water quality, in spite of the frequent swimming and recreational users.

Fifteen species of fish have been verified here from 1978 to today, among them bitterling, gudgeon, and moderlieschen. The bitterling is threatened by extinction in Berlin. A total of 6 of the verified autochonic fish species must be viewed as endangered.

Plötzensee in the Wedding borough is used for swimming. Trees line its shores.There are few submerged macrophytes. Ten autochtonic fish species, 3 of them threatened in Berlin, were verified. The capture of a single asp does not indicate that a population of this species exists here. Its presence in a closed still body of water is atypical and is probably due to stocking.

Plötzensee is one of the few bodies of water in Berlin that have not been stocked with non-indigenous fish in the course of fishing management. This circumstance is held to be worth maintaining.

Schwarzensee is located in a hollow in Blankenfelde. Its shores are tree-lined. The northern and southern portions of the lake have flat bays with reeds. Submerged macrophytes were not determined. The lake appears very near-natural and is not used for fishing.

In spite of its near-natural appearance, the lake only accommodates a single (environmentally tolerant) species of fish, the crucian carp. Stocking of liquid manure caused a fish-kill in 1987 and is possibly one cause for the lack of species. The southern part of the lake would be suitable as a spawning area for other fish, including crucian carp and pike. A natural population is not possible, for the lake is isolated and there are no other waters in the vicinity where fish can reproduce naturally.

Steinbergsee has a size of 0.9 ha and is one of Berlin's smallest lakes. It is differentiated from ponds and sinks by inflow from Lübars and Waidmannslust, and outflow to Nordgraben. The shores are thickly lined with trees. It is managed by fishers and is stocked. Stock measures resulted in the verification of 19 fish species, 9 of them endangered. Fish populations seem small, in spite of stocking. The possibility that the lake has regular low levels of oxygen cannot be ruled out, nor that fish may wander here by way of Nordgraben. The gudgeon was the fish most often verified.

Teufelssee in Müggelheim was stocked with fish by the German Angler Association before their management was discontinued. The presently verified 11 fish species are mainly due to that. Their population is relatively small because of repeated fish-kills due to low oxygen levels. The shores are largely lined by alder trees. Their shadowing and leaf inputs led to a muddying of the polytrophic lake. They are also responsible for the lack of water plants. Oxygen deficits occurred during summer stagnation in connection with a lowering of the groundwater table by extractions for drinking water of the Friedrichshagen waterworks.

Teufelssee in Grunewald is located in a nature reserve, but is nevertheless one of Berlin's most frequented lakes. Its shores are lined with trees and some reeds. That gives the lake a multiplicity of structures and it appears near-natural.

A total of 13 species of fish were found in the lake. Five of them are Berlin `Red Data Book Species', including the bitterling, a species threatened by extinction. The population development of the bitterling must be estimated as declining. Mussels are required by bitterlings. Studies would have to determine if sufficient mussel species exist.

The shores of **Waldsee (Hermsdorf)** are not accessible to the public. This lake seems near-natural. Herbaceous areas are suitable habitats for broods and young fish and spawning grounds for fish who require aquatic vegetation. The lake appears very natural and is managed by a recreational fishing club. A total of 12 fish species were found, 5 of them endangered.

Waldsee (Zehlendorf) 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.

Eleven fish species were verified, 3 of them endangered. The moderlieschen is frequent here, as in Waldsee in the Reinickendorf borough. This lake does not have fish stocked by fishers, such as carp and zander. The same is true for fish preferred as bait, like gudgeon and ruffe.

The hypertrophic **Weiße See** (Weißensee) is a park lake managed by recreational fishers. The shoreline of old facines is monotonous and has few structures. Cyprinus 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.

A total of 18 species of fish were verified, 6 endangered. The high number of species is mainly due to management. Carp, tench, eels, pike and zander are regularly stocked. Grass carp, bream, gibel carp, roach, crucian carp, and rainbow trout are stocked irregularly.

Manmade Lakes

This group contains 16 of the sampled lakes. Their areas vary from the 0.5 ha Körner See to the 30 ha Flughafensee (Airport Lake). 26 fish species were verified. Individual lakes had at least 3 (Elsengrundbecken) to a maximum of 19 species (Flughafensee). The high number of species is due to

stocking; mainly of fish preferred by recreational fishers. This is evidenced by the presence of rainbow trout in more than 1/3 of these lakes, zander in 1/2 of them, and pike and carp in 3/4.

The **Arkenberger See** in north Berlin (Blankenfelde) was previously used as a sand pit. The lake, today eutrophic, was created in 1979 in the course of freeway construction and has been managed by recreational fishers since then. A building rubble dump is operated on the west shore. Another source of anthropogenic bodies of water pollution is the extremely heavy swimming use in summer. The shoreline of this artificial lake is poor in structures. Long stretches of submerged macrophytes are worth mentioning. All of the 16 verified fish species, 5 of them endangered in Berlin, are from stocking.

The **BUGA-bodies of water** (federal garden fair) in Neukölln, where the federal garden fair was once held, was created during landscaping of the park. The lake is maintained with water and is relatively low in nutrients and clear. The shore region is landscaped in some areas very naturally, is planted, and accommodates a vegetation of many species. Thick stocks of submerged macrophytes grow in the water.

Although numerous fish species were stocked here, including bitterling, only 7 could be verified. The presence of other species is uncertain; further studies are desirable.

Flughafensee is the deepest lake in Berlin with 30m. It was created as a sand pit for the construction of Tegel airport and is managed today by recreational fishers. There are near-natural shore vegetation at places not frequented by recreational visitors. Some of the reed beds are endangered by lowering of the groundwater table. The herbaceous bays at the southern part of the lake serve fish as spawning areas and the brood as growing shelter. The 19 verified species are mainly due to management.

The **Tiergarten park** has a range of lakes; some of them are connected by trenches. They were constructed and are supplied with water. They are **park lakes** with artificially stabilized shores and landscaped with vegetation. There is a connection to the Spree which is not conducive for fish. Spree river fish cannot use the Tiergarten lakes as alternatives during events such as sewage water releases, or as spawning refuges. These bodies of water were tested by Doering and Ludwig in 1989. They found up to 18 species of fish (in Neuer See). This large number is probably due to stocking. A connection to the Spree River which all species of fish could use would raise the value of these water for Berlin fish fauna.

The **Kaulsdorfer Seen** lakes in the Hellersdorf borough is a very recently created area containing 5 manmade lakes. Butzer See and Habermannsee lakes are the oldest of the group. They were built in 1942 in connection with the construction of the Reichsbahn-Umgehungsbahn (= railroad section) in Wuhlheide. The "Kiessee" gravel-lake was excavated in 1970. Sand excavations have been made at the Elsengrundsee lake since 1980.

The lakes have sandy sediments, except for Elsengrundbecken, where foul sludge from hydrogen-sulfides were determined. Elsengrundsee has been completely fenced by the Tiefbau industrial company that excavates sand here. All the other lakes are managed by fisheries and heavily visited by up to 30,000 recreational users a day in the summer. Recreational use was most responsible for the decline of the previously flourishing reed beds. Only remainders are present today and shores are strongly eroded. A near-natural shore vegetation worth preserving exists in areas where trees or bushes grow and there are no sunning spaces for visitors. Various species of submerged aquatic plants form valuable structural elements in the other lakes, except for Elsengrundbecken.

The Kaulsdorfer Seen lakes accommodate 17 species of fish, 4 of them endangered in Berlin. The highest number of species, 15, was verified in Habermannsee. Natural reproduction of pike was observed in flat, herbaceous areas of large lakes. The pike is primarily maintained by stocking because of the loss of spawning areas. The few remaining spawning areas are particularly deserving of preservation.

The near-natural **Laßzinswiesen** lake in Spandau forest was once a **sand pit.** It has been fenced-off and protected because of its importance for birds. Shore structures have a wide belt of reeds and trees. There are thick stocks of submerged macrophytes in clear water, relatively low in nutrients. Two of the 8 verified species are endangered, pike and gudgeon.

The **"Kiesteich" Spandau** on Spekteweg is used for fishing and recreation. The shoreline has some reeds, bushes and trees. A lowering of the watertable resulted in the drying out of herbaceous areas in the western part. These areas are no longer available as spawning grounds and shelter for broods. The 7 fish species verified are stocked. The types of species are those for recreational fishing.

Ziegeleisee in Hermsdorf is in north Berlin. Its flat, sandy areas on the north and northeast shores are used for swimming and water recreation (Freibad Lübars). Other edge areas have reeds, the shoreline has trees. The water is relatively low in nutrients. Two of the 11 verified species are endangered in Berlin.

Retention Basins

Retention basins are manmade bodies of water. They are constructed as collecting basins for surface waters and are not usually managed by fisheries. The shores are mostly reinforced.

Precipitation water collected in these basins from roofs, courtyards, street and other sealed surface are heavily contaminated with nutrients and pollutants, particularly PCB. The transported and sedimenting matter cannot enter open bodies of water. Rainwater reservoirs contribute to the frequently demanded reduction of nutrient and pollution inputs in surface bodies of water.

Existing fish stocks are often **stunted,** a phenomenon often observed in small bodies of water and retention reservoirs where predators are lacking. The absence of predators leaves nutrients as the limiting factor for population size. Environmentally tolerant and highly-reproductive fish such as roach, bream, crucian carp and others, often react by becoming capable of reproduction at ever smaller sizes.

The **Klötzbecken** is located in the Lübars community. It was built in 1968 in the course of planning an industrial area. The shores are monotonous. Grass exists only above the reinforcements. Submerged macrophytes and other structures that could be used by fish as spawning or shelter areas are lacking. The verified 9 species of fish are stocked by recreational fishers who manage the reservoir. There seems to be no natural reproduction of fish here, except for the three-spined stickleback.

The **rainwater retention basin on Osdorf Straße.** in the Lichterfelde borough is completely fenced-off. The shores are thickly grown with bushes and trees. There are thick stocks of cow lilies in shallow areas. Five fish species were found here, including bitterling. Roaches are stunted. The bitterling were probably stocked shortly before capture. The mussel species required for reproduction are missing.

The 1.8 ha large **Seggeluchbecken** is in the Märkischen Viertel. The shores are artificially stabilized and mostly without vegetation. The verified 11 species are stocked. It seems to be an unsuitable habitat to have so many fish species, because of its small size and lack of structures. That seems to be confirmed by the fact that natural reproduction was observed only by gudgeon and three-spined sticklebacks.

Small Bodies of Water (pools, sinks, ponds, etc.)

Ponds are artificial, dischargable bodies of water. The other bodies of water were usually naturally created as a result of landscape processes in the glacial ages, such as 'dead-ice' lakes, sinks, or resulting from decomposition, such as peat bogs. These bodies of water are differentiated from ponds in that they are not dischargable. Berlin practices no pond economy, which means the ponds are almost never emptied (except for restoration work). It seems legitimate to classify both types of bodies of water together.

No further differentiations of small bodies of water are necessary from a ichthyo-fauna point of view. 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 43 Berlin small bodies of water were verified to accommodate 25 species of fish, 19 of them indigenous. The numbers of species in individual bodies of water ranged from 0 (pond in Volkspark Lübars) to 18 (carp pond in the Charlottenburg borough). The average number of species per small bodies of water was 5.

Many small bodies of water in Berlin have stunted stocks of fish, such as the **Blanke Helle**, located in a crater-like basin in the Schöneberg borough. The shores have grass and few trees. The bottom of this shallow body of water is covered with a thick layer of mud. Moderlieschen and crucian carp were verified. The crucian carp are stunted from lack of nutrients, as often occurs in small bodies of water.

The 3 **Bucher Ponds** are connected and are located in the north of Berlin in the middle of a discontinued sewage farm operated until the mid-80's. It is managed by recreational fishers.

Pond III is completely surrounded by trees, but there are almost none at Pond I, which is mainly populated by large sedges. Pond II is the transition form between I and III. Pond I is clearly less used for recreational fishing than the other two, which are frequently used. This can be recognized in the undisturbed and full vegetation on the shores. Shores of Ponds II and III are trampled and eroded at accessible areas.

Submerged macrophytes are lacking and the bodies of water are all muddied. Severely sunken water levels led to the drying out of the first pond in summer, 1992, and to oxygen deficits in the other two. There are 12 fish species in the Bucher ponds, which are stocked.

The **Eckernpfuhl** pool is in the middle of a park in the Tempelhof borough. Its shore structures are a monotonous, regularly-formed reinforcement. Six species of fish were verified, all euryeco types.

The **Erlengrabenteich** pond is connected to the Upper Havel by a trench. Its shore is grown with reeds and trees, and it makes a near-natural impression. The 11 fish species present are primarily stocked, 3 are endangered. The morphology of this type of small bodies of water makes it unsuitable for fish species like asp, wels and zander. These 3 were verified. Their habitat requirements make a long-term survival in these bodies of water questionable.

The polytropic **Faule See** is in a nature reserve of the same name in the Weißensee borough. Originally without outflow, the area was connected in the previous century with a trench to the Panke bodies of water system. That caused the water level of the pond to sink more than a meter. The pond bottom is strongly muddied. There are oxygen deficits in the summer, resulting in repeated small fish-kills. There once were 10 species resident, but only 2 could be verified.

The shores of the **Hufeisenteiches** pond (Hufeisensiedlung in the Britz neighborhood) are partially stabilized by concrete plates. There is no shore vegetation nor water plants. This bodies of water must be termed as excessively anthropogenic formed and unnatural. Only stunted crucian carp stocks exist in the pond.

The **Karower Teichen** ponds are 4 hypertropic former fish ponds on the grounds of the discontinued Buch sewage farms. They are connected by pipeline. The ponds have some long areas of reeds and seem natural. They were managed by fisheries until 1990 and are presently provisionally secured as nature reserve. They are one of the most important water bird breeding areas in Berlin.

The ponds accommodate 5 fish species which are stocked, except for three-spined sticklebacks. Repeated fish-kills occur during the summer.

The **Karpfenteich Schloß Charlottenburg** (carp pond of Charlottenburg palace) is linked to the Spree river with a trench, but no migration of fish is to be expected, for the gate at the entrance to the Spree is impassable for fish. Eighteen species of fish were verified in these body of water, 6 of them endangered in Berlin.

Bream, white bream and three-spined sticklebacks were observed spawning in the trenches. The worth of these bodies of water for Berlin fish fauna could clearly be increased if the gate was made passable for all fish species. The construction of the Spree river in the inner city areas is monotonous: the Spree would be one important structural element richer, and the fish living in the Spree would be able to use the ponds and trenches as retreat areas and reproduction refuges.

Nine small ponds and kettle-ponds are located in the **Malchower Aue** wetlands, north of the Malchow lake. Shores have wide reed belts or are lined by alder swamp forests. 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, the three-spined and the nine-spined, which are endangered in Berlin, and gibel carp. Pond IX showed roach, tench, crucian carp, and carp, probably stocked by fishers.

The Malchow Aue is deserving of preservation as wetland and as habitat for sticklebacks. It is also important for the reproduction of indigenous amphibian species.

The **Roetepfuhl** pool in Britz is a relatively natural appearing body of water. It has thick stocks of reeds and underwater plants. Five fish species were verified, 3 of them non-indigenous. The pool is significant for fish and as an amphibian spawning body of water.

Completely without fish is the **Rosenthaler Teiche**. These ponds are located west of the Blankenfelder Chaussee avenue. Pond I is on the grounds of the Institute for Special Botany of the Humboldt University. They are fed by Zingergraben. Shores have grass and trees. There are large mud deposits on the bottom of the shallow ponds. Both ponds dry out each year for months at a time, making permanent populations of fish impossible. The thick shore vegetation makes this temporary body of water suitable for amphibian reproduction.

The **Rothepfuhl** pool in Mariendorf is shallow, with hardly any vegetation. The lowering of the groundwater table also sank the water level in the pool continually in recent years. The three verified fish species are stocked.

Surrounded by lawns and some trees, the **Rückertteich** is on the grounds of the Freie Universität Berlin. The bottom is muddied. There are small stocks of reeds on the shore, and submerged macrophytes. Large numbers of goldfish are stocked, and smaller numbers of tench, crucian carp, and gibel carp.

The **Teich im Stadtpark Steglitz** (pond in the Steglitz borough city park) is typical of these small bodies of water. Shoreline edges have bushes and trees, but they are not structurally effective as aquatic habitats for the pond. The contact zone to water, the true shore, is artificially stabilized and monotonous.

Fish stocks are also typical for these small bodies of water. Moderlieschen, crucian carp, and gibel carp were verified. These 3 species are characteristic for pools.

The **Südende** pond is similar to the Steglitz park pond. Here too the shores are mainly reinforced and monotonous. The bushes and trees around the shoreline strip cannot be used by water inhabitants as shelter, spawning, or nutrient areas. The only fish species verified were crucian carp and gibel carp, which could indicate that the pond has suffocated at least once. The capability of these carp to endure anaerobic conditions for short periods in extreme cases often makes them the "sole survivors".

The shore of the **Türkenpfuhl** pool in Mariendorf is lined with bushes and trees. The body of water is heavily polluted with household garbage. Of the 4 verified species of fish, 2 are endangered in Berlin.

Running Waters

This category includes smaller tributaries flowing into the Havel and Spree rivers, the upper streams of the Spree at its entrance into Berlin, and inflows of larger lakes. These 7 bodies of water still show lotic (running water) characteristics of near-natural habitat structures, such as pools, meanders, back currents, turbulences, and different bottom sediments. All of these structures have been eliminated almost everywhere else in these manmade landscapes by water construction measures and projects. The diversity of life found in running waters has also been severely reduced. The strict protection of those running water habitats still existing, and the restoration of destroyed habitats would be a very valuable contribution to the protection of fish species.

Other running waters have had their character changed very strongly, and are burdened by discharges from sewage treatment plants. They are described in the category sewage treatment plant discharges.

The **Fredersdorfer Mühlenfließ** originates in northeast Berlin on the Barnim flat upland. It has a watershed of about 230 km^2. The 27.6 km long river course actually begins after flowing through the Kesselsee, Fangersee, and Bötzsee lakes, to later flow into Müggelsee lake. Its last 3 km runs through the Berlin Köpenick borough.

There are 4 gates. One gate at the Rahnsdorferr Stau prevents the immigration of fish from Müggelsee, and another gate, Wehr Bruchmühle, prevents the migration of fish into Bötzsee lake. The stream is also impaired by drinking water production. The start of operations of well gallery B of the Friedrichshagen waterworks in 1983 causes wide areas of the stream to regularly dry out in summer.

Fredersdorfer Mühlenfließ fish fauna have been surveyed sporadically since the 60's. A total of 19 fish species were verified. Two of them endangered in Berlin, the weatherfish and burbot; one, the spined loach, is very endangered; and 4 others are endangered. All verified species in this water reproduce naturally, except for a seldom allochthone, the zander. In order to secure reproduction and survival, particularly of the fish species named above, it is necessary to maintain the flow of water all-year-round, and to make the existing barriers (gates, overpour edges) passable for fish.

The **Western Abzugsgraben** trench divides over a weir away from the Zitadellengraben and enters the Havel river below the Spandau locks. Directly under the gates is a relatively strong current, and sediments are sand to gravel. Rheophillic (current-loving) lotic (running water) fish find suitable habitats here, such as chub and dace. The bottom is muddied in areas of lower current further upstream. The banks look very near-natural and are lined with trees almost the entire length.

A total of 12 species of fish were verified, 6 of them endangered in Berlin. Havel fish, especially those preferring currents, can use the trench as spawning area.

Canals

Canals are manmade waterways with monotonous, reinforced banks of rock-fill, concrete or steel sheet pilings. They usually have a trapezoid profile. Berlin has more than 100 km of canals, if the canal-like construction 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.

The **Gosener Canal** was completed in 1936 and connect the Dämeritz and Seddinsee lakes. Most of its banks are still rock-fill. The average depth is currently 3m, the width 35m. Construction work to widen the canal has begun, starting from the south bank.

The Gosener Canal is used by recreational fishers. Water plants are seldom found. The probable cause is the continual wave impact produced by ship navigation.

13 species of fish were verified in the canal, 8 of them endangered. Verified small fish use the canal for spawning and/or compensatory migrations. It is to be expected that other fish (like smelt) also use the canal, since they are present in the surrounding lakes.

Canals in the inner-city area, such as the **Landwehr canal** and the **Kupfergraben** trench, are generally even more monotonously constructed than the Gosener canal. The banks are perpendicular and smoothly joined for reasons of space. In contrast to the rock-fill of other canal banks, there is not even usable space for hard substrate spawners, such as ruffe.

A particular problem of inner-city canals is fish-kills resulting from overflows of the mixed sewage and rainwater sewer systems after strong rainfalls (as in the Landwehr canal). The biological decomposition of discharged feces and other organic substances consumes oxygen. This leads to oxygen deficits in further sections and that can result in fish-kills.

Trenches, Amelioration Trenches

This group is composed of small, manmade, mainly straightened running waters. They were mostly used in sewage farms as inflow and outflow trenches, but also for dewatering, such as at the Gosener Wiesen in Köpenick. Their profile is trapezoidal. The discharge trenches of discontinued and still-in-operation sewage farms are usually heavily contaminated with nutrients and pollutants. Pure amelioration trenches (water improvement) used for watering or dewatering are usually only impacted if the surrounding area was, or is, intensively used for agriculture. The discontinuance of sewage farms and the lowering of the water table has dried up many of the trenches located in the previously used Buch sewage farms in the north of Berlin.

The **Grosse Sprintgraben** is a thickly herbaceously overgrown amelioration trench connected to the Lübars pond. Both species of stickleback were verified in it. It can be placed equal to the sewage field trenches in terms of its fishery biologic value and protection. Maintenance measures may be necessary to prevent a total overgrowth of vegetation and the disappearance of this water.

The feeding of mechanically purified Havel river water into the **Kuhlake** enabled the renewed populating of submerged macrophytes such as featherfoil, starwort, and water yarrow. The plant stocks, very thick in some places, promote rudd growth. Natural reproduction of pike takes place here. Although only 8 species of fish were verified, other species are to be expected.

The source of the **Lietzengraben** is in the state of Brandenburg, west of the Schönow village near Bernau. The Lietzengraben dewaters the sewage farms at Hobrechtsfelde, flows west past the Bogen lake chain, and into the Panke at the Karow Teichen. Both stickleback species were verified at different areas, crucian carp and gibel carp as well.

The extremely monotonous, mostly straightened **Prisengraben** dewaters parts of the Hobrechtsfelder sewage farms into the Lietzengraben. Macrophytes and other structural elements are completely missing. No fish were verified.

The **Zingergraben** flows through the Buch sewage farms and enters the discharge flow Stiller Don in the vicinity of Blankenfelder Chaussee. From here it divides away, feeds the Rosenthaler Pond and enters Nordgraben. Its banks are monotonous. The Zingergraben dries up regularly in summer above the Stille Don. It is extremely polluted with domestic waste at the height of Rosenthaler pond. The banks are misused as garbage dumps. This water represents an extreme biotope. It is only populated by dwarf sticklebacks, in shallow waters.

There are many discharge trenches around the discontinued Buch sewage farms, remainders of 100 years of such use. They are dry during the summer today 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 here their last retreat areas. The number of small trenches is continually being reduced. Those remaining must be especially protected. Otherwise the sticklebacks must be classified into a more endangered category. It would mean extinction for the dwarf stickleback.

SewageTreatment Plant Discharges

In order to better discharge the often considerable amounts of purified waste water from large sewage treatment plants (such as Schönerlinde), small streams were straightened to increase their discharge capacities. They were stripped, and their banks reinforced with rock-fill or concrete plates, as at the Neuenhagener Mühlenfließ, Panke, and Wuhle. This construction resulted in monotonous channels detrimental to fish. Their waters are severely contaminated with nitrogen compounds and pollutants.

The **Stille Don** is about 5m wide, a discharge flow of the Nord sewage treatment plant in Schönerlinde. Its cross-section is trapezoidal, the banks reinforced with rock-fill packing. The presence of fish could not be verified. Causes for that could be a lack of migration possibilities from surrounding bodies of water, or temporary waves of waste water toxic to fish. The degree of organic pollution alone is not high enough to account for the lack of fish - euryeco fish species have been verified in comparable bodies of water.

The **Nordgraben** goes away from the Panke north of Heinersdorfer Teiche, courses through northern Berlin and flows into Tegel lake. The trench is very unnatural, with artificial bank reinforcement, a straight-ahead course, and lack of structures. Only three-spined sticklebacks were found, although Nordgraben is theoretically reachable for other species of fish, such as from Steinberg lake.

From its source south of the city of Bernau, the **Panke** courses through north Berlin to finally flow into the Spree river. It was once a popular place to visit, but today only a few original areas and the section in Pankow Bürgerpark recall the original waters. The Panke was straightened at the end of the 60's, transformed into a discharge channel, and its banks were stabilized with non-natural materials. Larger sections of the Panke were piped in the Mitte borough from 1985 to 1987. This now subterranean runoff does not allow fish to climb from the Spree river. The high organic pollution is decomposed and causes oxygen deficits in still water areas.

Both of the stickleback species found here are listed in the Berlin Red Data Book: the three-spined stickleback as endangered, the dwarf stickleback as threatened by extinction.

The **Wuhle** flows on the periphery of the city through the boroughs of Hellersdorf and Marzahn, and flows into the Spree in Schöneweide. It is a mostly straightened, constructed discharge trench with a trapezoidal profile, and mostly banked with rock-fill, with concrete in some areas. The Wuhle is used as a recreational fishing body of water from the reservoir in Biesdorf to its entrance into the Spree.

The Wuhle had relatively many species until the end of the 70's. Between 1984 and 1986 it was impacted so strongly with waste waters from the construction of the new residential areas in Marzahn that repeated fish-kills occurred. The result was a complete lack of fish. The waste water impact is currently somewhat lower. Long stocks of underwater plants can now sometimes be found.

The Wuhle is divided by the Wuhle basin (the dam impossible for fish to cross) into two different fauna areas. A migration of fish from the Spree is possible in the downstream areas. Thirteen species were verified here which represent the species spectrum of the Spree. Upstream of the basin, and within it, there were a total of 10 species - only species primarily stocked by fishers.

Literature

[1] Auhagen, A. 1991:
Vorschlag für eine Präzisierung der Definition der in Roten Listen verwendeten Gefährdungsgrade, in: Auhagen, A., Platen, R., Sukopp, H. (Hrsg.), Rote Listen der gefährdeten Pflanzen und Tiere in Berlin, in: Landschaftsentwicklung und Umweltforschung, Sonderheft 6, S.15 – 23.

[2] Barthelmes et al. 1991:
Fischereibiologische Situationsaufnahme der Spree- und Dahmegewässer unter besonderer Berücksichtigung der Verhältnisse im Großen Müggelsee vor dem Hintergrund geplanter Sanierungsmaßnahmen zur Sicherung der Trinkwasserversorgung Berlins, Gutachten im Auftrag der Senatsverwaltung für Stadtentwicklung und Umweltschutz Berlin, not published.

[3] Bless, R. 1985:
Zur Regeneration von Bächen der Agrarlandschaft – Eine ichthyologische Fallstudie, in: Schriftenreihe für Landschaftspflege und Naturschutz, 26, 80 S.

[4] Bless, R., Lelek, A., Waterstraat, A.:
Rote Liste der Rundmäuler und Fische der Bundesrepublik Deutschland, Entwurf vom 10.7.1992, not published.

[5] von dem Borne, M. 1882:
Die Fischerei-Verhältnisse des Deutschen Reiches, Oesterreich-Ungarns, der Schweiz und Luxemburgs, Hofbuchdruckerei W. Moeser, Berlin, 306 S.

[6] Brehme, S., Geißler, T., Sedlaczek, J. 1992:
Die Rote Liste der Rundmäuler (Cyclostomata) und Fische (Pisces) von Ost-Berlin, RANA, 6, S. 162 – 167.

[7] Buchallick, C., Fleischer, L., Schulze, K. 1992:
Situations- und Konfliktbeschreibung am Fredersdorfer Mühlenfließ 1992, Umschulungsarbeit u.t.b., 58 S., not published.

[8] Burmeister, W. 1985:
Das Fredersdorfer Mühlenfließ – erstes geplantes ichthyologisches und malakologisches Schutzgebiet in Berlin, in: RANA, 3, S. 49 – 53.

[9] Burmeister, W. 1987:
Nachtrag zur Fischfauna des Fredersdorfer Mühlenfließes, in: RANA, 4, S. 97.

[10] Doering, P., Ludwig, J. 1989:
Fischfauna, in: Gewässer im Großen Tiergarten, Maßnahmevorbereitende Untersuchungen – Biotop- und Artenschutz, Gutachten im Auftrag der Senatsverwaltung für Stadtentwicklung und Umweltschutz Berlin, 165 S., not published.

[11] Eckstein, K. 1903:
Die Fischerei-Verhältnisse der Provinz Brandenburg zu Anfang des 20. Jahrhunderts, Verlag von Gebrüder Borntraeger, Berlin, 182 S.

[12] Eckstein, K. 1908:
Die Fischerei-Verhältnisse der Provinz Brandenburg zu Anfang des 20. Jahrhunderts, II. Teil: Die Gewässer der Provinz Brandenburg in alphabetischer Reihe und deren fischereiliche Verhältnisse, Verlag des Fischereivereins für die Provinz Brandenburg, 275 S.

[13] Fredrich, F., Wolter, Ch. (in print):
Ichthyoökologische Untersuchung des Fredersdorfer Mühlenfließes.

[14] Grosch, U. A. 1979:
Die Fischfauna in Berlin (West) am Ende der siebziger Jahre. Rückblick – Status – Prognose – Restitutionsmöglichkeiten, in: Berliner Naturschutzblätter, 23. Jg., 68, S. 530 – 536.

[15] Grosch, U. A. 1980:
Die Fischfauna in Berlin (West) am Ende der siebziger Jahre. Rückblick – Status – Prognose – Restitutionsmöglichkeiten, Fortsetzung und Schluß, in: Berliner Naturschutzblätter, 24. Jg., 69, S. 560 – 565.

[16] Grosch, U. A., Buchin, H.-E., Kroezus, E. 1974:
Über die Fischerei auf der Berliner Havel und die Arbeiten des Fischereiamts, in: Der Fischwirt, 24. Jg., 9, S. 49 – 52.

[17] Grosch, U. A., Elvers, H. 1982:
Die Rote Liste der gefährdeten Rundmäuler (Cyclostomata) und Fische (Pisces) von Berlin (West), in: Landschaftsentwicklung und Umweltforschung, 11, S. 197 – 209.

[18] Jörgensen, L. 1989:
Fischereibiologische Analyse der Kleinen Grunewaldseen in Berlin (West) im Rahmen des Bewirtschaftungsplanes vom 14.12.1987, Projektabschlußbericht, 242 S., not published.

[19] Kloos, R. 1981:
Die Verkehrswasserwirtschaft in Berlin, Hrsg.: Der Senator für Bau- und Wohnungswesen Berlin, Berlin, 48 S.

[20] Körner, S. 1992:
Vergleich zweier unterschiedlich belasteter und genutzter Fließgewässer hinsichtlich ihrer naturräumlichen Ausstattung und ihres Selbstreinigungsvermögens am Beispiel der Wuhle und des Fredersdorfer Mühlenfließes, Diplomarbeit an der Humboldt-Universität Berlin, not published.

[21] Lehmann, C. 1925:
Die Verunreinigung der Spree und Havel durch die Abwässer Groß-Berlins nebst einem Überblick über die fischereilichen Verhältnisse, in: Zeitschrift für Fischerei, 23, S. 523 – 548.

[22] SenStadtUm (Der Senator für Stadtentwicklung und Umweltschutz Berlin) (Hrsg.) 1985:
Umweltatlas Berlin, Bd. 1, Karte 02.08 Fischfauna – Verbreitung, Umweltansprüche und Gefährdung, 1:50 000, Berlin.

[23] SenStadtUm (Der Senator für Stadtentwicklung und Umweltschutz Berlin) (Hrsg.) 1988a:
Bewirtschaftungsplan für die Kleine Grunewaldseenkette, in: Umwelt- und Naturschutz für Berliner Gewässer, 4, Berlin, 30 S.

[24] SenStadtUm (Der Senator für Stadtentwicklung und Umweltschutz Berlin) (Hrsg.) 1988b:
Bewirtschaftungsplan für die Große Grunewaldseenkette, in: Umwelt- und Naturschutz für Berliner Gewässer, 5, Berlin, 31 S.

[25] Thienemann, A. 1925:
Die Süßwasserfische Deutschlands – Eine tiergeographische Skizze, in: Demoll, R., Maier, H.N. (Hrsg.), Handbuch der Binnenfischerei Mitteleuropas, Bd. III A, Stuttgart, 1941, S. 1 – 32.

[26] Vilcinskas, A. 1991a:
Rote Liste der gefährdeten Fische und Rundmäuler (Osteichthyes et Cyclostomata) von Berlin (West), in: Auhagen, A., Platen, R., Sukopp, H. (Hrsg.), Rote Listen der gefährdeten Pflanzen und Tiere in Berlin, in: Landschaftsentwicklung und Umweltforschung, Sonderheft 6, S. 157 – 167.

[27] Vilcinskas, A. 1991b:
Fischereibiologische Bestandsaufnahmen und Bewertungen im Malchower See und in den Gewässern der Malchower Aue, Gutachten im Auftrag des Planungsbüros von Prof. Tröger, not published.

[28] Vilcinskas, A., Wolter, Ch. 1992a:
Erfassung und Bewertung der Fischfauna in den Gewässern der ehemaligen Rieselfelder im Bereich des Forstamtes Buch einschließlich Rückstandsuntersuchungen an Fischen, Gutachten im Auftrag der Berliner Forsten – Landesforstamt, not published.

[29] Vilcinskas, A., Wolter, Ch. 1992b:
Erfassung und Bewertung der Fischbestände in den Kaulsdorfer Seen, Gutachten im Auftrag des Bezirksamtes Hellersdorf, not published.

[30] Wolter, Ch. 1991:
Untersuchungen zum Problem der fischereilichen Bestandsschätzung mit einem Echolot in Binnengewässern, Forschungsbericht Institut für Binnenfischerei, not published.

[31] Wolter, Ch., Vilcinskas, A., Geißler, T. (in preparation):
Berliner Rote Liste der gefährdeten Rundmäuler (Cyclostomata) und Fische (Pisces).