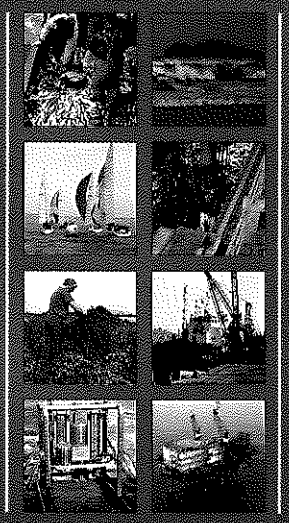
FISH KILLS IN IRELAND IN 1994 AND 1995

by

CHRISTOPHER MORIARTY

Fisheries Research Centre, Abbotstown, Dublin 15



MARINE INSTITUTE
FORAS NA MARA
Ireland

ISSN 0332-1789

Fishery Leaflet 169 *May 1996*

The Marine Institute Dublin 2

FISH KILLS IN IRELAND IN 1994 AND 1995

by

CHRISTOPHER MORIARTY

Fisheries Research Centre, Abbotstown, Dublin 15

Summary

In 1994, the downward trend in numbers of fish kills continued, the total for the year being 32. However, in 1995 a long spell of dry weather greatly reduced the flow in rivers in all parts of Ireland and the number of fish kills rose to 84, the highest since 1989.

In 1994, farmyard effluents, silage and slurry together accounted for one third of the fish kills. Industrial effluents and enrichment both caused 19% of the total. Storm water runoff and cement spillage in building operations were the other identified causes. In 1995, enrichment was the most frequent problem, followed by agriculture. Inadequately treated sewage was implicated in five cases and waterworks effluent in two. In 17 cases the mortalities were associated with reduced water flows or high temperatures or a combination of the two.

The dry summer in a number of cases revealed unsatisfactory levels of pollution which are usually masked by higher water flows such as occurred in 1994. The increase in farm-based problems suggested that some of the improved facilities for storage and treatment of farm waste which were made in the late 1980s may now be due for maintenance.

Enrichment of lake systems, particularly those of the Erne and Shannon, has now established itself as the most serious threat to the condition of natural waters. Fish kills are an early warning of a situation which may develop and have far-reaching effects on economic interests far removed from the fishery itself.

Introduction

The leaflets in this series give a summary of reports on fish kills, most of which have been provided by the Environment Officers of the seven Regional Fisheries Boards, together with complementary reports from officials of local authorities. The fish kills listed are those which are presumed to be caused by pollution. Reports of dead fish which can clearly be ascribed to disease or illegal fishing are not included.

Both numbers of fish and length of stream affected are usually approximations. It is rarely possible to account for all fish killed in any incident because many sink to the bottom and cannot be counted. Similarly, the length of the stream in which fish died is difficult to measure with certainty because dead fish can be carried downstream beyond the limits of the polluted water.

Major incidents

The most serious incident in 1994 was in the River Lung near Ballaghadereen on 16th June. An estimated 10,000 bream and roach were killed in a 5 km reach by organic waste from an unknown source. Other major kills, in which 1,000 or more fish died, all affected trout and young salmon and resulted from a variety of causes: farm effluent in two cases, a chemical spillage and a discharge from a sewage treatment works. The effects of the chemical spillage extended over more than 6 km of the Ara River, Co. Tipperary. The major farm effluent incidents were in the Farneybridge river, extending for 8 km and the Finglasha River over 3 km. Details are given in Table 1.

In 1995, although the number of incidents was high, major kills in the rivers were relatively few, with four involving 1,000 or more fish. The greatest number was 4,000, killed by slurry in the Shournagh River. Slurry was implicated again in the River Erne. The other two major kills resulted from low water. Four serious incidents took place in lakes, one in the Shannon and three in the Erne lakes Oughter, Gowna and the Inner Lake at Cootehill. All have been ascribed to enrichment of the water.

Distribution and dates

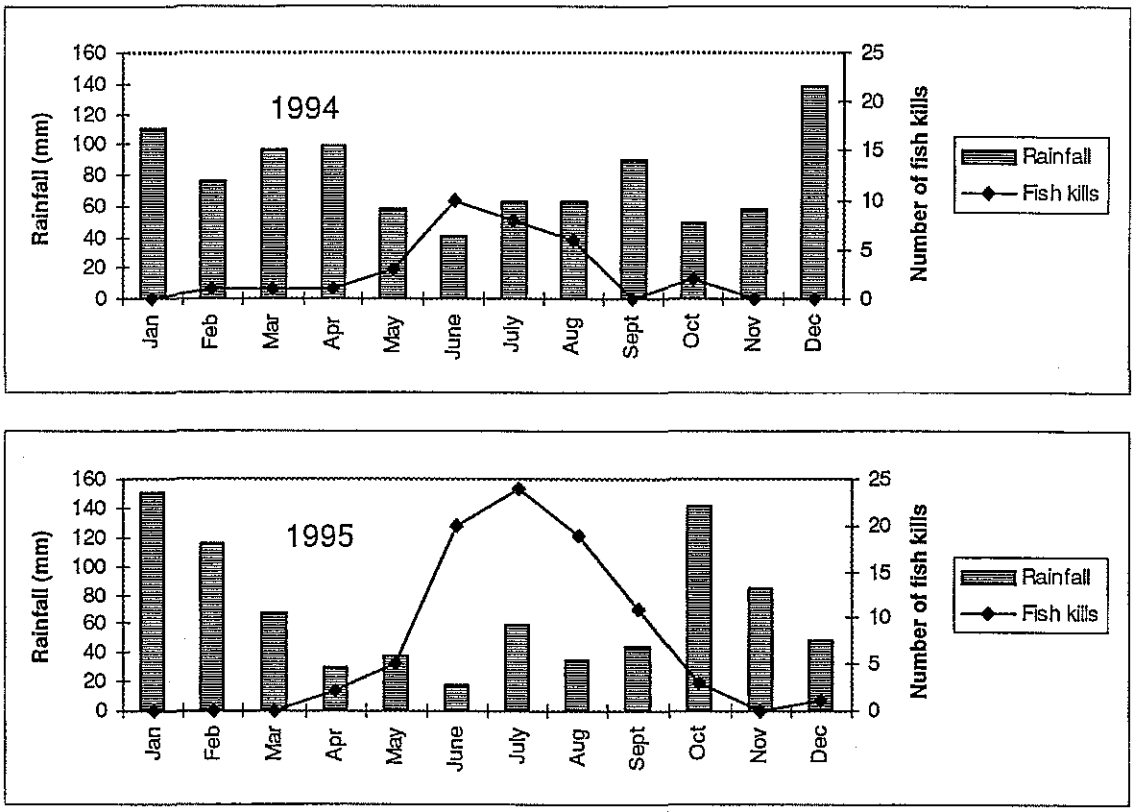
The Southern and Northern Regions were the most seriously affected in 1994, but both were below the average for the 13 year period. The numbers of kills remained low until summer, with only one in each of the months February, March and April and 3 in May. The peak month was June with 10 incidents, after which the numbers fell off again through July and August, with none in September. Most of the July incidents were in the Northern Region but in the other months fish kills were distributed throughout the country. Rainfall was relatively high throughout the summer and water levels were higher than usual.

The total length of stream affected was 49 km, more than double the figure for 1993, although the numbers of fish kills were almost equal. In 1993 a much higher proportion of the kills took place in lakes so that a smaller number of incidents were in

flowing water. The average length of stream affected, however, was 35% higher than in 1993 (Table 2).

At the end of April 1995, only two fish kills had been reported, followed by 5 in May. Rainfall in April, May and June was well below average and stream flow had been greatly reduced. July rainfall was realatively low and August and September were very dry. June and July both recorded the highest numbers of fish kills since 1989 and August the highest since 1983 when systematic recording began.

Figure 1. Rainfall at Birr and total monthly frequency of fish kills



The Eastern, Southern, Southwestern and Shannon Regions all had their highest numbers of incidents since 1989. The Western Region was the only one with a figure below average. Northwestern was double the average and the Northern Region had its highest number of incidents in the 13 year period, equal to that of 1987, the worst year on record.

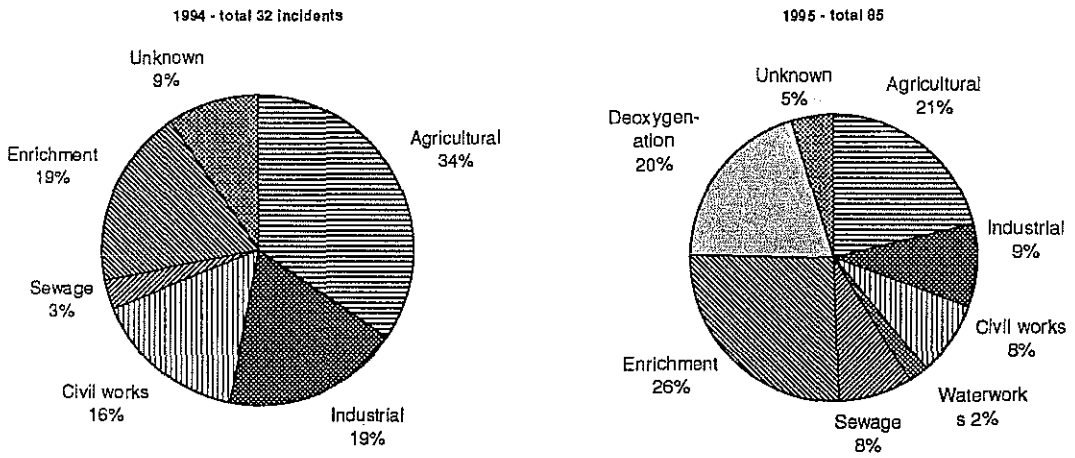
The stream length affected was twice as high as in 1994, totalling 102 km. In the Northwestern Region, thre were four incidents and mortality extended over more than 3 km in each, explaining the exceptionally high average.

Causes

Eutrophication has remained the most serious problem. Other forms of farm-based pollution increased sharply from the minimum they had reached in the previous year. Silage, however, which had been one of the most serious problems in the 1980s, was

implicated only twice in 1984. The most serious problem was of run-off from farmyards. The greatest number of point-source problems in 1995 were also agriculture-based. Silage showed a serious increase, accounting for half the incidents. Slurry came next with a total of 5.

Figure 2. Frequencies of principal categories of causes of fish kills.



In 1994 there were two kills resulting from faulty sewage treatment works and two from cement spillage. The numbers resulting from other causes remained low with no particular change from previous years.

This pattern changed in 1995 with the low water conditions. Deoxygenation came next to agriculture in the number of fish kills caused. The heading is used to cover a variety of causes, all associated with low water. In some cases, high temperature was considered the primary cause of death. In others, oxygen reduction resulted from dense weed growth which takes up too much oxygen at night. A total of 17 kills resulted from one or other of these. Sewage was implicated in 7 cases, the highest score since 1989. Accidental spills from factories, from swimming-pool and waterworks flushing and from gravel digging all caused small numbers of fish kills. Such accidents often result from a lack of awareness of the risks to fish life involved and can be eliminated with greater care.

Rainfall and temperature

The graphs in Figure 1 show dramatically the effect of prolonged summer drought on the number of fish kills. High rainfall in summer is usually associated with cold weather and low water temperatures and adequate dilution of effluents in streams. A dry summer is almost invariably one of low flows and high temperature adds greatly to the stress experienced by fish. Trout and salmon, above all, thrive in cold water. In fine weather, bright sun increases the temperature and the effect is exacerbated because the streams are flowing slowly and are not being cooled by rain or by the usual supply of ground water. Oxygen is less soluble in warm water than in cold and therefore a number of natural factors combine to make life very difficult for the fish. In some cases, the only cause of death appeared to be de-oxygenation or high temperature or both.

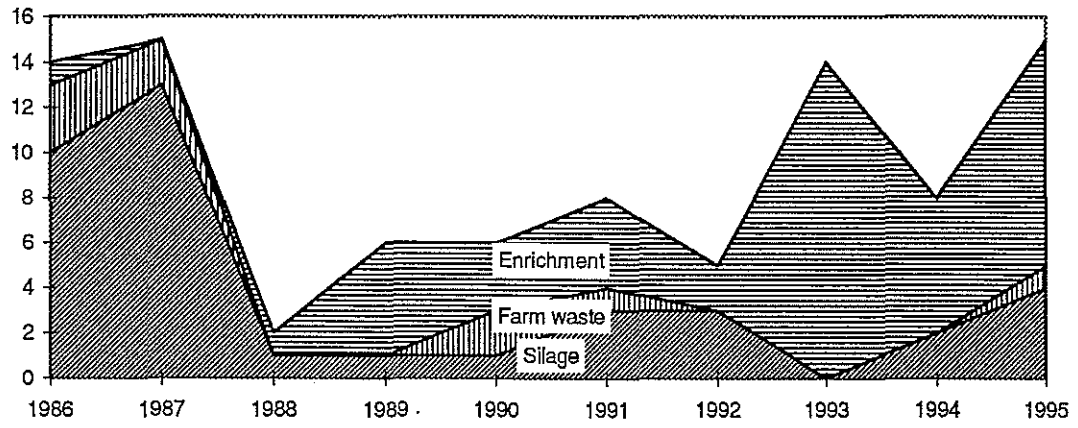
This goes some way towards explaining the sudden rise in the numbers of fish kills in 1995. From the point of view of environmental protection, the essential fact is that a level of pollution which might pass un-noticed in wet weather will result in fish kills in a hot summer. Hot summers cannot be predicted in advance and therefore effluent control must be rigidly enforced at all times.

Eutrophication

Enrichment of lake waters, from phosphates leached from farm land, continued to be a serious cause of problems and was the most frequently implicated. The evidence for eutrophication remains circumstantial because the situation is extremely complex. The phosphates themselves do not make the water unsuitable for fish life. The problem comes from a combination of factors. The availability of nutrients is a key factor in controlling the growth of green and blue-green microscopic algae. Sunlight, temperature and wind are additional factors. In cold, cloudy conditions the algae are unable to multiply as freely as in bright weather when the water is warmer. An exceptionally hot and dry summer, like that of 1995, provides ideal conditions for an excessive bloom of algae. Strong winds help to circulate lake water, dispersing the algal blooms and mixing any toxic products so that they are greatly diluted.

In some cases of algal blooms, the oxygen level in the water is reduced partly by the living algae at night, when they are not releasing oxygen by photosynthesis, and partly by the decay of dead algal cells. In others, the algae release toxins into the water. Occasionally these kill dogs and cause skin irritation on bathers, besides harming fish. However, in many cases, there is no obvious cause-and-effect: daytime oxygen levels are found to be close to normal and no toxins can be detected. The fish often show signs of disease. However, stress caused by deterioration of the water quality is enough to causes large numbers of fish, already weakened, to succumb to diseases caused by bacteria and parasites which are normally present in the water, but which do not affect un-stressed fish populations.

Figure 3. Numbers of agriculture-based fish kills in the Northern Region.



The strongest argument in implicating 'enrichment' as the cause of fish kills is the fact that, in the course of the past twenty to thirty years, the phosphate content of the large

lowland lakes has increased, algal blooms have become more frequent and the numbers of fish kills in lakes have increased to an alarming degree. Changes in the nature of agriculture-based fish kills in the Northern Region, nearly all of which relate to the lakes of County Cavan, are shown in Figure 3. Point-source problems diminished rapidly after 1987 but have been gradually replaced by those caused by enrichment.

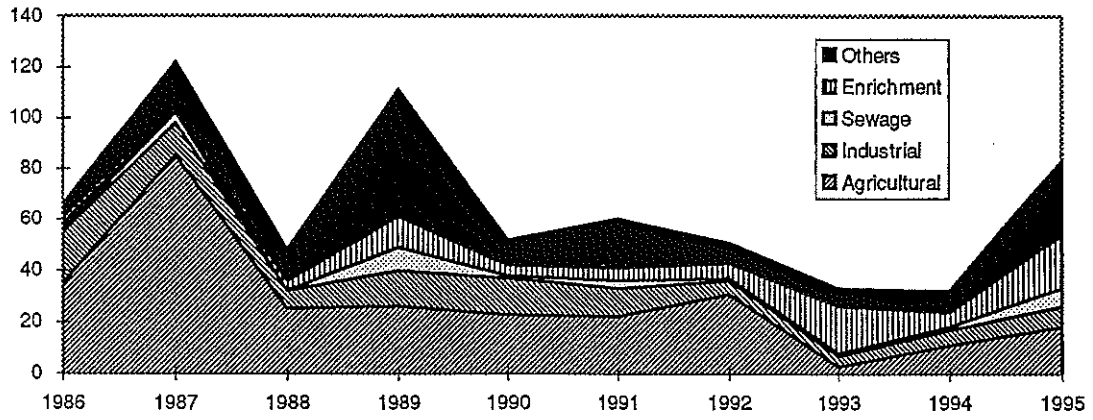
Recent trends and their significance

The very high number of fish kills in 1987 led to many important steps being taken to reduce the problems of water pollution. Farm wastes and silage, in particular, were contained much more effectively than in the past. Apart from one blip in 1989, associated with a hot, dry summer, a very satisfactory downward trend in the numbers of fish kills was apparent (Figure 4). The sharp rise in 1995 was an important reminder that the problems of pollution have not yet been solved. The low water conditions in many cases revealed how damaging low levels of pollution can be under certain conditions. They drew attention to sewage treatment plants which were not working efficiently and also served as a reminder of the damage that can be caused to fisheries by inadequate control of flushing from swimming pools and water treatment works and greater care is called for in tshi area. The most encouraging point here, however, is that most of the problems have not increased seriously over the years.

Farm-based problems, however, have increased steadily since 1993 and may need to be given serious attention on the scale they received in 1987 if this trend is to be stopped. It seems possible that facilities which had been improved seven or eight years ago may be falling into neglect again.

Enrichment of lakes and, to a less obvious extent, of rivers remains the most serious problem. Table 2 shows the extent to which fish kills in lakes have increased in numbers since the 1980s. This trend became very noticeable in 1993 when the total of 15 incidents in the Northern Region was four times the average of the preceding years. This trend was also apparent in the Shannon lakes in which there were 6 kills in the four years 1986 to 1989 and 10 in 1992 to 1995. The problem abated in 1994 but was serious again in 1995.

Figure 4. Numbers and causes of fish kills in all regions.



The argument that the lethal effects of excessive phosphate have not always been clearly demonstrated is too dangerous to be maintained. Sub-lethal effects are plainly evident while routine chemical analyses over many years have demonstrated the increasing phosphate loading. The pattern of fish mortality, coinciding with the rise in phosphate in solution and frequent algal blooms, points very strongly to eutrophication being the cause of the problems.

If the numbers of fish kills in the Erne and Shannon lakes continue to increase, the stocks may become seriously depleted with a consequent reduction in income from angling tourism. Even though the stocks themselves may not yet be under severe threat, the frequent appearance of dead, dying or distressed fish in popular angling waters presents a very serious negative image not only to anglers, but to all industries which are enhanced by Ireland's justifiable reputation as an unpolluted environment. The increasing mortalities of coarse fish must be taken as a clear early warning of environmental degradation which, if not addressed, will have consequences far beyond the welfare of the fishing industry.

Acknowledgements

This leaflet is a summary of reports supplied by the Environmental Officersof the seven Regional Fisheries Boards. A number of additional reports have been made by County Council officials. The help of Trevor Champ, Central Fisheries Board and of officers involved and their advice on the presentation of this report is gratefully acknowledged.

Previous reports

Edward Fahy	Leaflets *128* and *132*	(1983 - 1985)
Desmond McCarthy	*141* and *143*	(1986 - 1988 and summary 1969-87)
Christopher Moriarty	*146, 149, 157, 159*	(1989 - 1993)

Table 1. Summary of 32 fish kills reported in 1994. Estimates of numbers in lakes are given by : *** more than 10,000, ** between 1,000 and 10,000, * less than 1,000. Exact values where given indicate numbers of dead fish visible and are usually underestimates. 'Enrichment' indicates mortality in phosphate-rich lakes where no other cause is apparent.

	River/Lake	*Location*	*Stream length (m)*	*Species*	*Numbers*	*Cause*
Eastern Region (3)						
14 Jun	Blackwater	Monaghan town H6534	1,500	Trout	100	Industrial
17 Jun	Ballyvoleen	Glynn T9725	3,000	Trout	150	Crop spraying
5 Aug	Killary	Lobinstown N8882	300	Trout	50	Farm effluent
Southern Region (9)						
11 May	Gradoge	Mitchelstown R8312	2,000	Trout	50	Farm effluent
7 Jun	Acore	Gowran S6656	1,500	Trout	50	Farm effluent
15 Jun	Ara	Tipperary R8835	1,000	Trout, eel, loach	300	Industrial
2 Jul	Mill Stream	Inistioge S6337	350	Trout, lamprey	250	Cement spillage
6 Jul	Suir	Knockageragh S1371	800	Trout	150	Farm effluent
24 Jul	Ara	Lattin R8135	6,500	Trout, eel, loach, stickleback	1,000	Chemical spillag
3 Aug	Clashawley	Fethard S2134	1,000	Trout	1,000	Sewage treatme
5 Aug	Farneybridge	Farney Bridge S0859	8,000	Trout	1,000	Farm effluent
9 Aug	Trib of Clodiagh	Drumbane S0256	2,000	Trout	15	Unknown
Southwestern Region (2)						
15 Mar	Mall Stream	Dingle Q4502	1,000	Trout	100	Unknown
14 Apr	Keel	Carriganimmy W2883	2,000	Trout	500	Slurry
Shannon Region (5)						
17 May	Broadford	Broadford R3122	4,000	Trout	30	Farm effluent
26	Finglasha	Feohanagh R3627	3,000	Salmon fry, trout (50)	4,000	Farm effluent
12 Jun	Abbey	Limerick R5857	1,000	Flounder	500	Sewage
16 Jun	Lung	Ballaghadereen M6495	5,000	Bream, roach	10,000	Organic waste
16 Jun	Deel	Maghoona R3132	200	Trout	17	Factory effluent
Western Region (3)						
14 Feb	Erriff	Srahlea Bridge L9770	100	Salmon	200	Bridge grouting
28 Jun	Loughrea outflow	Loughrea M6216	50	Trout	100	Storm water
29 Jun	Westport House L.	Westport L9984	lake	Trout	*	Storm water
Northwestern Region (1)						
20 Oct	Carnay	Milltown G4368	2,000	Trout	100	Chemical spillag
Northern Region (9)						
7 Jun	Laragh (trib.)	Stradone H5006	1,000	Trout, roach, perch	20	Silage
21 Jul	Annaghmakerrig L.	Annaghmakerrig H5821	lake	Perch	*	Enrichment
21 Jul	Sillan L.	Shercock H6808	lake	Perch	*	Enrichment
21 Jul	Oughter L.	Cavan H3506	lake	Perch, roach	**	Enrichment
21 Jul	Garadice L.	Ballinamore H2012	lake	Perch, roach	*	Enrichment
27 Jul	Owenboy	Drumfree C3838	2,000	Trout	800	Silage
2 Aug	Larey L.	Stradone H5102	lake	Perch, roach	**	Enrichment
8 Aug	Killyvaghan L.	Rockorry	lake	Perch, roach	*	Enrichment
17 Oct	Sruhansheskinone	L Meelagh B7513	40	Trout	80	Leachate from l

Table 1 (continued) Summary of 84 fish kills recorded in 1995

	River/Lake	Location	Stream length (m)	Species	Numbers	Cause
Eastern Region (14)						
25 May	Blackwater	Milltown Bridge H6635	300	Trout	24	Industrial
16 Jun	Blackwater	Monaghan H6835	800	Trout, loach, stickleback	20	Deoxygenation
17	Little Boyne	Edenderry N6232	500	Trout	28	Sewage
23	Glyde (tributary)	Magheracloone N8001	8,000	Trout, salmon, loach, eel, s'back	500	Silage
10 Jul	Moynalty L	Carrickmacross H8603		Bream	19	Unknown
19	Trimblestown	Trim N7557	2,000	Trout	200	Fungicide
19	Mountain Water	Glaslough H7241	600	Trout, gudgeon, loach	50	Sewage
1 Aug	Derry	Donadea N8133	500	Trout	25	Farm effluent
9	Barora	Mullagh N7186	1,000	Trout, salmon, minnow	100	Industrial
9	Clody	Bunclody S9056	60	Salmon	30	Industrial
10	Slaney	Ferrycarrig T 0122	2,000	Eel, flounder	1,000	Deoxygenation
19	Dee	Ardee N9591	1,000	Trout	70	Deoxygenation
1 Sep	Grifeen	Lucan O0335	1,000	Eel, stickleback	200	Sewage
6	Peter's Lake	Monagahn H6733		Roach, pike, eel, tench	20	Deoxygenation
Southern Region (21)						
24 May	Suir	Penane Bridge S1269	500	Trout	50	Enrichment
4 Jun	Triogue	Portlaoise S4798	2,000	Trout, stickleback	200	Enrichment
5	Awbeg	Castlecor R4606	3,000	Trout, salmon	200	Silage
21	Triogue	Mountmellick N4707	2,000	Trout	50	Enrichment
29	Blackw./Owenea	Mountmellick N4305	3,000	Trout, minnow	300	Deoxygenation
29	Erkina	Rathdowney S2978	1,000	Trout	40	Enrichment
1 Jul	Pococke	Kilkenny S5257	500	Trout	40	Deoxygenation
1	Ara	Cordangan R9033	1,000	Trout	150	Enrichment
11	Camcor	Birr N0504	100	Trout, loach, stickleback	16	Swimming pool
12	Suir	Thurles S1258	1,000	Trout, loach, perch	300	Sewage
14	Clashawley	Fethard S2134	900	Trout	254	Sewage
16	Dinin	Castlecomer S5373	100	Trout	15	Farm effluent
19	Triogue	Portlaoise S4798	200	Trout	3	Industrial
26	Suir	Ardfinnan S0817	100	Trout	40	Storm sewer
31	Trib. Bannow Bay	Fethard-on-Sea S7801	1,000	Mullet, eel	300	Temperature
2 Aug	Trib. Clashawley	Moyglass S1642	1,500	Trout, stickleback, loach	70	Tanker discharge
26	Suir	Glen Castle S3123	3,500	Salmon	51	
30	King's	Ballingarry S3144	1,000	Trout, minnow	1,000	Stream dry
27 Sep	Womanagh	Ladysbridge W9872	1000	Trout, Stickleback, eel	350	Waterworks
2 Oct	Suir	Golden S0138	140	Trout, salmon, crayfish, etc.	150	Stream dry
27	Bradoge	Mitchelstown R8211	2,000	Trout	200	Farm effluent
Southwestern Region (11)						
1 Apr	Ventry Stream	Ventry Q3702	2,000	Trout, flounder, eel, lamprey	400	Slurry
29	Shournagh	Donoughmore W4787	10,000	Trout, salmon, lamprey, loach	5,000	Slurry
8	Inny	Mastergeehy V5774	50	Salmon, trout, eel	10	Gravel digging
8 May	Inny	Mastergeehy V5774	50	Trout	10	Gravel digging
13	Rostellan L	Rostellan W8665		Trout	10	Enrichment
30	L Aderra	Ballintotis W9573		Rainbow trout	30	High temperature
1 Jun	Brownsmill R	Ballintubber		Trout	10	Silage
5 Jul	Lee	Cork W6472	500	Trout, eel, flounder	500	Waterworks
25	Curraheen	Bishopstown W6470	2,000	Trout, salmon, lamprey	300	Domestic effluent
19 Aug	Owenacurra	Midleton W6574	300	Trout	100	Low water
21 Sep	Owenacurra	Midleton W6574	1,000	Trout, salmon, flounder, eel	200	Low water
Shannon Region (13)						
1 Jun	Brownsmill	Ballintubber W6256	1,000	Trout	10	Silage
12 Jun	L Ourna	Nenagh R8886		Trout	170	Enrichment
30	Silver	Cadamstown N2208	100	Trout	65	Temperature
1 Jul	Lenamore	Lenamore N2563	500	Trout	80	Enrichment
4	Kilboy Estate L	Kilboy S8771		Trout	50	Enrichment
10	L Key	Doon G8208		Perch and roach fry	***	Enrichment
12	Gaiey	Drommurrin Q3594	2,500	Trout, sea trout, flounder	400	
15	Sunnagh	Inchicronan R4387		Trout, minnow, stickleback	500	Silage
15	Lung	Ballaghadereen	4,000	Pike, bream	400	Milk processing
2 Aug	Cloonlyon	Ballygar M7751	100	Trout	50	Temperature

Table 1 (continued - Shannon Region - 1985)

19	Camcor	Birr N0504	800	Trout, salmon	190	Swimming pool
28	Dysart	Mount Dalton N3151	5,000	Trout	500	Stream dry
2 Sep	Arra	Newcastlewest R2833	150	Trout	60	Industrial effluent
Western Region (2)						
30 Jun	Cross			Trout	30	Deoxygenation
28 Aug	Robe by-pass	Ballinrobe M1863	100	Trout	100	Deoxygenation
Northwestern Region (4)						
12 Jun	Rossow	Cuilmore M0092	3,000	Trout, stickleback, eel	600	Silage
30	Rashbraghan	Willsborough G7237	3,000	Trout	200	Slurry
5 Aug	Douglas	Riverstown G7422	5,000	Trout	700	Cattle slurry
11 Sep	Castlebar	Castlebar M1490	5,000	Trout, perch	400	Enrichment
Northern Region (19)						
12 Apr	L Oughter	Killykeen H3507		Perch, roach	**	Enrichment
16 May	L Avaghon	H6814		Pike	50	
5 Jun	Trib. of Annalee	Auley H4409	1,000	Trout, stickleback	100	Silage
19	Erne	Drumkilly N4338	5,000	Trout, salmon, eel, roach, etc.	1,000	Cattle slurry
22	L Oughter	Extensive H3505		Perch, roach	***	Enrichment
29	Magherarny	Magherarny H5730	2,000	Trout, pike	100	Silage
9 Jul	Annalee	Ballyraine H3411	2,000	Trout, salmon, perch	100	Silage effluent
20	L Gowna	Extensive N2988		Perch, roach	***	Enrichment
23	Inner Lake	Cootehill H6118		Perch, roach, bream	**	Enrichment
2 Aug	Annaghmakerrig L	Annaghmakerrig H5821		Perch, roach	***	Enrichment
3	Swanlinbar	Swanlinbar H1927	100	Trout	100	Silage
10	L Macnean	Blacklion H0937		Perch	**	Enrichment
11	Erne Estuary	Assaroe Lake G8761	350	Trout, salmon	3	Enrichment
19	Stracashel	Glenties G8993	50	Salmon, trout	16	Temperature
1 Sep	Dromore	Cootehill H5715	1,000	Bream, roach, pike	150	Industrial
7	Drumsheil L	Cootehill H5815		Bream, perch, pike	86	Enrichment
14	L. Shinan	Shercock H7103		Roach, perch	*	Enrichment
22	Town Lake	Cootehill H6114		Bream	*	Enrichment
11 Dec	Tullaghobegley	Millmount B9331	1,000	Salmon, trout	500	Cement spillage

Table 2. Numbers of fish kills reported from rivers and lakes.

		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Region											
Eastern	*River*	10	22	13	25	13	7	7	0	3	13
	Lake	1	0	0	3	1	0	0	1	0	1
Southern	*River*	7	37	9	24	15	19	17	1	9	21
	Lake	0	0	0	0	0	1	0	0	0	0
Southwestern	*River*	3	11	5	23	4	5	3	6	2	9
	Lake	1	0	1	4	1	2	0	0	0	2
Shannon	*River*	28	25	10	17	7	14	11	2	5	9
	Lake	0	2	4	0	0	0	2	3	0	5
Western	*River*	2	4	0	3	1	4	3	1	2	1
	Lake	0	0	0	0	2	0	0	0	1	1
Northwestern	*River*	0	1	4	4	2	0	1	3	1	4
	Lake	0	1	0	0	0	0	0	0	0	0
Northern	*River*	9	16	2	5	3	4	5	1	7	9
	Lake	5	3	2	4	3	4	2	15	2	10

Table 3. Numbers of fish kills by Fishery Region

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Mean
Eastern	31	23	11	11	22	12	28	14	7	7	1	3	14	14
Southern	12	27	14	7	37	9	24	15	20	17	1	9	21	16
Southwestern	7	11	3	4	11	6	27	5	7	3	6	2	11	8
Shannon	8	32	5	28	27	14	17	7	14	13	5	5	13	15
Western	6	2	1	2	4	0	3	3	4	3	1	3	2	3
Northwestern	6	2	0	0	2	5	4	2	0	1	3	1	4	2
Northern	15	13	7	14	19	4	9	6	8	7	16	9	19	11
Total	85	110	41	66	122	50	112	52	60	51	33	32	84	70

Table 4. Numbers of fish kills in principal cause categories

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Total
Agricultural	35	85	25	26	23	22	31	3	11	19	28
Industrial	20	13	7	14	14	11	5	4	6	8	10
Civil works	2	2	2	11	1	1	4	3	5	6	4
Waterworks	0	1	3	4	2	0	0	2		2	2
Sewage	1	4	0	9	1	3	1	1	1	7	3
Enrichment	2	0	4	12	4	5	6	18	6	21	8
Deoxygenation	0	1	0	25	2	8	0	1		17	6
Unknown	6	16	7	10	5	10	4	1	3	4	7
Total	66	122	48	111	52	60	51	33	32	84	661

Table 5. Numbers of fish kills per month in each Fishery Region

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Mean
January		1			1			1			1		0	1
February		2	1		2	1					2	1	0	1
March		4	1	1		3	1	2		1	1	1	0	2
April	1	4	2	1	1	6	3	3	1		1	1	3	2
May	2	10	3	1	16	9	15	10	13	5	2	3	5	7
June	23	34	23	36	51	19	34	12	13	18	3	10	21	23
July	38	31	6	17	31	1	48	10	10	22	18	8	23	20
August	15	12	1	3	18	6	9	7	16	1	1	6	19	9
September	3	8	1	1	2	3		6	5	2	3		10	4
October		3	1	6		1	1				1	2	2	2
November	2	1	1			1	1		1					1
December	1		1					1	1	2			1	1
Total	85	110	41	66	122	50	112	52	60	51	33	32	84	900

Marine Institute
80 Harcourt Street
Dublin 2, Ireland
Ph: +353.1.478 0333
Fx: +353.1.478 4988
Web: www.marine.ie
E-mail: institute.mail@marine.ie