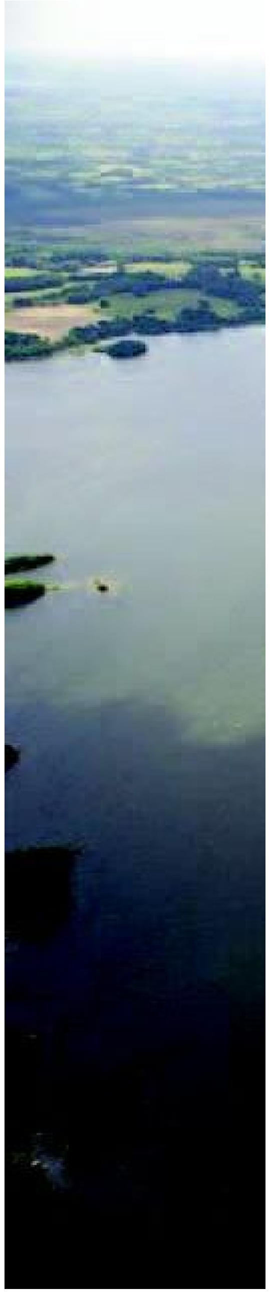
Shannon Regional Fisheries Board
Bord Iascaigh Réigiúnach na Sionainne





Lough Sheelin and its catchment Water Quality Status and Nutrient Loadings 1998-2005

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EXECUTIVE SUMMARY

Lough Sheelin is a trout fishery located in counties Cavan, Meath and Westmeath, with a surface area of 1855 ha, and a total catchment area of c.24,900 ha. The lake is one of the twelve lakes in Western Europe capable of supporting substantial stocks of large wild brown trout (O'Grady, 2000).

The catchment is characterised by intensive agriculture, there are two Local Authority wastewater Treatment Plants in the catchment at Oldcastle, Co. Meath and Ballyjamesduff, Co. Cavan. The soils in the Lough Sheelin catchment have a poor hydraulic infiltration capacity, surface run-off is frequent causing manures and fertilisers to be washed off to surface water streams. The lake has shown signs of eutrophication since the early 1970's.

The Shannon and Central Fisheries Boards are committed to the continual monitoring and the introduction of measures to improve and work towards restoring the water quality status of Lough Sheelin and endeavour to achieve the restoration of the lake as a premium trout fishery. This report was commissioned by The Shannon Regional Fisheries Board (SHRFB) in order to determine the current status of the nutrient loading discharges to Lough Sheelin.

This study found that there was a modest decrease in the total phosphorus loadings to the lake over the period 1988-2005. This suggests that phosphorus losses from the Sheelin catchment to the lake are slowly declining, however the rate of change in nutrient loadings to the lake is so slow that the aim of restoring Lough Sheelin to a premium wild brown trout fishery will not be realised in any reasonable time scale. There is a clear relationship between rainfall and nutrient loadings to the lake. However it is thought there is a considerable time lag between reduction in nutrient levels being applied to the land and any reduction in nutrient loadings to the lake. In-lake chlorophyll levels also decreased over the study period, but this is also affected by unrelated factors e.g. zebra mussels.

Whilst the Mountnugent Stream and the Ross River have the greatest influence on nutrient loadings, phosphorus exports from the Bellsgrove and Schoolhouse catchments also contribute substant nutrient loadings to the lake which are disproportionate with the flow of these streams. The impact of large shock loadings to the system is highly significant, with one single three day event giving rise to 87% of the Bellsgrove's total phosphorus loadings in 2004.

Intensive agricultural industries continue to present the principal threat to Lough Sheelin. Point sources are also a factor and Oldcastle wastewater treatment plant is in need of significant upgrade with added phosphorus removal facilities. While Ballyjamesduff waste water treatment plant was upgraded in 1999, there has been a substantial expansion in the domestic loading to the town since then. Industrial discharges also contribute to the problems in the feeder streams and the lake. Indications are that landspreading practices in the catchment have improved somewhat, however there is still considerable evidence of landspreading taking place before high rainfall events. As populations in the catchment increase, lack of capacity within the wastewater plants have the potential to undermine any improvements to landspreading practices.

CATCHMENT MANAGEMENT RECOMMENDATIONS

POLICY AND LEGISLATION

A comprehensive waste management strategy for the catchment must be devised.

The establishment of an inter-agency group to oversee the Management of Water Quality within the Lough Sheelin catchment should be a priority.

It is strongly recommended that waste treatment systems with phosphate removal should be installed in the catchment and that environmental factors in intensive agricultural operations must be given equal weighting with sociological and economic factors.

Regulations must target the practice of spreading to dispose of waste on soils that are not phosphorus deficient.

A full review of present bye-laws relating to farm waste should be undertaken and the adoption of appropriate bye-laws in the remainder of the catchment.

Meath County Council must upgrade the wastewater treatment plant at Oldcastle as a matter of urgency, whilst the wastewater treatment plant at Ballyjamesduff must be monitored and if necessary upgraded.

Local Authorities must exercise appropriate planning policies and controls in relation to the capacities of wastewater treatment plants to ensure developments are not granted planning permission where a wastewater treatment plant has insufficient capacity or is not meeting standards for effluent quality.

Shannon Regional Fisheries Board should maintain its policy of opposing any developments in the catchment which would give rise to further phosphorus loadings to the lake.

The EPA should continue to regulate and monitor waste management through licensing.

ENFORCEMENT

Continued vigilance is required on a 24/7 basis by Local Authorities, the EPA and SHRFB.

The competent authorities must identify and target those responsible for pollution.

Intensive monitoring of Oldcastle and Ballyjamesduff wastewater treatment plants to identify non-compliance and take action where necessary.

Rigorous inspections and cross compliance verification of intensive agricultural sector.

The public and stakeholders should be made aware and actively encouraged to report suspected cases of pollution to the competent authorities.

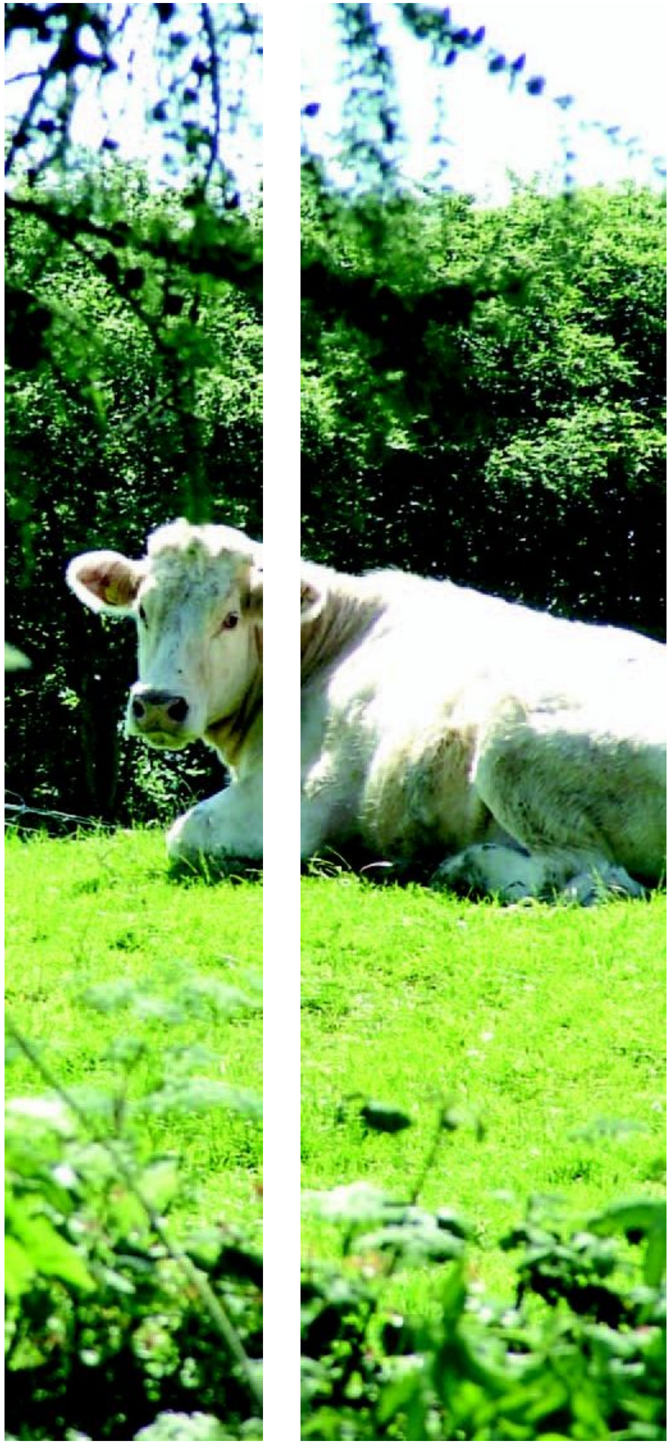
Continued compliance monitoring and court action where necessary by state and semi-state bodies.

EDUCATION

Continued education of stakeholders and initiatives to provide advice and education on waste management to industry, farmers and the intensive agricultural sector should continue.

SAMPLING REGIME AND NUTRIENT LOADING MODEL

It is important that the current monitoring programme is maintained and updated, on-going monitoring by the Shannon Regional Fisheries Board, Local Authorities and EPA must continue.



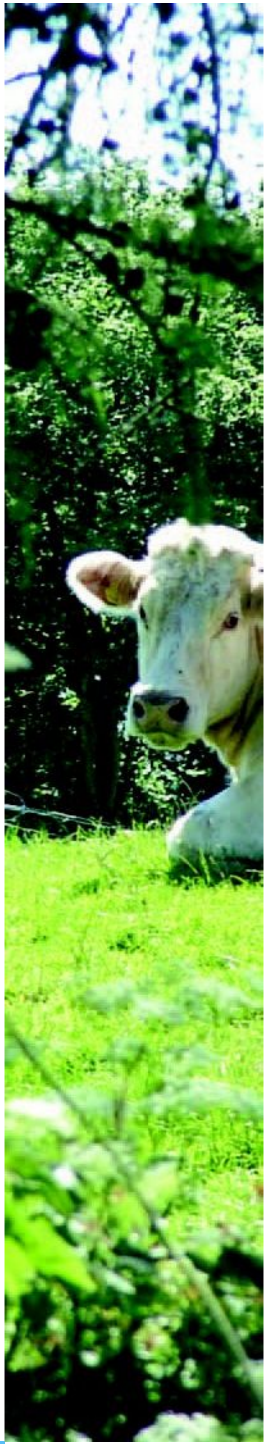
1. INTRODUCTION

Lough Sheelin is a trout fishery located in counties Cavan, Meath and Westmeath, with a surface area of 1855 ha, and a total catchment area of c.24,900 ha. The lake is one of the twelve lakes in Western Europe capable of supporting substantial stocks of large wild brown trout (O'Grady, 2000). The high pH of this limestone lake, combined with its low average depth contributes to its wild brown trout producing potential. The catchment is characterised by intensive agriculture.

The lake has shown signs of eutrophication since the early 1970s, and its trophic status has been well documented. As a result it has received both national and international attention. Studies of the trophic status and monitoring of the water quality are being carried out on a continuous basis by the Shannon Regional and Central Fisheries Boards and Cavan County Council. The findings of work up to 1998 are presented in a number of papers (Champ, 1979; 1991; 1993 and 1998, John, Champ and Moore, 1982; Dodd and Champ, 1983; King 1988; Duggan and Champ, 1992).

In 1985 Cavan County Council issued Section 12 notices to owners of intensive piggery units and in 1987 to owners of large cattle units, these notices prohibited the land-spreading of manures in December and January. In October 2000 Cavan County Council adopted the Water Pollution (Agricultural) Bye-Laws 2000 to regulate the storage and spreading of animal manures, and spreading of chemical fertilisers onto land with reference to levels of phosphorous. In 2004 Cavan County Council introduced Bye laws to control the design, operation and maintenance of wastewater treatment systems for single houses (Water Pollution (Wastewater treatment systems for single houses) Bye-laws, 2004). These provided for the assessment of all such systems by 31st December 2005. Cavan County Council set a target to return the water quality of the lake to mesotrophic status by 2007 (Cavan County Council, 2005) as required under the Phosphorus Regulations. The Lough Derg Lough Ree Catchment Management Programme identified the Sheelin Catchment as a high risk area for phosphorus loss (Cavan County Council, 2005). The Catchment is also identified as high risk in the Characterisation Report on the context of the Water Framework Directive (WFD) (EPA, 2005).

Lough Sheelin and the catchment area it drains is an important natural resource with significance for fisheries, angling, tourism, amenity use and nature conservation. The



Shannon and Central Fisheries Boards are committed to the continual monitoring and the introduction of measures to improve and work towards restoring the water quality status of Lough Sheelin and endeavour to reinstate the lake as a premium trout fishery. Sheelin is also one of the few waterbodies identified in the WFD monitoring programme as a river/lake interaction site for nutrient loading. (EPA, 2006). To demonstrate their commitment, this report was commissioned by The Shannon Regional Fisheries Board in order to determine the current status of the nutrient loading discharges to Lough Sheelin (i.e. an update of comparable data prior to 1998). The compilation and analysis of the data during the period 1998-2005 will influence the future management strategy for the catchment.

Phosphorus is an essential component of the biological cycle in lakes, rivers and streams. High concentrations of phosphorus can indicate the presence of pollution and lead to eutrophic conditions. Phosphorus levels control the primary productivity of the waterbody, because phosphorus is the limiting factor in algal growth. Nitrogen is also an essential nutrient in terms of plant growth.

Mayfly

2. AIMS

THE PURPOSE OF THIS STUDY IS TO:

Calculate the nutrient loading (tonnes) of total phosphorus (TP), orthophosphate (OP), total nitrogen (TN) and total oxidised nitrogen (TON) entering Lough Sheelin over the period 1998-2005. The River Inny out-flow from the lake at Finea was also examined to quantify the amount of nutrients being retained by the lake.

Monitor and assess the nutrient content and thus the water quality status of Lough Sheelin and its tributary streams.

Quantify the contribution of the individual tributary streams (nutrients and hydraulic load) to the lake and identify factors influencing nutrient discharge to the lake.

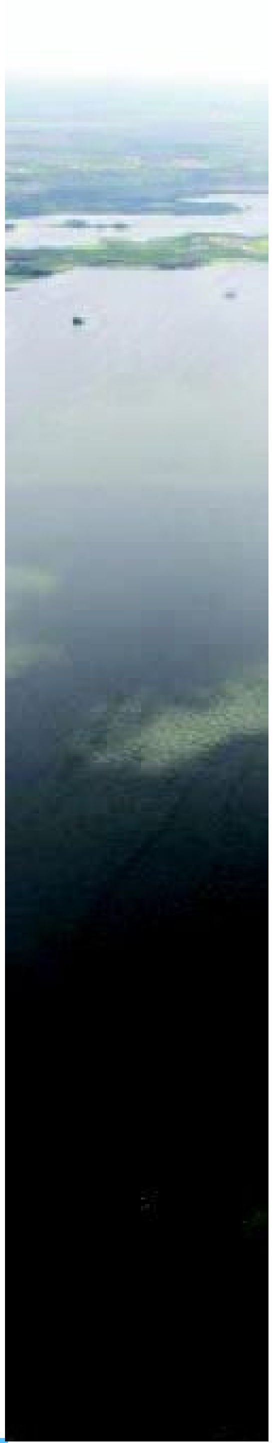
Evaluate the key sources of nutrient enrichment that have dramatically impacted on overall nutrient loading to the lake.

Determine if there has been an improvement or conversely, a decline in the water quality of the lake.

Formulate recommendations and guidelines for the future fisheries management of the Lough Sheelin catchment, in-keeping with the Board's aim of the restoration of Lough Sheelin as a premium trout fishery.

Identify areas for improvement in relation to nutrient management within the Lough Sheelin catchment.

Review the sampling regime and flow data collection in order to evaluate the programme and the efficiency and effectiveness of the nutrient loading model.



3. STUDY AREA

Lough Sheelin is a relatively large lake situated in the upper reaches of the Inny River, an important tributary of the River Shannon. The catchment area is made up of 9 main inflowing tributaries (1-9) and these, along with the River Inny outflow (10) (Fig. 1), form the basis of this report. The catchment areas of each of these rivers (to the gauging station and to the lake) are shown in Table 1.

Figure 1 Map of Lough Sheelin and its tributary streams

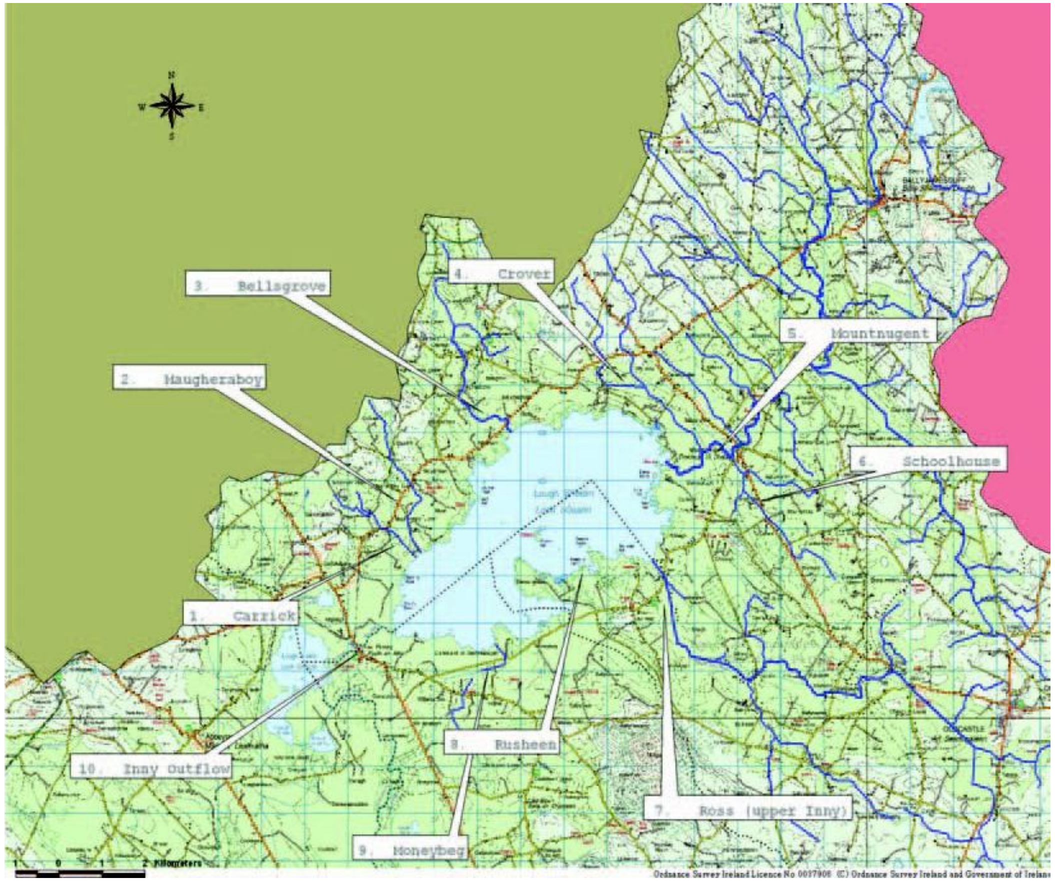


Table 1 Catchment areas of tributary streams to the flow gauge and to Lough Sheelin (source Champ, 1991)

STREAM	AREA TO GAUGE KM^2	TOTAL AREA TO LAKE KM^2
Carrick	2.15	3.18
Maughera	2.92	3.21
Bellsgrove	9.20	9.35
Crover	5.70	5.70
Mountnugent	89.74 }	99.20
Schoolhouse	7.59 }	
Ross	76.52	84.45
Rusheen	2.74	3.32
Moneybeg	4.16	4.20
Combined area of gauged streams	212.61	212.61
Surface area of lake	18.5	
Un-gauged area discharging directly to lake	18.91	
Total area of catchment to gauge at Finea	249.0	

The Lough Sheelin catchment is predominantly a rural area with intensive agriculture in the form of piggeries, mushroom production, dairy, poultry farming, meat plants and abattoirs. Other agricultural activities in the area include dry stock and sheep farming. The towns of Ballyjamesduff and Oldcastle are located within the catchment, with populations of 1,401 and 1,858 respectively (CSO, 2006). Both of these towns have some light industry and are serviced by Local Authority wastewater treatment plants, with the Oldcastle Plant having a population equivalent (pe) of 1400 in 2002/3 (EPA Urban Waste Water Discharges in Ireland, 2002-2003) and the Ballyjamesduff wastewater Treatment Plant was upgraded to provide for a 2200 pe in 1999 (Table 2 shows phosphate levels in sewage and other materials). Given that both Oldcastle and Ballyjamesduff provide commercial, retail, employment and secondary level education centres for the surrounding rural areas, the actual loading to the wastewater treatment plant is likely to be considerably higher than the town populations. The Oldcastle wastewater treatment plant in particular is considered to be in urgent need of upgrading and was the cause of a significant fish kill on the River Inny in August 2005, when over 2000 brown trout were killed.

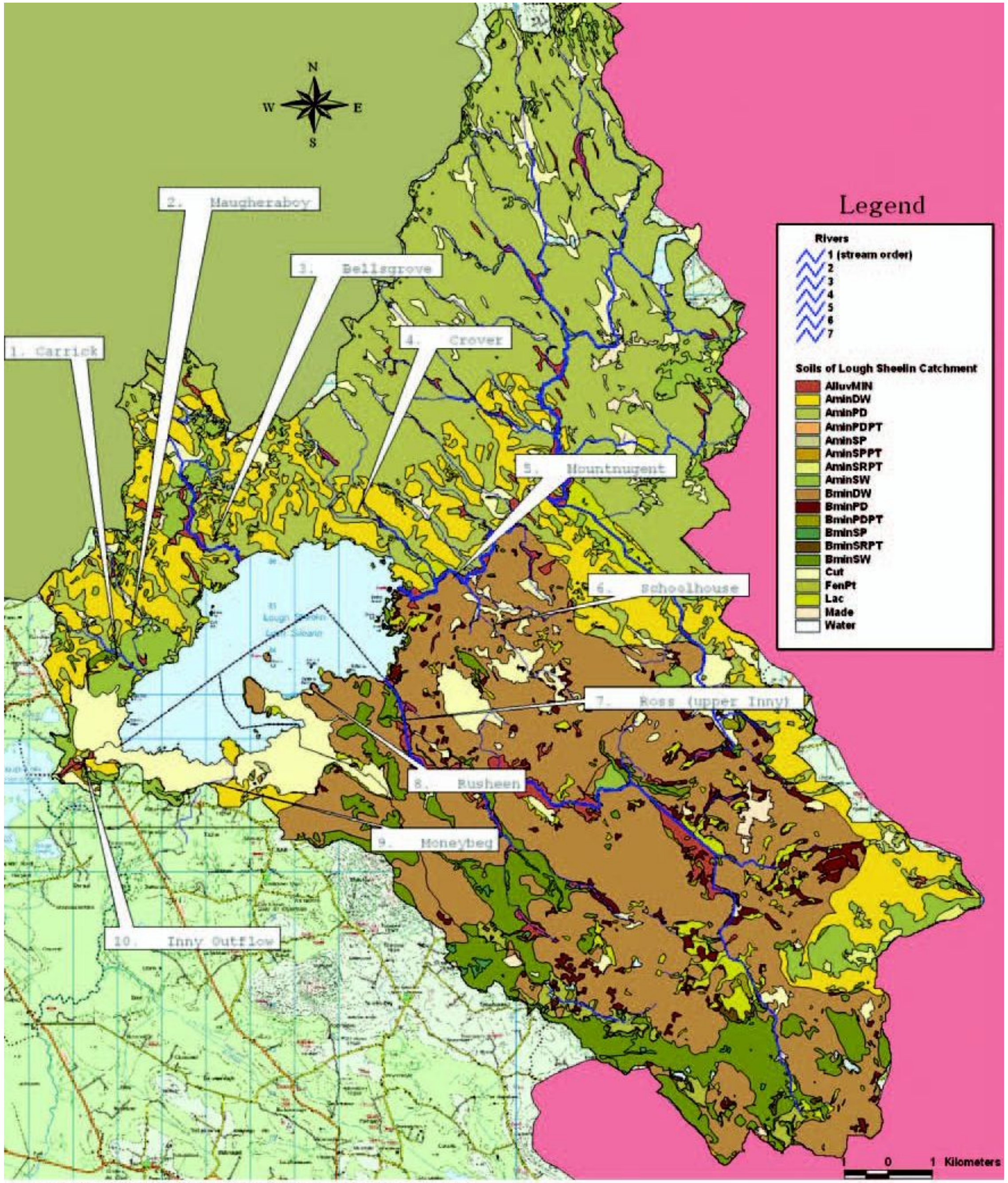
Table 2 Phosphate Levels for different types of municipal and agricultural waste (adapted from Teagasc, 2006)

Waste	Phosphate content mg/l
Raw Sewage	15
Silage effluent	560
Poultry slurry	5,000
Pig slurry	1,400
Cattle Slurry	700

During the Slurry Export Scheme from 1981-1984 (inclusive) of total of 238,000 m^3 (52.4 million gallons) of slurry was exported from the area. The volume of pig manure produced in the Sheelin area increased from 7 million gallons pre 1971 to over 30 million gallons in 1980 (Dodd and Champ, 1983).

Brown Trout

Figure 2. Sheelin Catchment soils (Teagasc Data supplied by the EPA) Note: Soil descriptions are given in full in Appendix 2.



3.1 SOIL AND GEOLOGICAL CHARACTERISTICS OF THE LOUGH SHEELIN CATCHMENT

The geology of the area immediately surrounding Lough Sheelin is underlain by upper carboniferous limestone, with the upper reaches of the Ross River flowing over middle carboniferous limestone, whilst the upper reaches of the Bellsgrove, Crover and Mountnugent streams are underlain by silurian quartzite.

Soil is a critical factor to be considered when studying nutrient loss and subsequent loadings entering a lake from its catchment. Lough Sheelin in particular, has soil types which are vulnerable to nutrient loss. The soil types in the Sheelin catchment (Fig. 2) vary, they are cutaway bog in the South and South West; the drumlin topography to the West and North, where the majority of the catchment's piggeries are located, are predominantly gley soils. The soils to the East of the catchment are brown earths, grey-brown podzolics and gleys. The Bellsgrove soils are grassland mineral soils, brown podzolics and gley soils.


4. METHODOLOGY

During the period, 1998-2005, water samples were taken and flow gauge readings noted (Table 1.) three times per week from the designated sites (1-10), with the exception of the Bellsgrove stream, Ross and Mountnugent Rivers where continuous automatic water samplers were in place between 1998 and 2000. Samples were analysed by the Central Fisheries Board laboratory for nutrient analysis. Mid-lake water samples were taken for nutrient and pigment analysis along with transparency readings, with a normal sampling frequency of once per month.

4.1 CHEMICAL ANALYSIS

In 1997 the TRAACS auto analyser machine at the Central Fisheries Board laboratory was commissioned to measure total phosphorus, orthophosphate, total oxidised nitrogen and total nitrogen. Between 1998-1999, an Ultra Violet digestion method was used on samples analysed for Total Phosphorus. From 2000 onwards, offline digestion of total phosphorus samples was carried out using the Persulphate Method for Simultaneous Determination of Total Nitrogen and Total Phosphorus (Standard Methods for the Examination of Water and Wastewater 2005, 21st Edition).

Total kjeldahl nitrogen (TKN) determination was suspended in 1997 and since then total nitrogen (TN) was measured instead. TKN is a measure of ammonical nitrogen. Total oxidised nitrogen (TON) measures nitrates and nitrites; total nitrogen (TN) is a measure of all forms of nitrogen. For comparison with earlier results an estimation of TKN can be made by subtracting TON from TN. In 2004 and 2005 due to a malfunction in the TRACCS nutrient analyser TN determination was suspended, whilst TON was measured. For periods where no TN data exists, the TN figures were extrapolated using the relationship between TN and TON.

4.2 FLOW DATA

Three times per week spot gauge readings were recorded for most of the streams throughout the sampling period. Rating curves for flow gauges were obtained from the EPA to allow the calculation of mean daily flow rates. Flow data for Maughera was calculated from a flow graph which was used to estimate the flow data for previous years.

The total flows for the Ross River were calculated by adding together the flows from the gauges for the Upper Inny River at Ballinrink Bridge and the Halfcarton tributary. The flow gauge on the Carrick stream was only operational in the year 2003, a decision was made to use the 2003 flows in all calculations for the Carrick Stream. This small stream dries up in prolonged periods of dry weather e.g. 1995.

4.3 NUTRIENT LOADING CALCULATIONS

These calculations were based on chemical data for the inflowing streams to Lough Sheelin and the out-flowing River Inny (Table 1) and flows for these streams. Annual nutrient loadings to each gauge were calculated (metric tonnes) by multiplying mass daily flow by concentration of nutrients present in water samples. This data was then adjusted to allow for the un-gauged portion of the catchment downstream of the gauge and prior to the confluence with the lake for each tributary. Rainfall data, chemical composition of precipitation and class A Pan Evaporation data were obtained from Met Eireann. Using these data the nitrate and phosphorus loadings directly to the lake surface were factored into the results.

The Mean Phosphorus export value was calculated by dividing the loading to the lake (kg) of each nutrient by the catchment area (km^2).

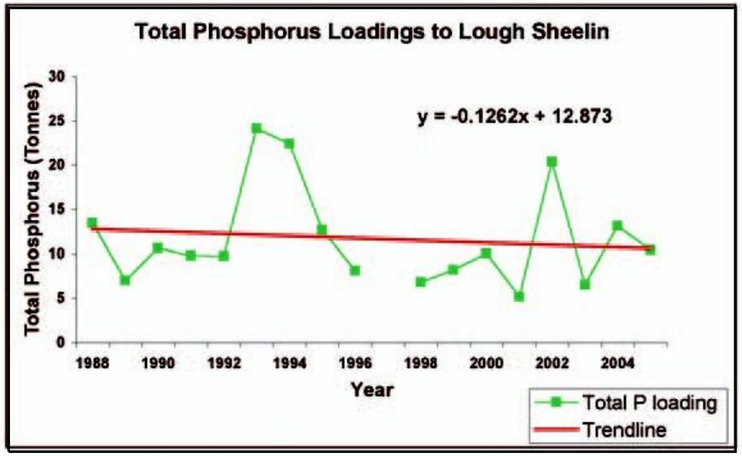
$$\text{Phosphorus Export} = \frac{\text{Nutrient (kg)}}{\text{Catchment area (Km}^2\text{)}}$$

Staff Gauge

5. RESULTS AND DISCUSSION

5.1. PHOSPHORUS LOADINGS

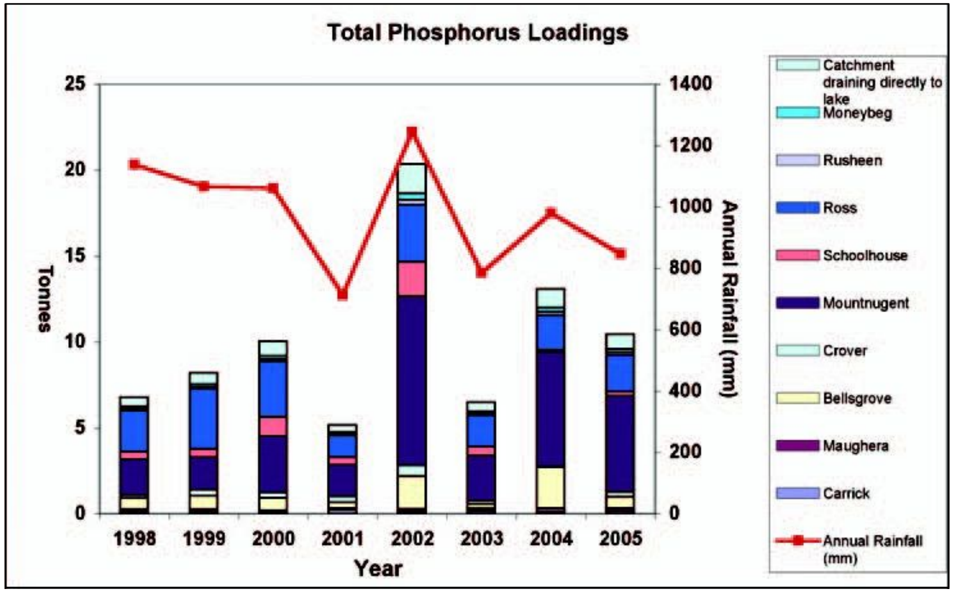
Figure 3 Total Phosphorus Loadings for Lough Sheelin 1988-2005.



The trendline in Fig. 3 shows a modest decrease in the TP loadings to the lake over the period 1988-2005. This suggests that phosphorus losses from the Sheelin catchment are slowly declining. However it is thought there is a considerable time lag between reduction in nutrient levels being applied to the land and any reduction in nutrient loadings to the lake and in the sediments (T. Champ *pers comm*.). This is due to high phosphorus levels in some soils and phosphate levels within the lake sediments becoming re-suspended during high winds and becoming available for use by algae and plants.

Studies carried out on Lough Neagh and Lough Erne show that when land spreading practices continue at the same level, nutrient loadings to the lakes have continued to increase due to sustained inputs and increased losses from agriculture despite substantial phosphorus reduction at the principal wastewater treatment plants. (Foy *et al*, 1996).

Figure 4 Total Phosphorus Loadings and Annual Rainfall Levels for Lough Sheelin 1998-2005

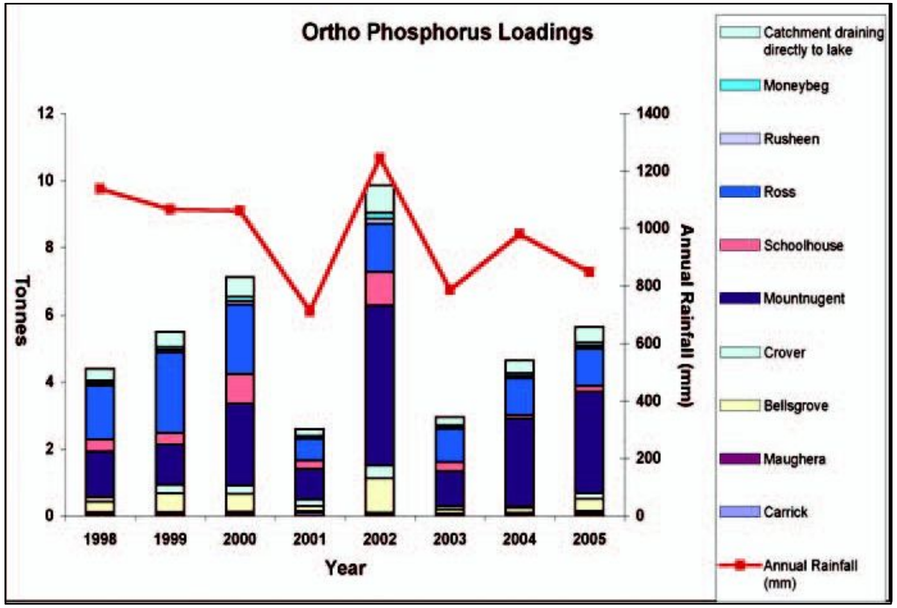


There is a clear relationship between nutrient levels and rainfall. Rainfall determines river flows, which in turn determine the volume of nutrients transported to the lake. This is particularly evident in 2002 where rainfall levels and loadings peaked in tandem. It is thought that measurements of total phosphorus in water samples in 1998 and 1999 are underestimated due to the Ultra Violet methodology used for phosphate digestion prior to analysis in these years.

The Mountnugent stream phosphate loadings account for a substantial proportion of loadings to the lake (between 23% and 58% of the total TP inflow to the lake during the study period), particularly in 2002 (48%), 2004 (51%) and 2005 (53%). The Ross River also contributes considerable loadings (ranging from 15% of the total in 2004 to 42% in 2002). The Bellsgrove stream loadings peaked in 2004 when the TP from this stream was 18% of the total TP inflow to the lake from all tributaries. The Bellsgrove is known to be a spate stream, with runoff reaching the river quickly after rainfall events. Further investigation of this figure showed that, during a three day period in March 2004, 2.07 tonnes of TP (to the gauge) entered the lake from the Bellsgrove stream. This particular incident represents 87% of the 2004 TP for the Bellsgrove and 16% of the TP flowing into Lough Sheelin in 2004. In the same three day period 5% of the Mountnugent annual TP load (0.35 tonnes) entered the lake. The source of these nutrients was not confirmed.

Nutrient loadings (both phosphorus and nitrogen) were significantly higher in the Schoolhouse stream in the years 2000 and 2002, TP loadings for these years were 11.1% and 9.8% of the annual TP totals respectively. The 2002 levels can be attributed to rainfall levels (Fig. 4). Phosphorus loadings for the Schoolhouse were greatly reduced in the years 2004 (1.2%) and 2005 (2.3%).

Figure 5 Orthophosphate Loadings and Annual Rainfall Levels for Lough Sheelin 1998-2005

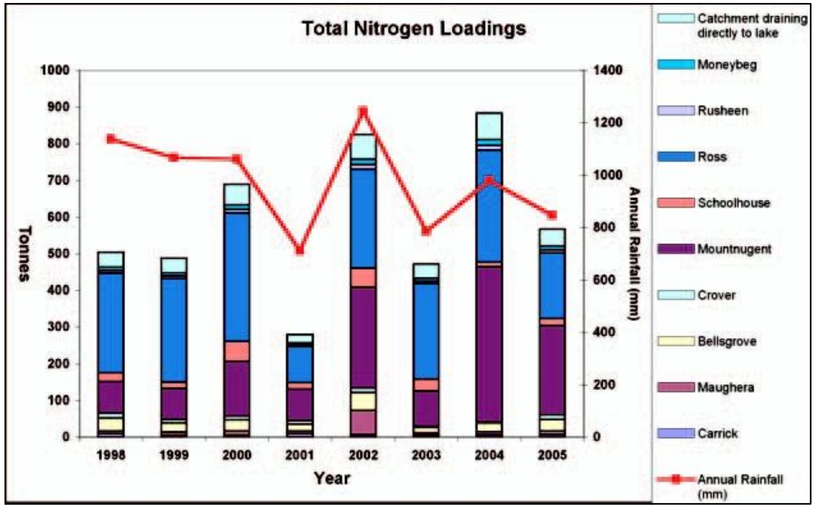


The OP results (Fig. 5) generally mirror the trend of the TP results. In 2004 the Bellsgrove stream has low orthophosphate loadings (3.2%), considering the increase in TP loadings that year which suggests sediment bound and/or organically bound phosphate may have made up the balance.

5.2 NITROGEN LOADINGS

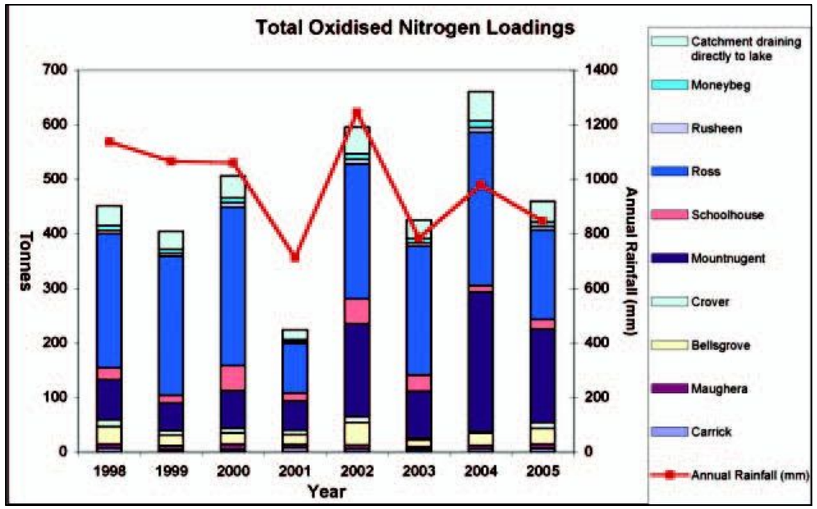
The Ross River has the greatest influence of all of the streams on the nitrogen loadings, accounting for between 31.5% and 58.1% over the period (Figs. 6 and 7), much more so than it does on the phosphorus loadings. This is not unexpected considering the free draining or permeable soils (good infiltration capacity) in this part of the catchment. Nitrates penetrate the soils (leaching) and enters the river in sub-surface drainage water. Less run off from soils accounts for the lower phosphate load in the Ross or Upper Inny River. The Mountnugent stream levels also comprise a large proportion of the TN (ranging from 17.1% to 47.9%). The Schoolhouse stream loadings are noticeably high in 2000, 2002 and 2003. The Bellsgrove stream shows peak loadings in the years 1998, 2002 and 2005.

Figure 6 Total Nitrogen Loadings and Annual Rainfall Levels for Lough Sheelin 1998-2005



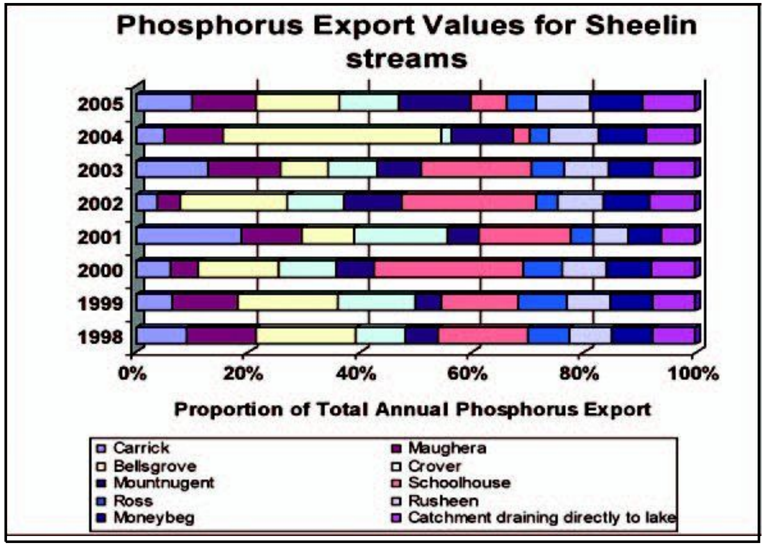
Over an 11 day period in October 1998, 23.7 tonnes of TN and 8.9 tonnes TON entered lake from the Mountnugent stream. These elevated nitrogen levels coincided with a pollution incident related to a tributary of the Mountnugent stream.

Figure 7 Total Oxidised Nitrogen Loadings and Annual Rainfall Levels for Lough Sheelin 1998-2005



5.3 PHOSPHORUS EXPORT VALUES

Figure 8 Phosphorus Export Values for Sheelin streams



Phosphorus export values show the relative importance of each stream in terms of loadings taking account of the catchment size. Fig. 8 shows that the Bellsgrove and Schoolhouse streams have much greater phosphorus loadings per km^2 than the other tributaries. It also shows that much of the

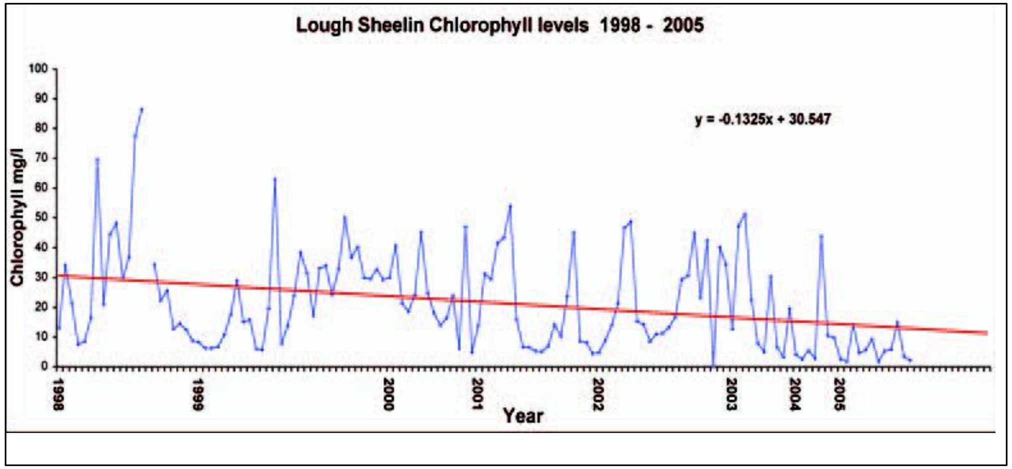
Table 3 Phosphorus Export Values (kg/km^2) for Sheelin streams

Tributary	Catchment area km^2	1998	1999	2000	2001	2002	2003	2004	2005
Carrick	3.18	35.66	31.12	35.23	70.26	43.32	47.64	34.65	48.61
Maughera	3.21	47.88	53.92	26.73	39.41	43.86	46.52	69.05	55.68
Bellsgrove	9.35	68.05	81.93	78.19	34.08	204.58	29.63	254.52	71.17
Crover	5.70	34.01	64.37	55.98	61.64	112.29	31.98	11.74	51.45
Mountnugent	91.46	22.53	20.68	35.74	19.89	107.50	28.75	72.34	60.90
Schoolhouse	7.74	61.26	63.78	143.89	58.81	257.60	69.40	19.59	30.64
Ross	84.45	28.18	41.29	38.40	15.25	39.43	21.61	24.00	25.42
Rusheen	3.32	29.30	35.31	43.49	22.34	89.58	28.14	57.59	45.70
Moneybeg	4.20	29.30	35.31	43.49	22.34	89.58	28.14	57.59	45.70
TOTAL catchment to lake	212.61	31.92	38.62	47.14	24.33	95.74	30.55	61.59	49.17

loadings entering the lake from the Ross River and Mountnugent streams are proportional to the catchment size, but are influenced by soil permeability.

5.4 CHLOROPHYLL LEVELS

Figure 9 Sheelin Chlorophyll levels 1998-2005



Note that the number of samples on an annual basis varies between 7 and 30, every sample result is plotted in Fig. 9 so the distance on the x-axis between years is not equally spaced. There is reduction in lake chlorophyll levels over the study period (Fig. 9), this is reflected by the downward slope in the trendline (shown in red). This graph reflects the findings of the nutrient level calculations which show peaks of total phosphate inflows in 2002 and at times of high flows (Fig. 4). As would be expected annual rainfall has a large bearing on inflows to and flushing from the lake.

Earlier studies have shown that Chlorophyll levels in Lough Sheelin are strongly related to TP inputs, more so than inputs of other nutrients and that phosphorus is the limiting nutrient in relation to water quality issues (Champ 1991).

5.5 TROPHIC STATUS

Table 4 Lough Sheelin total phosphorus and trophic status

Year	Total Phosphorus (mgP/l)	Chlorophyll mg/m^3		Transparency metres		Trophic status
	Mean	Mean	Max	Mean	Min	
1998	27	37.972	86.11	0.777	1.0	Eutrophic
1999	17	23.638	62.594	1.928	1.0	Eutrophic
2000	15*	30.511	46.871	1.733	1.4	Eutrophic
2001	36	17.486	53.543	2.063	1.5	Eutrophic
2002	40	24.283	48.442	1.939	0.7	Eutrophic
2003	46	20.401	50.916	2.129	1.0	Eutrophic
2004	36	11.046	43.640	3.396	3.0	Eutrophic
2005	38	5.729	14.697	3.406	3.0	Mesotrophic

* TP data was only available from January - March in 2000.
TP UV Phosphate digestion used in these years.

Using the physical, chemical and biological data presented (Table 4), trophic status is assigned to the lake for each year using the OECD classification system, in many cases the data does not fully fit into any single category and an overall status is applied based on the majority of parameters.

In general phosphorus levels were low for a eutrophic lake in 1998-2000 (the TP methodology as stated above was thought to be under-estimated in these years), but the chlorophyll and transparency data clearly confer a eutrophic status in these years. Zebra mussels (see photograph above right) were first reported in Lough Sheelin in Autumn 2001 and their presence and colonisation was confirmed in Spring 2003. In 2004 and 2005 a marked improvement in water transparency is evident, this is almost entirely attributable to the spread of zebra mussels (Dreissena polymorpha) in Lough Sheelin. Adult zebra mussels reproduce when temperatures exceed 15°C, producing tens of thousands of young per female mussel. They can reproduce at one year of age and typically live for 3 to 5 years. Each zebra mussel can filter as much as 1 litre of water per day trapping the algae in its gills. They feed on phytoplankton, small zooplankton and bacteria.

Zebra Mussels

Champ (1993) found that a distinct relationship existed between Secchi disc, TP and chlorophyll for Lough Sheelin. The presence of the zebra mussel contributes to improved water clarity by filter feeding. It is therefore likely that the strong relationship between TP and chlorophyll no longer exists in Lough Sheelin and other zebra mussels infested lakes. It should be noted that the impact of zebra mussels on TP levels is not known. The algae are a symptom of eutrophication, but phosphorus is the principal cause.

Whilst the results in Table 4 suggest an improvement in trophic status (using chlorophyll as the indicator) from eutrophic to mesotrophic status, this is not a true reflection of actual current lake status as the phosphate levels remain within the eutrophic category. The nutrients which are the primary cause of eutrophication in the lake remain high, but the visual symptoms (blue green algal blooms and discoloured water) have greatly improved. It is anticipated that maintenance of high nutrient loadings, particularly TP while zebra mussels remain in the lake, will drive production more towards rooted weeds and filamentous algal growth.

5.6 LANDSPREADING IN THE SHEELIN CATCHMENT

In many cases land spreading of slurries is used as a means to dispose of waste, and frequently results in excess fertilisation of the soil. This is especially the case where soil nutrients levels are already high (AFT, 1972). Umbilical systems are commonly used in this catchment to spread slurry, along with slurry tankers.

5.7 FACTORS CONTRIBUTING TO NUTRIENT LOADINGS TO THE LAKE

In this report phosphorus is considered in more detail than nitrogen levels, given the levels of phosphorus and nitrogen loadings to Lough Sheelin, phosphorus is the limiting factor in this case. Increased levels of nutrients, principally phosphorous, discharging to surface waters has led to eutrophication of the lake. Eutrophication is a state or a response to increased nutrient levels (i.e. the enrichment of water) causing accelerated and undesirable growth of microscopic algae and other forms of plant life. There are two principal sources of nutrient enrichment, point sources - comprising of single point discharges from wastewater treatment plants and outfalls from industry and diffuse sources which include agriculture, both small scale and intensive factory farming (run off from farmyards and fields), septic tanks and sewage treatment systems and forestry.

The situation regarding point source discharges has improved in some locations. Of particular note the loadings to the Mountnugent stream reduced after 1999 when the upgraded Ballyjamesduff sewage network and new waste water treatment plant became operational (Cavan County Council, 2005). This is also suggested by the phosphorus export data presented for the Mountnugent River in this report.

An Foras Taluntais (AFT, 1975) found that discharges of pollutants (organic matter and nutrients was related to the time interval and the intensity of rainfall after spreading. The extent of pollution was related to the quantity of slurry applied. Studies showed that if rainfall occurs within 48 hours of slurry spreading organic matter, nitrogen and phosphorus can be lost to waters by surface run-off from poorly drained soils. They found that phosphorus losses in run-off water may remain unacceptably high for 6-8 weeks after the application. They also showed that the risk of pollution was reduced (but not removed) if one week elapsed before heavy rains and slurry was spread in the growing season.

The Lough Derg/Ree Catchment Management Project identified nutrient loss from agriculture to be a contributor to eutrophication of the lake and postulated that the loss of phosphorous arising from over-use of fertiliser, inadequate farmyard management and poor slurry disposal practices can be significant (Cavan County Council, 2005).

Slurry spreading

5.8 SOILS

Water soluble or particulate phosphate can be transferred from soil to water in three ways:

1) run off across the land surface in rainwater
2) moving via the soil profile to watercourses
3) flow to groundwater through preferential flow pathways and into watercourses via seepage from the water table

Humpreys et al (1999) considered that the greater part of phosphorus (P) export from mineral soils occurs in surface rather than subsurface runoff. Studies have shown that runoff from grassland generally carries little sediment, and is, therefore, dominated by the dissolved phosphorus form (Pietilainen and Rekolainen, 1991; Sharpley and Rekolainen, 1997). The mineral soils in the Bellsgrove catchment support grassland farming and therefore the main form of loss of dissolved phosphorus from soils takes the form of surface runoff. Dissolved phosphorus is, for the most part, immediately available for biological uptake (Nurnberg and Peters, 1984; Walton and Lee, 1972) and can increase the biological productivity of surface waters. Teagasc (Humphreys et al, 1999) conducted intensive studies on phosphate soil levels in the Bellsgrove catchment. They found that there were three important issues to consider:

1) the concentration of soil p
2) the capacity of soil in the catchment to retain phosphorus (known as the sorption capacity of the soil)
3) the interaction between rainfall and the depth of soil from which dissolved phosphorus is removed in runoff water.

5.9 SUMMARY DISCUSSION

The above factors all have a role to play in the nutrient loading from the Sheelin streams to the lake. Intensive agricultural industries, pig production, dairying and domestic sewage continue to present the principal threat to Lough Sheelin. Point sources are also a factor and while Ballyjamesduff waste water treatment plant was upgraded in 1999, there has been a substantial expansion in the domestic loading to the town since then. Oldcastle waste water treatment plant is also in the need of significant upgrade and requires phosphate removal facilities. Industrial discharges in the catchment also contribute to the problems in the feeder streams and lake.

Recent developments in legislation, such as the Water Framework Directive, Nitrates Directive and Phosphorus Regulations, will serve as a framework for management strategies to deal with the water quality issues within the Sheelin catchment. This will be administered through the Shannon International River Basin District for the Water Framework Directive. However enforcement of water quality legislation to tackle polluters must be maintained. It is vital that all parties, the Shannon Regional Fisheries Board, Local Authorities and Environmental Protection Agency all play their role in enforcement of the legislation to improve water quality in Lough Sheelin and its catchment. The Department of Agriculture and Teasgasc are also important players in the Lough Sheelin catchment to encourage good agricultural practice and education of stakeholders. Successful environmental management of nutrients in the agricultural sector is the key to resolving the enrichment problems of Lough Sheelin. The farming community within the catchment have adopted informed management practices. However, further reductions in nutrient loads to waters can and must be achieved and the future of the lake depends on this.


Oldcastle wastewater treatment plant.

6. CATCHMENT RECOMMENDATIONS

6.1 POLICY AND LEGISLATION

A comprehensive waste management strategy for the catchment must be devised taking into account local conditions and relevant legislation with involvement from all competent authorities.

Inter-agency co-operation is essential. A group should be set up to oversee the Management of Water Quality within the Lough Sheelin catchment in order to utilise and maximise available resources. This could be done under the auspices of the Shannon River Basin District.

Given the inadequate nature of many of the soils in the Lough Sheelin catchment as spreadlands, consideration must be given to the use of phosphorus treatment systems in intensive agriculture. Environmental factors in intensive agricultural operations must be given equal weighting with sociological and economic factors.

Regulations must target the practice of spreading to dispose of waste on soils that are not phosphorus deficient, where soil phosphorus levels are already surplus to requirements for good agricultural practice. Greater regulation of 'spreadlands' and only slurry loading by using soil p testing.

Introduction of Bye-laws, such as the Cavan County Council septic tank bye-laws to improve the quality of domestic wastewater treatment systems for single unsewered houses in other counties within the catchment. Incentives and grant-aided schemes for the replacement of inadequate treatment systems should be considered.

Revision of existing bye-laws for implementation of the Phosphorus Regulations taking account of current Teagasc recommendations for soil p index. The adoption of appropriate bye-laws in the remainder of the catchment.

Local Authorities must exercise appropriate planning policies and controls in relation to the capacities of wastewater treatment plants to ensure developments are not granted planning permission where a wastewater treatment plant has insufficient capacity or is not meeting standards for effluent quality in accordance with case law and the Department of Environment circular 07/96.

Meath County Council must upgrade the waste water treatment plant at Oldcastle as a matter of urgency, whilst the wastewater treatment plant at Ballyjamesduff must be monitored and if necessary upgraded in a timely fashion, in advance of developments occurring.

Shannon Regional Fisheries Board should maintain its policy of opposing developments in the catchment with give rise to further phosphorus loadings to the lake.

The EPA should continue to regulate and monitor waste management through licensing.

6.2 ENFORCEMENT

Continued vigilance is required on a 24/7 basis by Local Authorities, the EPA and SHRFB.

Analysis has shown the dramatic effect that large shock pollution loads have on the nutrient loadings to the lake. For this reason it is important, whilst being cognisant of all activities which might give rise to pollution to ensure that the competent authorities must identify and target those responsible.

Intensive monitoring of Oldcastle and Ballyjamesduff wastewater treatment plants to identify non-compliance and take action where necessary.

Rigorous inspections and cross compliance verification must be conducted at intensive agricultural premises and on farms with regard to schemes, grant aiding, directives, legislation and planning by the Department of Agriculture, Local Authorities and the EPA.

The public and stakeholders should be made aware and actively encouraged to report suspected cases of pollution to the competent authorities.

Continued compliance monitoring and court action where necessary by state and semi-state bodies.

6.3 EDUCATION

Continued education of stakeholders within the catchment through REPS programmes and other initiatives, such as 'Fisheries Awareness Week' and schools education programmes.

Initiatives to provide advice and education on waste management to industry, farmers and the intensive agricultural sector should continue.

6.4 SAMPLING REGIME AND NUTRIENT LOADING MODEL

It is important that the current monitoring programme is maintained and updated, on-going monitoring by the Shannon Regional Fisheries Board, Local Authorities and EPA must continue.

Intensive monitoring of water quality should be conducted in the Mountnugent, Ross, Bellsgrove and Schoolhouse catchments to identify and work towards resolving water quality issues.

Mechanisms for estimating flow data in the Rusheen and Moneybeg streams (3.2% of the total gauged stream area) must be improved and incorporated into the calculations going forward. However both of these streams (Rusheen in particular) are very poor streams for gauging flow and hydraulic loadings are currently calculated using average discharge for the catchment area, this practice may have to continue during the summer months.

The flow gauge on the Carrick stream should be reinstated to provide greater accuracy.

The use of automated samplers would provide more accurate figures in that improved sampling frequency or continuous sampling would result in all peak nutrient values being detected key loading events would not be missed resulting in more accurate calculation of nutrient loadings to the lake. Although there are considerable costs associated with the installation, running, maintenance and monitoring of these samplers, these costs are justifiable and invaluable in environmental terms. A limited grab sampling programme is unlikely to capture peak loading and significant underestimation will result. For economic reasons it would be most effective to use two automatic samplers on the Ross and Mountnugent rivers as their gauged catchments represent 78.2% of the gauged area of the Lough Sheelin catchment. Given the flashy nature of the Bellsgrove stream and the large contribution of nutrients from this stream relative to its size through shock loadings and the loadings in the Schoolhouse stream there would be a considerable benefit in installing continuous automatic sampler on these catchments.

The regular nature of the current sampling program (with a frequency of three samples per week) improves the likelihood of detecting peak nutrient levels, it is likely that if sampling frequency were decreased many of these peaks or shock loads would not be detected. The example given in relation to March 2004 on the Bellsgrove illustrates the importance of detecting these high points as they have a major influence on loadings to lake.

Maintain the sampling program and water quality analysis. In this regard the importance of laboratory support cannot be over emphasised. Continued investment in equipment and maintenance of equipment is recommended to ensure the integrity of this long term data set.

Further analysis of temporal and seasonal factors in relation to rainfall,run-off and nutrient loadings should be conducted.

Focused and intensive investigations on the Schoolhouse stream are merited.

Reference should be made to on-going studies on the effects of zebra mussel populations on water clarity (Secchi), chlorophyll levels and nutrient levels in order to modify the lake sampling programme to ensure relevant data are collected on an on-going basis.

Sheelin Art Competition

7. REFERENCES

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8. APPENDICES

Appendix 8.1 Nutrient Loadings for the Lough Sheelin Catchment, 1998-2005

TOTAL PHOSPHORUS (Tonnes per annum)								
Stream	1998	1999	2000	2001	2002	2003	2004	2005
Carrick	0.11	0.10	0.11	0.22	0.14	0.15	0.11	0.15
Maughera	0.15	0.17	0.09	0.13	0.14	0.15	0.22	0.18
Bellsgrove	0.64	0.77	0.73	0.32	1.91	0.28	2.38	0.67
Crover	0.19	0.37	0.32	0.35	0.64	0.18	0.07	0.29
Mountnugent	2.06	1.89	3.27	1.82	9.83	2.63	6.62	5.57
Schoolhouse	0.47	0.49	1.11	0.45	1.99	0.54	0.15	0.24
Ross	2.38	3.49	3.24	1.29	3.33	1.83	2.03	2.15
Rusheen	0.10	0.12	0.14	0.07	0.30	0.09	0.19	0.15
Moneybeg	0.12	0.15	0.18	0.09	0.38	0.12	0.24	0.19
Catchment draining directly to lake	0.55	0.67	0.82	0.42	1.69	0.53	1.09	0.86
Total Inflow	6.79	8.21	10.02	5.17	20.35	6.50	13.10	10.45
Outflow	4.97	3.07	2.62	1.94	5.61	2.27	2.82	5.90

ORTHO-PHOSPHORUS (Tonnes per annum)								
Stream	1998	1999	2000	2001	2002	2003	2004	2005
Carrick	0.06	0.06	0.08	0.10	0.05	0.04	0.04	0.07
Maughera	0.04	0.05	0.05	0.03	0.05	0.03	0.05	0.08
Bellsgrove	0.32	0.56	0.53	0.15	1.01	0.13	0.15	0.36
Crover	0.13	0.25	0.26	0.20	0.39	0.09	0.03	0.18
Mountnugent	1.37	1.20	2.45	0.92	4.76	1.05	2.64	3.03
Schoolhouse	0.35	0.34	0.87	0.24	0.99	0.29	0.09	0.16
Ross	1.62	2.41	2.06	0.65	1.45	0.99	1.10	1.11
Rusheen	0.06	0.08	0.10	0.04	0.14	0.04	0.07	0.08
Moneybeg	0.08	0.10	0.13	0.05	0.18	0.05	0.09	0.10
Catchment draining directly to lake	0.36	0.45	0.59	0.21	0.82	0.24	0.38	0.47
Total Inflow	4.40	5.50	7.11	2.60	9.86	2.95	4.64	5.64
Ouflow	1.02	1.23	0.96	0.40	1.28	0.83	1.15	3.22

Appendix 8.1 continued Nutrient Loadings for the Lough Sheelin Catchment, 1998-2005

TOTAL OXIDISED NITROGEN (Tonnes per annum)								
Stream	1998	1999	2000	2001	2002	2003	2004	2005
Carrick	7.99	4.15	5.00	8.58	5.75	4.88	5.76	6.32
Maughera	6.62	7.46	9.89	5.68	7.42	4.88	6.86	8.46
Bellsgrove	31.89	19.99	20.26	17.71	41.39	12.90	22.33	28.85
Crover	12.65	7.85	8.48	8.24	10.59	3.42	2.19	11.07
Mountnugent	73.29	50.98	69.17	53.16	170.12	85.75	256.39	170.66
Schoolhouse	21.94	13.93	45.97	14.62	45.60	29.62	11.71	17.73
Ross	246.01	254.67	290.74	90.99	247.10	236.03	280.54	164.07
Rusheen	6.37	5.68	7.15	3.18	8.52	6.01	9.45	6.59
Moneybeg	8.06	7.18	9.04	4.02	10.78	7.60	11.95	8.34
Catchment draining directly to lake	36.27	32.35	40.70	18.11	48.54	34.24	53.81	37.56
Total Inflow	451.09	404.23	506.39	224.28	595.80	425.33	660.99	459.66
Inny Ouflow	103.52	116.97	121.26	44.57	133.32	80.21	99.27	201.95

TOTAL NITROGEN (Tonnes per annum)								
Stream	1998	1999	2000	2001	2002	2003	2004	2005
Carrick	9.33	4.76	5.70	9.85	6.44	5.48	6.26	6.82
Maughera	7.73	8.66	11.11	6.57	66.19	5.54	7.85	9.37
Bellsgrove	34.74	24.72	29.94	19.27	48.96	14.47	24.12	31.49
Crover	13.69	9.43	10.24	9.47	12.48	4.01	2.39	12.23
Mountnugent	86.15	85.99	149.54	86.12	274.72	96.02	423.82	244.66
Schoolhouse	23.97	16.07	54.00	17.11	51.38	32.42	12.90	18.89
Ross	271.83	282.82	350.73	99.20	271.04	260.77	305.36	178.64
Rusheen	7.12	6.87	9.78	3.98	11.83	6.67	12.72	8.17
Moneybeg	9.00	8.69	12.38	5.03	14.97	8.44	16.09	10.33
Catchment draining directly to lake	40.54	39.15	55.73	22.66	67.39	37.98	72.46	46.52
Total Inflow	504.10	487.17	689.15	279.27	825.41	471.80	883.97	567.11
Inny Ouflow	138.54	146.71	153.46	58.06	169.69	100.98	130.25	248.60

IFS Soil	IFS Attribute	IFS Code
Deep well drained mineral		1
Derived from mainly acidic parent materials	AminDW	11
Derived from mainly basic parent materials	BminDW	12
Shallow well drained mineral		2
Derived from mainly acidic parent materials	AminSW	21
Derived from mainly basic parent materials	BminSW	22
Deep poorly drained mineral		3
Derived from mainly acidic parent materials	AminPD	31
Derived from mainly basic parent materials	BminPD	32
Poorly drained mineral soils with peaty topsoil		4
Derived from mainly acidic parent materials	AminPDPT	41
Derived from mainly basic parent materials	BminPDPT	42
Podsolised soils with/without peaty topsoil		
Mineral podsolised soils and peaty topsoil with occasional iron pan layer	PodPDPT	43
Alluviums		5
Mineral alluvium	AlluvMIN	51
Peaty alluvium	AlluvPT	52
Marl type soils	AlluvMRL	53
Alluvium undifferentiated	AlluvUND	55
Lacustrine alluviums	AlluvLk	56
Peats		
(Raised)		6
Raised bog	RsPT	61
Raised bog (cutaway)	Cut	62
(Blanket)		
Mountain	BktPt	63
Lowland	BktPt	64
Cutaway	Cut	65
Miscellaneous		7
Made	Made	74
Lake	Water	76
Reservoir	Water	76

NOTES

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