Executive Summary of Lough Melvin Catchment Management Plan

Edited by:
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June 2008

Northern Regional Fisheries Board

Bord Iascaigh Réigiúnach an Tuaisceart

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Edited by: Emer Campbell, Lough Melvin Nutrient Reduction Programme Manager & Bob Foy, Project Principal

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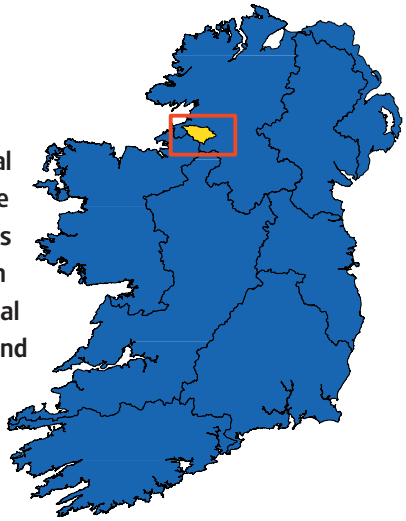
Comhshaol, Oidhreacht agus Rialtas Áitiúil
Environment, Heritage and Local Government

The Programme is funded by the EU INTERREG IIIA Programme for Ireland/Northern Ireland and the project partners; Northern Regional Fisheries Board; Agri-Food and Biosciences Institute (AFBI) Northern Ireland; Queen's University Belfast and; Teagasc.

From 1st July 2008 Environment and Heritage Service became Northern Ireland Environment Agency.

Executive Summary



Ireland's waterways, lakes and wetlands are a significant part of our natural heritage and their management and maintenance is our responsibility, as the current generation of environmental caretakers. One of these, Lough Melvin is a unique and internationally significant lake located in the counties of Leitrim and Fermanagh. Described as "one of the few remaining natural post-glacial salmonid lakes in northwestern Europe", the lake covers an area of 2206 ha and is renowned for its early "run" of Atlantic salmon, unique assemblage of fish species and diversity of flora and fauna. In relatively pristine condition, the lake and surrounding catchment area are highly valued for their recreational, heritage and environmental qualities by anglers, tourists, scientists and the local community.

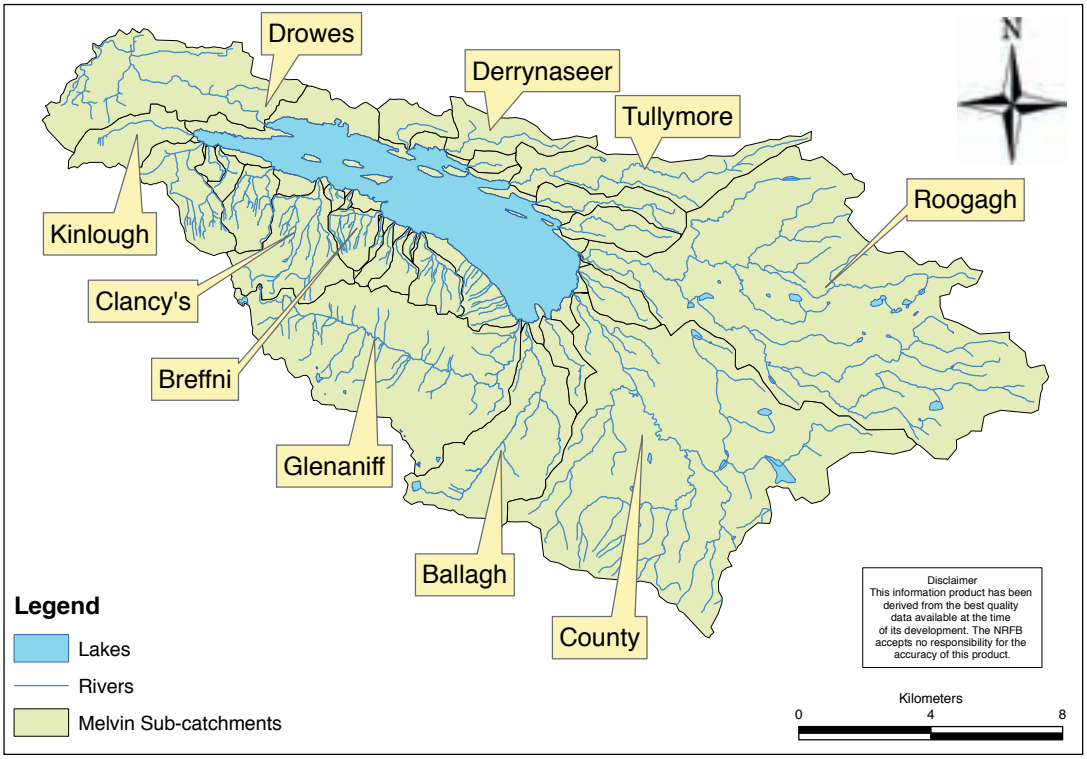


Figure 1: The Lough Melvin catchment covering an area of over 22,000ha

Due to the importance of Lough Melvin as an oligo-mesotrophic (low-medium nutrient) lake that supports a diversity of habitats and species, it has been designated as a Special Area of Conservation (SAC) under the EU Habitats Directive. However, the health and status of Lough Melvin is particularly vulnerable to human activities, with the most significant threat being an increase in phosphorus loadings from housing, forestry and agriculture within the surrounding catchment. Currently phosphorus concentrations in the lake have increased by over 40% in little more than a decade and monitoring of the catchment rivers indicates that phosphorus loadings are continuing to increase.

To protect the water quality and ultimate health of Lough Melvin, the sources of nutrients from the surrounding catchment need to be managed and methods for their control developed and implemented. It is imperative that this action is taken now to ensure the survival of this rare natural resource otherwise irreversible damage may be done to the system. Linking activities within the surrounding catchment to

environmental impacts on the lake and managing the lake at a catchment scale, is the only way that management actions can be prioritised and targeted for the most effective and beneficial environmental outcomes. The Lough Melvin Catchment Management Plan aims to provide a basis for the conservation of Lough Melvin into the future in an effective and holistic way.

1 The Lough Melvin Nutrient Reduction Programme

The Lough Melvin Nutrient Reduction Programme was funded by the EU Interreg IIIA Programme for Ireland/ Northern Ireland and the Project Partners. The aim was to develop a Catchment Management Plan (CMP) for the lake that would promote good ecological status and address the primary catchment threats of which, nutrient enrichment is the most critical. The overall goal derived for the Lough Melvin CMP is to:

"Protect the health and unique environmental values of Lough Melvin and its catchment"

Much of the CMP focuses on nutrient enrichment, as this is a key threat to ecological health, but it also covers other potential threats. It incorporates outputs from four Project Strands. The Project Partners were responsible for individual strands with the Northern Regional Fisheries Board (Strand 1) providing overall coordination of the Programme. An outline of the strands is provided below.

Strand 1 Programme Coordination

Project Partner: Northern Regional Fisheries Board. Harry Lloyd- Project Principal. Dr. Milton Matthews. Emer Campbell- Programme Manager, Angela Killalea- Administrative Assistant, Colm O'Kane- GIS Technician, David Laing- Forest Project Officer, Michael Quinn- Wastewater Project Officer. This strand aimed to produce a catchment management plan for Lough Melvin that would promote "good ecological status" (as required by the Water Framework Directive) and could form the basis of a Biodiversity Action Plan (as may be required by the Habitats Directive). It also undertook to raise awareness and promote improved environmental management. Within Strand 1 targeted assessments of the impacts on Lough Melvin from forestry and waste water treatment facilities in the catchment were also undertaken.

Strand 2 Agri-Environmental

Project Partner: Teagasc Research. Dr. Owen Carton & Dr. Donnacha Doody (to April 2007); Dr. Rogier Schulte & Dr. Paul Byrne- Agri-Environmental Manager. The strand developed an agri-environmental suite of measures to safeguard and improve the status of mesotrophic lakes such as Lough Melvin.

Strand 3 Economic Assessment

Project Partner: Institute of Agri-Food and Land Use, Queen's University Belfast. Prof. George Hutchinson, Dr. Danny Campbell- Research Assistant & Dr. Claire Cockerill- Research Assistant. The aim of this strand was to conduct an economic assessment of costs and benefits of the proposed programme of agri-environmental measures and to investigate the use of "nutrient trading" a tool for delivering lower nutrient input to the lake. This strand also provided an economic valuation for the conservation of the fish assemblage in Lough Melvin.

Strand 4 Water Quality and Carbon Isotope Analysis

Project Partner: Agri-Food and Biosciences Institute (AFBI), Belfast and Queen's University Belfast. Dr. Bob Foy- Project Principal and Chris Barry- Research Assistant. The aim of this strand was to complete a water quality analysis programme for Lough Melvin and its inflowing river network with specific emphasis on nutrients and their sources.

2 Catchment Management Plan Development

The Lough Melvin CMP is the product and culmination of the investigations undertaken in Strands 1 to 4 and involved a number of steps (Figure 2).

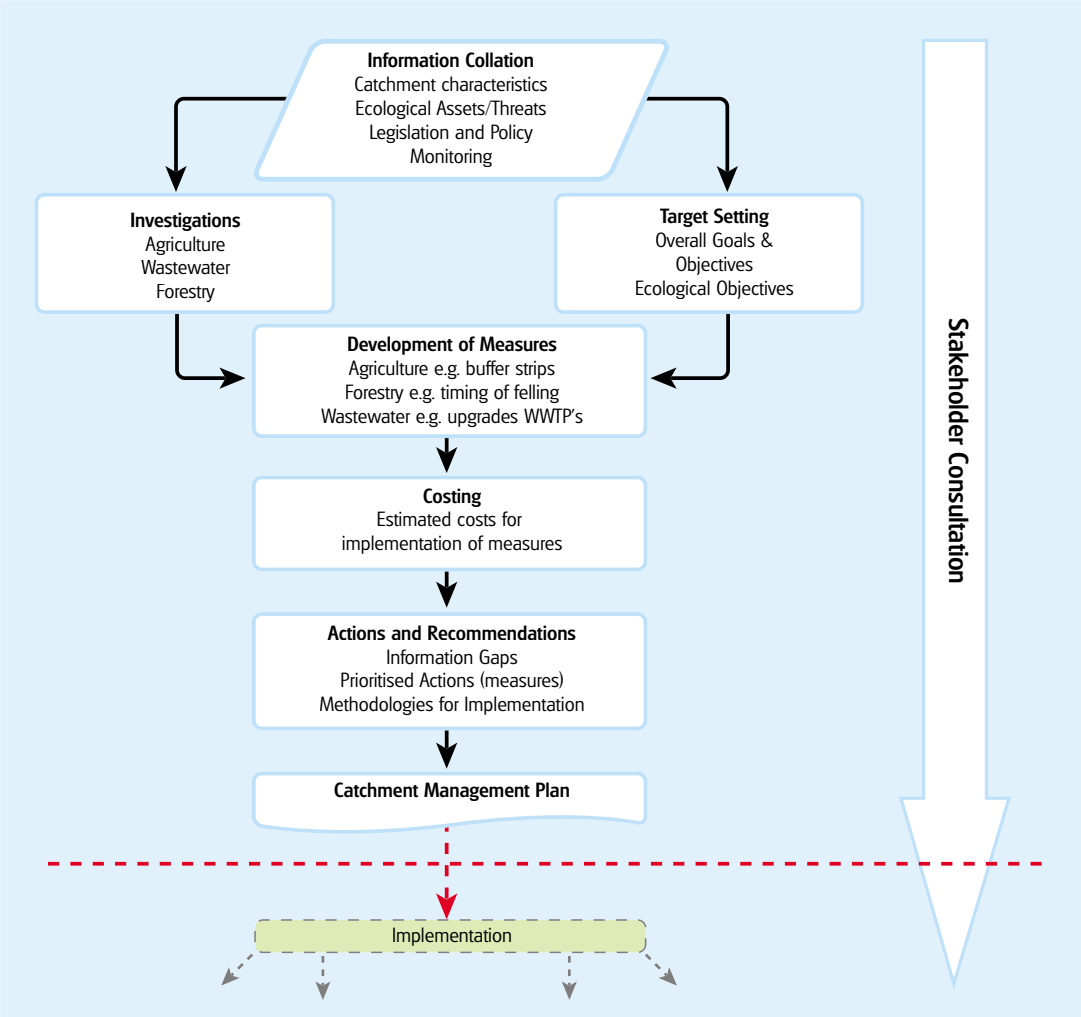


Figure 2: Catchment Management Plan Development Process

It was developed in consultation with three main stakeholder groups. These were the: Lough Melvin Catchment Management Group; Lough Melvin Steering Committee and; wider community and specific interest groups. The Lough Melvin Catchment Management Group consisted of representatives of cross-border government, semi-state bodies and research organisations, which have a role in the long-term and sustainable management of the lake. The Steering Committee was also a cross-border group with the majority of members having specific, assigned, and formal responsibilities in the development of the CMP.

In addition, stakeholders were consulted individually or brought together to provide advice and expertise for particular topics, investigations or parts of the Plan. The Forestry Working Group was established to oversee the work undertaken for the forestry component of the Programme and comprised of members representing private and public forestry management organisations. The wider community and specific interest groups were engaged directly or were provided with the opportunity to become involved and have input to the Programme through a variety of means including information evenings, one-on-one and group meetings/presentations, feedback forms, surveys etc.

Two public consultation events were held for the Programme. The first, in June 2007, was to promote the unique values of Lough Melvin and highlight the potential threats to the lake. The second held in February 2008 presented results from the various investigations and get feedback from the local community. Both information evenings were publicised via local newspapers, community information notes, posters in local shops, libraries etc., on the Programme website and by direct invitation.

3 Lough Melvin's Significance

Lough Melvin is an exceptional example of a naturally oligo-mesotrophic lake with low to medium nutrient levels and supporting a diverse range of plants and associated animal life. Lakes of this type are of significant environmental and conservation importance having become increasingly rare in Ireland and the UK due to widespread human induced changes within their catchments.

Plate 1: Melvin's unique fish: Gillaroo (top) sonaghan (left) and ferox trout (right). Note: not shown to scale.

Lough Melvin is best known for its unique and internationally important assemblage of fish species, most of which are indigenous to the lake, some of which represent the only remaining populations of their type. The lake supports Atlantic salmon, rare Arctic (Melvin) char, indigenous sonaghan, gillaroo and ferox trout. The salmonid fish community in Lough Melvin originates from the end of the last Ice Age and its continuation is an indication of the lake's relatively pristine and undisturbed state. Within the catchment, nationally and internationally significant habitat types (and species) such as peat bogs, nutrient poor and species rich grasslands, hay meadows, oak woodlands and natural scrubland are found.

Lough Melvin's ecological assets and values provide for a wealth of "spin-off" tangible and intangible environmental, social and economic benefits e.g. tourism, drinking water supply, and ecological interest. The lake is a very important recreational and heritage area for anglers, tourists, scientists and the local community. In turn, the economic and social benefits depend on and consequently will impact on, the ecological integrity and health of the system.

Plate 2: Lough Melvin and surrounding land uses of forestry, housing and agricutlture

There are many pressures acting on the environment of Lough Melvin, which can adversely affect and alter the quality of the habitat that the lake and surrounding catchment provides. The health of Lough Melvin and its ecological communities is particularly vulnerable to catchment pressures and landscape uses. The biological integrity of the lake is at risk from a number of key threats, which include the introduction of pest plants and animals, water abstraction, climate change, fish stocking, land clearance and disturbance, recreational pressures and drainage/dredging of tributaries. However, the most significant threat is nutrient enrichment (from housing, forestry and agriculture) which inevitably lowers biodiversity.

4 A High Risk Catchment

Phosphorus is transported from land to water in decreasing order of importance via surface runoff, subsurface flow and leaching to groundwater. The export rates of phosphorus can vary considerably with catchments depending on soil type, hydrology, slope and climatic conditions.

Rainfall and runoff are high within the Lough Melvin catchment and the soils are naturally nutrient poor and inefficient at binding and holding onto phosphorus. Soils are poorly drained so that surface runoff is commonplace. This, in association with high slopes and an extensive hydrological network makes the catchment particularly effective at rapidly transferring phosphorus from land to the lake. Areas in the catchment that may be particularly prone to the loss of nutrients were defined using three catchment characteristics for specific risk factors for phosphorus loss. These were: distance from watercourses or hydrological connectivity; slope and; soil desorption risk.

This analysis, shown in Figure 3, demonstrated that high risk factors predominated and for management purposes, provides justification that effectively the whole of the catchment is potentially at high risk for phosphorus transport. Overall, less than 4% of the catchment area fell into the lowest risk classes for phosphorus desorption, hydrological connectivity and slope. Some 36% fell into the highest risk class for each of these three categories. The soil phosphorus desorption map also shows very limited areas (3%) that could be considered to have low or medium risk of desorption of P from any soils in the catchment that are enriched with phosphorus. For hydrological connectivity, over 60% of land is within 200m of a stream. This measure of connectivity is based on the river and stream network shown in the 1:50000 Ordnance Survey map and so ignores connectivity provided by the multiplicity of small open field drains that occur throughout the catchment. Only for slope was a majority of the catchment area not in the highest risk class.

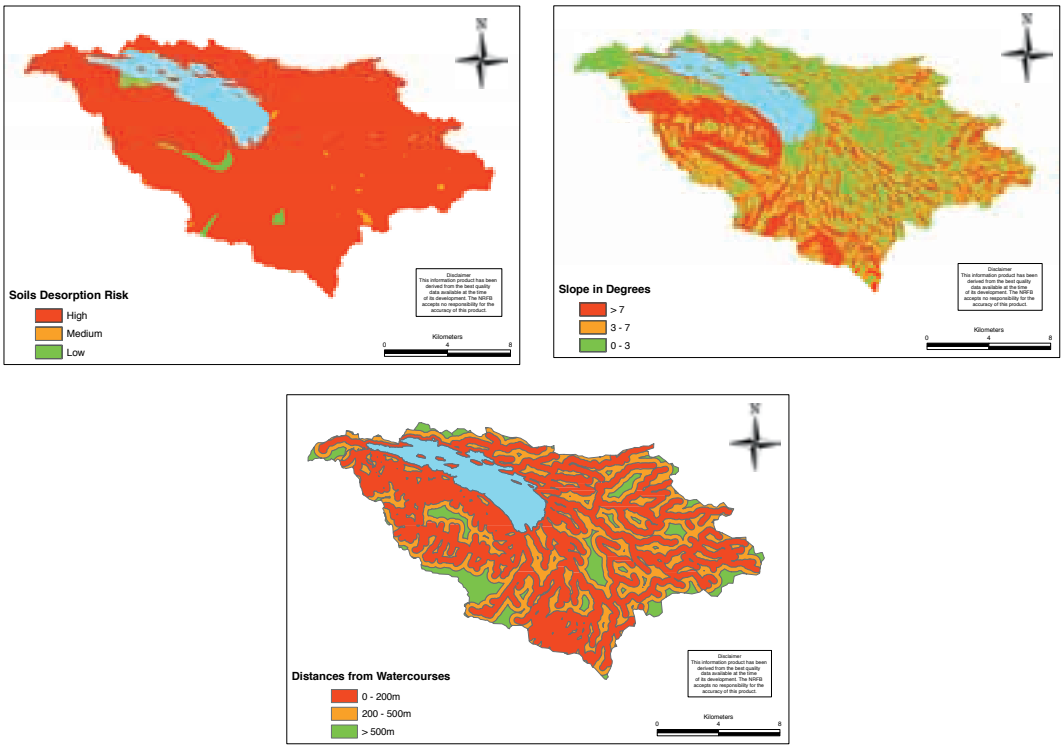


Figure 3: Soils Desorption risk, slope risk and distances from watercourses maps (left to right).

It is recommended that the whole of the Lough Melvin catchment be considered to have a high overall risk of phosphorus loss from diffuse pollution.

5 Lough Melvin's Water Quality Status

5.1 Overview

Prior to the investigations on Lough Melvin during 2006 and 2007 that are reported in this section, the only integrated monitoring programmes on the lake and its inflowing river network were from 1990 and 2001/02. These studies combined physical-chemical and biological monitoring. Additional surveys of lake nutrients and chlorophyll a were available from 1995 and from 2002 to 2004. The main finding from these investigations was that total phosphorus (TP) concentrations in the lake increased after 1995. Freshwater eutrophication is closely linked to increased availability of phosphorus as this nutrient usually limits primary production. As TP is used as a key parameter for defining the trophic status of lakes and rivers, the increase was and is a cause for concern in the management of the lake. During 1990 and 1995/96, mean TP concentrations in Lough Melvin were quite stable at close to 19 µg L^{-1}, which is typical of a mesotrophic lake. By 2001/02, TP was over 50% higher to 30 µg L^{-1} which was approaching the lower limit of 35 µg L^{-1} used to define eutrophic lakes. In addition, significantly higher TP concentrations were observed in inflowing stream waters in 2001/02 compared to 1990 linking the increase to greater external inputs of phosphorus from the catchment.

However, the increase in TP loadings to the lake observed in 2001/02 was smaller than the increase in lake TP concentration, so that the higher losses of TP from the catchment recorded in 2001/2 alone could not account for all the rise in lake TP concentration. It was suggested by Girvan & Foy (2006) that this discrepancy reflected an unusual or one-off perturbation of the catchment in the late 1990s and/or 2000, which caused a pulse of phosphorus to enter the lake, contributing to the elevated lake TP observed in 2001. A potential candidate for this perturbation was increased clearfelling in the catchment as a severe storm in December 1998 left extensive areas of fallen coniferous trees and was followed by timber recovery and accelerated rates of clearfelling. Clearfelling of conifers on peat soils in Ireland has been found to increase phosphorus concentrations in drainage water. It therefore was judged likely that increased forestry activities were responsible for the rapid increase in lake TP between 1995 and 2001.

A number of other observations from the lake and catchment were consistent with a sudden forest related perturbation around 1999/2000. For example, between August 2002 and the end of 2004 lake TP concentrations declined to an average of 24.5 µg L^{-1}, suggesting a measure of recovery. Additionally, water clarity had decreased in Lough Melvin by 2001/02, which was consistent with another observed impact of clearfelling on peat soils, namely increased dissolved organic carbon losses, which give the waters of Lough Melvin their characteristic peat stain.

Although TP measured in 2004 had declined from the concentrations observed in 2001/02, the mean concentration remained some 25% above values recorded in the 1990s. The limited monitoring record could not determine whether this was due to a long-term increase in lake TP or a legacy effect of the perturbation that occurred around 2000. If the lake was undergoing a long-term increase in P, then the increase observed between 1995 and 2004 was such that if continued unabated, enrichment would shift lake TP from its desired mesotrophic class to a eutrophic status by around 2030.

Accordingly, and to provide up to date information on water quality and loadings of nutrients to the lake an integrated programme of water quality monitoring was commissioned as part of the Lough Melvin Nutrient Reduction Programme. With respect to TP and chlorophyll *a* the data obtained for all monitoring is summarised in Figure 4.

5.2 Results

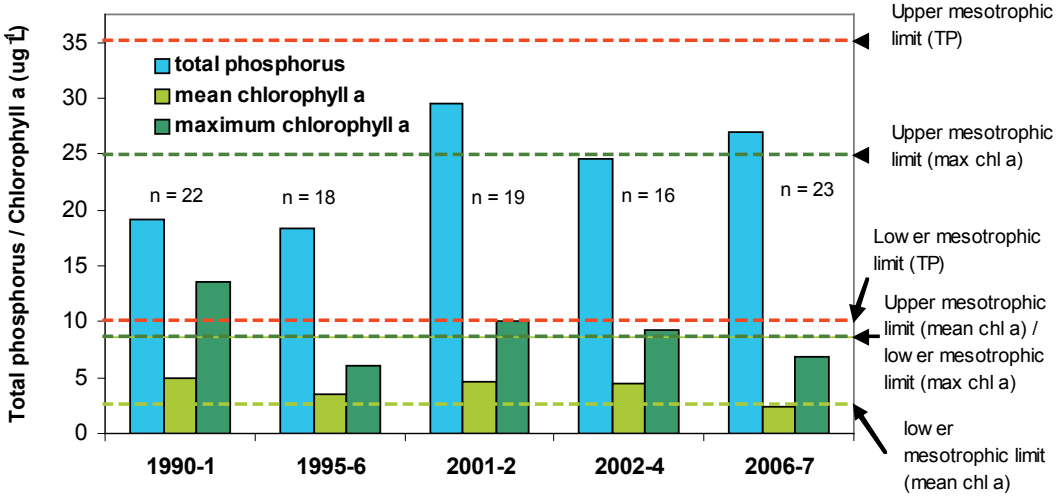


Figure 4: Mean annual total phosphorus, mean annual chlorophyll a and maximum chlorophyll a concentrations. Upper and lower limits are shown for mesotrophic status based upon the OECD (1982) classification scheme.

Monitoring of the lake in 2006-7 found no evidence for a continued decline of lake TP that was observed from 2001 to 2004, but rather TP increased to 27 µg L^{-1} or 50% above what are considered to be base levels observed in 1990 and 1995.

Despite considerable phosphorus enrichment, algal abundances in Lough Melvin have remained at low levels indicative of oligo-mesotrophic status. Clearly, factors other than phosphorus availability must also limit algal production. Sufficient light for photosynthesis and growth by algae only reaches to (no more than) five metres depth in Lough Melvin due to rapid attenuation by the peat stained water. As a result, algae spend the majority of time in darkness and receive insufficient light to exploit the abundance of phosphorus. Peat staining has therefore exerted a stabilising effect in Lough Melvin by counteracting the algal response to phosphorus enrichment.

Plate 3: Algal Bloom in Lough Melvin

Nevertheless, phosphorus-enhanced algal growth still presents a significant threat. The frequency and severity of blue-green algal blooms, that are unsightly and potentially toxic to humans, pets and livestock, is far greater under conditions of high phosphorus availability. Sheltered bays and backwaters, which possess a high recreational and aesthetic value, are particularly prone to prolonged blue-green algal blooms. The littoral zones of the lake may also be subject to increasing pressure on the basis that algae attached to the substrate and aquatic plants are not limited by light and will exploit increases in phosphorus availability. Fast growing filamentous species of algae tend to become dominant under conditions of nutrient enrichment and these have the potential to displace natural floras and alter community structure. This is of particular significance in Lough Melvin where the littoral macrophyte community is a primary reason for its designation as a Special Area of Conservation (SAC) under the Habitats Directive.

Widespread increases in phosphorus export intensity have occurred in the catchment. The south-east area of the catchment, largely devoted to agriculture, has consistently shown the greatest increases. Accumulation of soil phosphorus, poor septic tank functioning and a number of agricultural practices are highlighted as potential causes. Additional monitoring in 2006-07 showed that forested areas have among the highest phosphorus export rates in the catchment but some of the lowest nitrate export rates, while agricultural areas displayed both high phosphorus and nitrate export rates. Discharges of effluent from the three wastewater treatment plants within the catchment presently play only a small role in the enrichment of the lake. However, there are numerous new developments and as their associated human populations expand they have the potential to increase phosphorus inputs to the lake.

The gradual increase in phosphorus loading from diffuse sources is currently the most significant long-term cause of enrichment of Lough Melvin. However, the rapid increase of phosphorus export following clearfelling, although relatively short lived, has highlighted the need for an integrated approach to forest management for the Lough Melvin catchment as a whole. For example, annual limits of the areas subjected to clearfelling should be managed on a catchment basis so as not to jeopardise the status of the lake.

The annual cycles of temperatures and dissolved oxygen concentrations has been relatively consistent since 1990, and remain favourable for aquatic biota. Periods of stratification were observed in 2007 during which dissolved oxygen became depleted in the deeper waters, however these were of sufficiently short duration to allow dissolved oxygen to remain sufficiently high so as not to warrant immediate concern.

The zooplankton and phytoplankton communities in Lough Melvin have not displayed any major shifts over time although the abundances of species that can utilise terrestrial organic matter washed into the lake have significantly increased, suggesting that such exports have increased.

Plate 4: Stonefly Nymph

The low algal abundances observed in 2006/2007 may simply reflect a natural fluctuation. However, there is evidence to suggest that due to the greater organic matter loading, attenuation by dissolved terrestrially derived compounds may have increased the degree of light limitation and thus decreased primary production. Additionally, they may reflect increased predation by zooplankton on phytoplankton, with the zooplankton populations stimulated by increased organic matter loadings from the catchment. The potential for a decrease in the overall productivity of the lake due to higher catchment inputs of organic carbon exists and may be of significance in regard to the long-term quality of the lake as a recreational fishery.

Lough Melvin currently fulfils the criteria required to justify designation as a mesotrophic lake. Nevertheless, the clear upward trend in phosphorus loading and lake concentration demonstrates that action must be taken to avoid further deterioration of the habitat and a breach of the lower eutrophic threshold.

6 Concentration and Load Targets

To maintain the ecological, social and economic values that Lough Melvin supports, the concentration of phosphorus in the lake must be maintained at a sustainable level. Current nutrient loads to Lough Melvin are approximately 13 tonnes of P per year with the concentration in the lake now averaging 27 µg L^{-1}. This is a 50% increase on what are considered to be base levels in 1990 of 19 µg L^{-1}.

A TP concentration of between 19 and 25 µg L^{-1} equates to an average nutrient loading of less than 10 tonnes to 12 tonnes per annum. Therefore, a reduction in loads of approximately 3 tonnes (23%) would be required to reduce the concentration in Lough Melvin to baseline levels.

7 Agriculture

In Ireland, eutrophication of rivers and lakes has been identified as one of the major causes of impaired water quality. Eutrophication of rivers and lakes due to P losses has been identified as the most important impact of Irish agriculture on water quality. The increased agricultural contribution to the phosphorus loading of surface waters in recent decades has coincided with the departure from traditional extensive farming practices comprising grazing, haymaking and out-wintering of cattle towards a more intensive form of agriculture.

Plate 5:
Cows grazing in the Lough Melvin catchment and cows in Lough Melvin

Nutrient losses from agriculture may have point or diffuse origins. Point sources, those which have a discrete point of origin, may include runoff from yard areas, defective tanks and leaks. Diffuse sources are derived from accumulated soil nutrients which are then lost in runoff from the land. To achieve a satisfactory level of productivity farmers apply fertilisers, but increasing the nutrient supply to land over and above agronomically optimum levels also increases the relative risk of nutrient loss to water. Soils have a finite capacity to absorb phosphorus and soil P levels that exceed this capacity may result in increased P-concentrations in soil water. Whilst this phosphorus loss can be agronomically insignificant, it can have significant limnological implications with concomitant environmental and economic costs. Such phosphorus losses are not evenly distributed within agricultural land but show a pronounced spatial variation according to hydrology, agronomic management and soil type. While the physical landscape characteristics and climate play a fundamental role in determining the potential for phosphorus loss in any given area (i.e. govern the potential for transport), the main source of P is determined by Soil P Test levels as a function of historic and current nutrient inputs and land management practices.

Agriculture has been identified as one of several sources of phosphorus to Lough Melvin. Previous reports (Girvan & Foy, 2003) on water quality in the catchment demonstrated that agriculture was the largest single contributor to the phosphorus loadings to the lake. The sensitivity of Lough Melvin is such that further increases in loads are undesirable and thus there is an urgent need to develop and implement mitigation strategies for P-loss from agriculture.

Agriculture in the Lough Melvin catchment is considered extensive. Stocking rates are generally low and largely reflect the limited carrying capacity of the land. Soils in the catchment are dominated by gleys and peats, which cover 47% and 40% of the catchment area, respectively. The former are characterised by poor drainage characteristics and weak structure. This limits their landuse and carrying capacity, and leaves them vulnerable to poaching damage by grazing stock, which may increase the risk of overland flow

and associated P loss. The farming landuse on these soils is therefore mostly confined to suckler and sheep enterprises. Traditionally, initiatives to improve nutrient management on farms have tended to focus on the needs of intensive farming and operate within a framework that will ensure optimum production, and are not necessarily aligned with the geo-environmental context of catchments where stocking rates and soil phosphorus levels are relatively low.

Plate 6: Silage Bales

Currently, there are both regulatory and voluntary controls on agriculture to protect water quality. The implementation of the Nitrates Directive and the Water Framework Directive (WFD) has posed challenges to agriculture to modify nutrient management practices so that the "good ecological status" requirement of the WFD can be achieved by 2015. Voluntary agri-environmental schemes (AESs) established under Regulation 2078/92 of the 1992 Common Agricultural Policy (CAP) reward farmers for farming in an environmentally responsible manner. Regulation 2078/92 stipulated that "measures must contribute towards other specific environmental goals set out in Community legislation". In this respect, agri-environment measures may be used to meet commitments under the Nitrates Directive and Water Framework Directive and may necessitate customised streams within them requiring more targeted management regimes to protect the more sensitive waters.

The aim of Strand 2 was to identify the specific risks of nutrient loss to water quality posed by agriculture in the Lough Melvin catchment (with wet soils and a mesotrophic waterbody) and, in order to reduce P losses to water, determine appropriate agri-environmental measures to address these risks. These measures could then be promoted for uptake voluntarily, via the AESs either by incorporating the measures identified into them, or alternatively implementing them via a stand-alone scheme for the catchment.

7.1 Methods

Existing datasets were collated to assess landscape conditions and agricultural activities in the catchment. Farm stakeholders were contacted to identify their perception of the main environmental issues in the catchment, risk assessments were undertaken for individual farms, and mitigation measures were identified and evaluated. Therefore, the methodology comprised two distinct aspects: (i) identification of risks and (ii) identification and evaluation of measures. The identification of risks comprised five components, namely farm selection, farm systems survey, farmyard survey, field-by-field survey, and estimation of stock carrying capacity. Identification of measures to address these risks involved literature reviews and consultation with researchers and other relevant stakeholders. The identified measures were subsequently evaluated by researchers, policy-makers, practitioners, and farmer stakeholders through survey questionnaires and workshops. The participation of farmers in these processes was considered central to the successful identification of measures that the farmers would be willing to implement. The final stage in evaluating the measures was determining the effectiveness of the measures and costing them so that a cost-effectiveness analysis could be completed. This was to achieve a balance by realising the need for a trade-off between measures popular with farmers and equally important, the desire for policy-makers to mitigate P loss at least cost.

Plate 7:
Slurry pit almost full mid-January

7.2 Results

Many of the risks associated with agriculture are intensified in the Lough Melvin catchment due to its bio-physical environment - high rainfall levels, high runoff risk, high drainage density and high desorption risk (due to the preponderance of peat and gley soils), - all of which create conditions that potentially exacerbate phosphorus loss to water. The field-by-field surveys found that 31% of the surveyed area presented a geo-environment with high risk for phosphorus loss to water owing to the coincidence of source and transport P-loss factors. A further 30% had a medium risk and 39% presented a low risk for phosphorus loss.

Specifically, outside of risks associated with the landscape, the following risks from agriculture were observed:

The farms surveys demonstrated that there is significant scope for improvement in nutrient management planning (NMP) on many farms. This was primarily attributed to the lack of specific information on soil test P levels of individual fields (with specific reference to the lack of identification of Index 4 fields), a lack of knowledge on NMP or lack of alignment of NMP to the Soil Test P of individual fields, or to difficulties with slurry management due to landscape conditions. P inputs in excess of agronomic requirements were commonly observed, which over time have resulted in a build-up of soil P levels – 22% of the surveyed area within the catchment was in Index 4. Having soils at Index 4 STP levels produces no agronomic benefit whilst presenting a potential threat to water quality. This build-up of P was found to be localised within farms and resulted from slurry applications being concentrated on a limited number of fields. This practice reflects the limited spread areas available on the ground which is primarily a consequence of soil conditions or topography affecting accessibility and trafficability. The high P inputs to certain individual fields may also reflect the tendency to maximise output (in order to maintain stocking rates) on those fields where possible to compensate for the lower productive potential of other fields.

As well as the application rates, the application timing also presents a risk to water quality. These applications, at inopportune times (on poor soil conditions in early spring), in a landscape where the potential for incidental losses is high are often necessitated by inadequate storage facilities that are legally compliant but not always adequate, particularly in "wet" springs. These difficulties highlight the problem associated with slurry management in such a landscape and warrant further research and development on sustainable farm management strategies.

Plate 8: Slurry applied to field where site conditions present risks for loss

7.3 Recommendations

A management prescription for agriculture in the catchment to reduce P loss has been proposed based on the measures identified from the literature, the results of the evaluation of these measures by the various relevant stakeholders (including local farmers), and the cost effectiveness analysis of the measures. The recommended management prescription for agriculture in the catchment is based on the following four pillars:

Pillar 1 involves provision of nutrient and agri-environmental advisory programme that includes soil testing and a Nutrient Management Plan (NMP), free of charge to the farmer. This will involve adoption of the most cost-effective and popular source reduction measures. It is considered pivotal in facilitating knowledge transfer and implementation of Best Management Practices, in order to reduce P loss in the long-term by addressing sources or pressures. Elements of this NMP should include the following category A measures:

1. Identification of Index 4 soils and peaty soils, by soil sampling of all fields within the catchment.
2. Reduce slurry/fertiliser application rates to agronomically optimum levels: this represents a direct win-win situation in which both direct costs to the farmer and potential for P-loss to water are reduced simultaneously.
3. Feeding low P concentrates. Though this measure will be cost-effective, its total impact will be small in light of the relatively small of P entering the catchment in the form of concentrates.
4. Removing P in silage and not replacing the P off-take on Index 4 soils. This measure will be restricted in its application as it will only be applicable to a limited number of fields and subject to the availability of alternative and suitable spreading areas.

Pillar 2 involves reducing P loss in the short-term by addressing pathways. This will be effective in improving water quality in the short to medium term by intercepting P that is being lost in runoff. This will involve adoption of the most cost-effective and popular interception measures. These measures include:

1. Sediment barriers or sedimentation ponds in drainage ditches.
2. Grass buffer zones of 2.5m width adjacent to water courses.
3. Hedgerows aligned to the relief profile; perpendicular to overland flow.

The latter two measures are currently optional under existing AESs and could be encouraged for uptake in the Lough Melvin catchment.

Together, implementation of Pillars 1 and 2 are estimated to have the potential to reduce P-loss to water by c. 50% of theoretically maximum potential reduction at 6% of theoretically maximum potential costs.

Pillar 3 In the event that the implementation of measures in Pillars 1 and 2 should not lead to sufficient reductions in P-loss from water, implementation of reserve measures (i.e. measures that were ranked to be medium cost-effective and/or "second choice" with farmers) for source reduction or pathway interception could be considered. These include:

1. Provision of compensation for reductions in overall stocking rate.
2. Provision of compensation for reductions in stock by selling calves in autumn.

Together, implementation of Pillars 1 and 2 and 3 are estimated to have the potential to reduce P-loss to water by c. 80% of theoretically maximum potential reduction at 16% of theoretically maximum potential costs.

Pillar 4 involves a review of concerns not addressed by these measures. Further considerations, which relate to the current instruments regulating agriculture in the catchment may also need to be evaluated and enhanced if required:

1. The main challenge in the catchment is the limited slurry spreading area available. This results in slurry applications being concentrated on those fields where accessibility is possible. A manifestation of this is that 22% of the surveyed area is in STP Index 4. This is currently only partly addressed by the Action Plan for the Nitrates Directive, i.e. there may be sufficient forage area or 'net farm area' to suggest that there is < 170kg ha^{-1} but in reality, much of this organic N may be concentrated on a limited number of fields. In the event that implementation of Pillars 1, 2 and 3 does not result in adequate reductions in P-loss to water, withholding slurry applications on Index 4 soils may be required. At the same time, this should not be allowed to lead to situations where slurry is consistently and singularly re-routed to Index 3 soils with high connectivity to water.

2. In the current Action Plan for the Nitrates Directive in the Republic of Ireland (RoI) states that an Index 3 can be assumed where a soil test is not available. This facilitates continued P inputs to fields that are at Index 4 where these remain unidentified. By contrast, under the Northern Ireland (NI) regulations P from fertiliser may only be applied if soil analysis shows that there is a requirement for it and this is potentially an approach that would have merits across the entire catchment.

3. A concern raised by various stakeholders has been the building of housing and slurry storage facilities under the Department of Agriculture grant schemes in the RoI. These concerns have included the facilitation of intensifying agriculture by allowing more livestock to be kept, facilitating animal B&B arrangements, and finding suitable spread area for the additional slurry produced. There is anecdotal evidence that some farmers graze cattle outside of the catchment, bring these cattle back to the catchment for winter housing and also spread the slurry in the catchment. These practices may inadvertently be encouraged by current grant schemes.

4. In the recent past (last 12 months) the value of nutrients in slurry has increased sharply, following the sudden rise in fertiliser prices. Indeed it may now be economically feasible or even advantageous for farmers to export excess slurry to areas outside the catchment. In particular, this would address concerns identified above where availability of suitable spreadlands is limited to Index 4 soils, or where nutrients are imported into the catchment through animal B&B arrangements.

5. A significant proportion (perhaps 50%) of farmers in the catchment are currently utside of AESs; an increased participation rate in such schemes should benefit water quality. It is envisaged that participation in REPS may increase in the advent of increased payments under REPS 4. However, uptake may be accelerated with a concerted local promotion of the schemes by the relevant agencies. In the event that not all farmers participate it may be worth considering a stand-alone scheme for implementing specific measures to protect water quality. Such schemes may not require farmers to put all the farm under the scheme but only those high risk areas. One means of facilitating such a scheme would be via auction processes as discussed by Strand 3 project partners.

8 Forestry

Well-managed forests and woodlands provide social, economic and environmental benefits including recreational areas, rural employment and a range of ecological habitats. With respect to climate change, forestry offers a means of storing carbon dioxide and is a potential source of renewable energy. As a rule, the nutrient exports from forestry are lower than those recorded from agricultural land. Thus, a switch from agricultural land to forestry would be expected to lower inputs to water of phosphorus and nitrogen compounds.

Unfortunately, forestry activities also have the potential to negatively impact on the aquatic environment and some of these are the precise reverse of the benefits listed above. While nutrient exports from forests are lower than from lowland agricultural land, in the uplands, exports of phosphorus from forestry are often higher than upland areas of rough grazing. Thus, forestry has been a source of eutrophication of upland lakes. It has also been implicated in acidification, bank erosion and sedimentation.

Plate 9: Forestry on blanket peat in the Lough Melvin catchment

The potential for heavily afforested coniferous catchments to act as a diffuse source of nutrients has been well documented within northern Europe and is particularly relevant for a sensitive catchment such as Lough Melvin. The potential for forestry to result in erosion, sedimentation and alter catchment hydrology are also of concern to the extent that they adversely impact on salmonid survival. The majority of phosphorus entering Lough Melvin originates from diffuse sources within the surrounding catchment and although established forests contribute or lose only relatively small amounts of phosphorus, losses can increase substantially during the establishment, fertilisation and deforestation phases particularly on peat soils.

8.1 Lough Melvin Study

As part of the Lough Melvin Nutrient Reduction Programme, the objective of the Forestry Component was to assess the potential risk that forestry poses to the nutrient status of Lough Melvin. This involved determining the characteristics of forestry within the Lough Melvin catchment; identification of areas and activities considered to be of high risk of causing eutrophication and, where possible, quantification of the potential impacts. Where sufficient information was available, mitigation measures have been proposed. The information collation and review stage was greatly aided by members of the Forestry Working Group (Forest Service NI, Forest Service RoI, private foresters and Coillte).

Compared to the island of Ireland where forest cover is only 10% of the land area, forestry is a much more significant land cover in the Lough Melvin catchment as it accounts for over 25% of the catchment area (Figure 5).

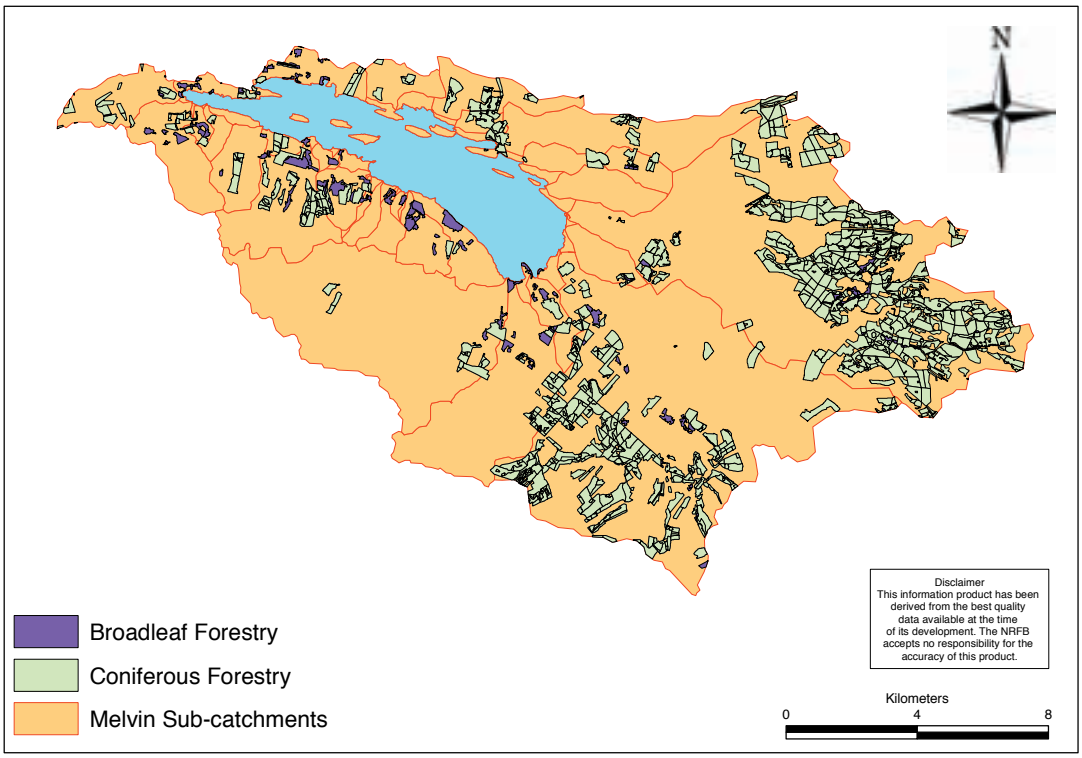


Figure 5: Distribution of Forestry in the Lough Melvin Catchment

The most prevalent commercial species planted throughout the catchment are Sitka spruce (*Picea sitchensis*) and Lodgepole pine (*Pinus contorta*) which are particularly suitable for the Irish climate and soil conditions. In total, 45% of forestry within the Lough Melvin catchment is grown on peat soils and 42% on gley soils, which have a low adsorption capacity for phosphorus. In addition, peat soils are relatively infertile and so require fertilisation.

8.2 Risk factors

Many of the risks associated with forestry are increased in the Lough Melvin catchment due to the sensitive catchment characteristics such as high runoff risk, high slopes, proximity to watercourses, high P - desorption risk and high precipitation rates. The following points highlight the key forestry related pressures within the Lough Melvin catchment.

- The low binding capacity of organic blanket peat for phosphorus. 45% of all forestry is grown on blanket peats and 42% grown on gleys.
- Nutrient deficient stands within the Lough Melvin catchment may require future applications of phosphate fertilisers.
- Low yield classes in the catchment may lead to future applications of fertiliser at the reforestation stage.
- 61% of Coillte and Forest Service NI forestry was planted before the introduction of the *Forestry and Water Guidelines* and the introduction of forest certification. Buffer zones are absent in many of these older sites.
- The catchment has a high run-off risk and a high connectivity due to its high density drainage network. The Roogagh and County rivers drain heavily forested sub-catchments.

- 49% of the forestry in the catchment is planted on areas classified as having high risk for soil desorption, slope and proximity to watercourses.
- Windthrow sites are common throughout forested areas of the catchment leading to increases in clearfell activities.
- Clearfell activities pose a risk of elevated phosphorus loss due to the breakdown of brash especially on blanket peat sites.
- Currently 419 ha are identified for clearfell in the catchment in 2015 but there is insufficient cross-border consultation between the forest management organisations regarding how the total yearly area of clearfell and fertiliser application in the catchment may impact on nutrient losses to Lough Melvin.

8.3 Future Nutrient Loads from Forestry

Clearfelling is identified as the forestry activity that has the greatest potential to cause the release of nutrients. Therefore, this section focuses on future clearfelling activity within the catchment to highlight the future loads expected from forestry over the next 7-8 years. Locations of proposed clearfelling within the Lough Melvin catchment between 2007 and 2015 are largely within the heavily forested Roogagh catchment although an area on the north-eastern shore of Lough Melvin near Muckenagh Bridge is identified for clearfelling in 2011 that could directly impact on the lake. The most notable feature is that there are 419 ha projected for clearfelling in 2015, which is almost 15 times the area clearfelled in 2007.

Table A: Forest areas projected for clearfelling in the Lough Melvin catchment 2007-2015.

Year of Clearfell	Area
2007	28 Ha
2008	32 Ha
2009	88 Ha
2010	72 Ha
2011	115Ha
2012	75 Ha
2013	20 Ha
2014	131 Ha
2015	419 Ha

To quantify the total phosphorus loads from future clearfell operations within the Lough Melvin catchment, a phosphorus loss model was developed that assessed the impact of clearfelling using phosphorus exports rates from forest land. The model shows significant increases in phosphorus loss from increased clearfelling activities within the catchment between 2007 and 2015, but most particularly in 2015 with loads projected to increase from 625 kg P in 2007 to 3530 kg P in 2015 (Figure 6). Note that these loads are for clearfelling only and do not include nutrient loads from other forestry activities for e.g. fertilisation. These loads can be compared with the current loading of phosphorus to Lough Melvin, which is estimated to be approximately 13 tonne P per year but with a target of 10 tonne P per year. Thus, the projected loading for 2015 from clearfelling alone of 3.5 tonnes P is 27% of current loading, which is considered undesirably high. Based on current knowledge it would be expected that lake concentration of total phosphorus would increase in proportion to the increase in catchment loading.

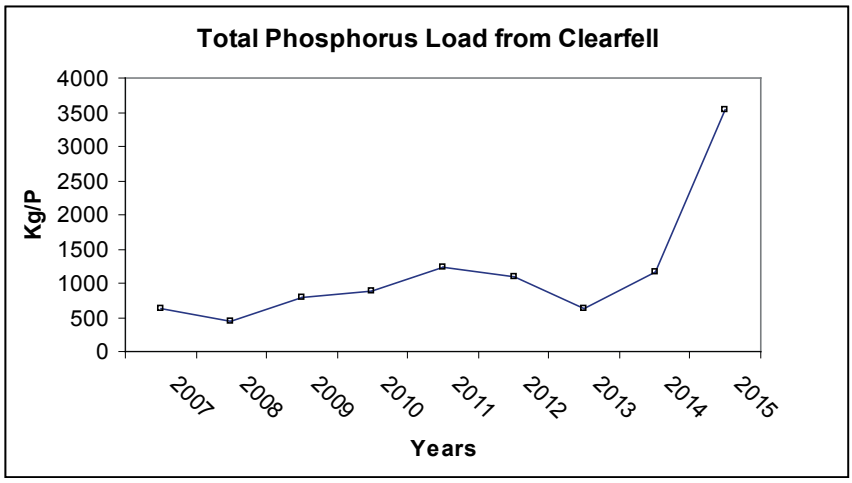


Figure 6: Forecast Phosphorus loads from clearfelling operations (only) in the period 2007-2015.

If these activities progress with no intervention or mitigation, and assuming that there are no other increases in phosphorus from other forestry activities or other land use activities within the catchment, then the concentration in Lough Melvin would be expected to increase to between 32 µg L^{-1} and 34 µg L^{-1}.

8.4 Recommendations

It was widely acknowledged by stakeholders including members of the Forestry Working Group, that the Lough Melvin catchment is highly sensitive and that forestry organisations have an obligation to reduce the potential risk forestry activities pose to the ecological status of the lake. The forestry industry over the past 20 years has made significant changes to forestry practices and developed new environmental guidelines in line with scientific research, to minimise the impact on the environment. However, the sensitivity of the Lough Melvin catchment to nutrient loss and the sensitivity of the lake to nutrient enrichment must be stressed, reiterated and accounted for. The interaction between forestry and water is complex and risks of phosphorus loss are increased under particular catchment characteristics.

In light of the increase in nutrient loads from clearfelling activities alone within the catchment in the short to medium term, it is imperative that measures are put in place to reduce or eliminate the impacts on Lough Melvin. Consequently, a total of 57 forestry measures were developed from literature and in consultation with technical experts, to reduce the impacts of forestry on the water quality of Lough Melvin. The measures aimed at building on existing protective measures incorporated in the Forestry and Water Guidelines and were targeted specifically to the Lough Melvin catchment. The measures were ranked and prioritised and then assessed at a Forestry Workshop.

The following top 8 measures were identified:

1. Buffer zones should be created beside watercourses in line with best management practices where windthrow is not a risk factor. This measure would require operational change for existing sites.
2. Coillte and the Forest Service NI should develop progressive felling plans on a whole catchment basis. This requires annual consultation between the two organisations.

3. Aerial fertilisation proposals from RoI and NI should be combined prior to consultation with the regulatory authorities at a cross border level i.e. The Fisheries Board, River Agency and E.H.S. This measure requires only operational changes and could be done with an annual assessment and agreement between Coillte and Forest Service NI.
4. Brash should be removed as far back from watercourses as possible. This measure will require operational changes and environmental side effects would need to be considered.
5. On clearfell sites, strategically position ochre at the end of collector drains (Pilot Study to be undertaken by COFORD).
6. The poorest nutrient deficient sites should be identified and allocated for areas of open space as part of forest redesign plans. This most appropriate delivery route for this measure is considered to be the Indicative Forest Strategy and Forest Design Plans. It was considered a measure that could easily be accommodated in the NI portion of the catchment.
7. On reforestation sites, no fertiliser should be applied until vegetation has re-established.
8. In areas of high risk, silt traps should be installed either prior to ground preparation or harvesting. This is already standard practice.

Other recommendations from the Forestry Working Group:

- Sensitive areas (such as spawning grounds) in the catchment should be better identified and forestry operators made aware.
- Difficult forestry sites posing single event risks should be identified and managed through correct environmental planning.
- Where sensitive sites and difficult forestry sites combine, consultation between appropriate agencies on protective measures is needed.
- The planting of broadleaf woodland should be undertaken in areas of high run-off risk, areas prone to over grazing and poaching from intensive stocking.
- The current study did not have a monitoring programme that was targeted to specific land uses and it was recommended by the Forestry Working Group that an independent, targeted monitoring programme be established immediately for the Lough Melvin catchment to identify the benefits and impacts of forestry on water quality.

8.5 Summary

The agreement by the forestry organisations on a set of measures is a first step towards managing the increased nutrient loads expected from forestry in the future. However, it is only a first step. It is essential that consultation and cooperation is enhanced between the forestry organisations operating in the catchment and that the recommendations presented in this study are developed further and ultimately implemented. Work must continue to deliver action on the ground, before any environmental benefits can be realised.

9 Housing-Wastewater

In the past decade, the human population within the Lough Melvin catchment has increased dramatically in line with the growth in housing experienced around the country. The population of Kinlough, which has perhaps seen the greatest increase in number of dwellings in County Leitrim, doubled between the censuses in 2002 and 2006, from over 300 to nearly 700. Currently, there are approximately 3000 people resident within the catchment with approximately 40% (1161) resident in three villages; Kinlough and Kiltyclogher in County Leitrim and Garrison in County Fermanagh (Figure 7). In addition, Rossinver in County Leitrim is a small hamlet located on the Ballagh River.

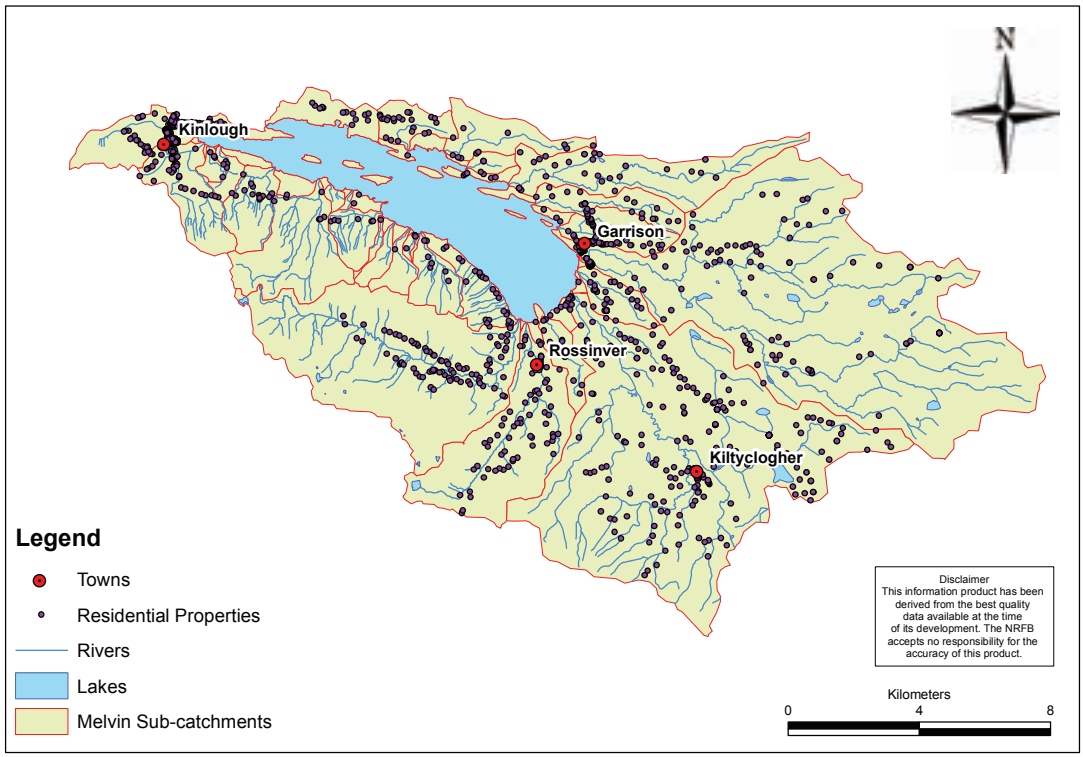


Figure 7: Urban centres and rural residential properties in the Lough Melvin catchment

The impacts of increased development and housing within the catchment include land disturbance that causes erosion and sedimentation in nearby waterways and organic pollution of water. For lakes, the dominant impact is eutrophication from wastewater generated by occupied dwellings. Wastewater contains significant amounts of phosphorus primarily from sewage and the use of household detergents. Currently, for housing in the Lough Melvin catchment most of this phosphorus will reach the lake, contributing to the lake's nutrient loading.

The main purpose of wastewater treatment processes, either through a Wastewater Treatment Plant (WWTP) or on-site wastewater treatment system is to remove organic matter and pollutants such as ammonia. However, these systems are not necessarily designed or effective at removing nutrients, especially phosphorus, and this is particularly the case for septic tanks within the Lough Melvin catchment.

A short desktop study and septic tank survey was undertaken to identify and highlight the potential issues associated with wastewater and housing within the Lough Melvin catchment. The outputs are summarised below.

9.1 WWTP

In the Lough Melvin catchment, the villages of Kinlough, Kiltyclogher, and Garrison are serviced by WWTPs. These plants treat the wastewater of 38% of the catchment population.

The effluent from Kinlough WWTP enters Lough Melvin via the Kinlough River at the south–western end of the lake. In 2006, Leitrim County Council installed phosphorus removal facilities (ferric dosers) with the aim of reducing effluent TP levels to < 2 mg P L^{-1}. However, there have been fluctuations in the quality of effluent being discharged from the WWTP. These reflect population expansion in Kinlough, which has limited the capacity of the WWTP to deal with peak loads. A new WWTP to be completed by 2009 will have a p.e. of 2100 and is considered to have significant capacity to cope with the further expansion of Kinlough. The effluent will be required to meet a stringent TP standard of 0.8 mg P L^{-1} which has been set by Leitrim County Council. This standard reflects the sensitivity of Lough Melvin to enrichment. Other standards to be met by the new WWTP are BOD <11 mg L^{-1} and total suspended solids <15 mg L^{-1}.

The Garrison WWTP, which provides primary and secondary treatment, discharges directly to Lough Melvin via a pipe that runs under the walkway at the Garrison Pier. Environment and Heritage Service have issued a Water Order Consent specifying the effluent annual average standard as 40 mg L^{-1} BOD, 60 mg L^{-1} suspended solids and 2 mg P L^{-1} total phosphorus. However, these levels are higher than those that have been set by Leitrim County Council for Kinlough WWTP. Monitoring results from 2006 and 2007 suggest that there is great variability in the quality of the effluent from the WWTP. Phosphorus removal facilities have recently been installed which should reduce the nutrient loading and an upgrade is planned to allow phosphorus removal, largely in recognition of the need to maintain the condition of the lake under the Habitats Directive.

Kiltyclogher WWTP is much smaller than those at Garrison and Kinlough as it services a population of approximately 170. It discharges via a drain into the County River. Treatment is considered to be poor, barely achieving secondary treatment standards and there is no facility for phosphorus removal. Kiltyclogher has also received funding for a new WWTP to be built on the same site with a capacity of 500 p.e. Work on the new plant was due to start in mid 2008 and be completed by the end of 2009. Standards to be met by the new WWTP are BOD <25 mg L^{-1}, total suspended solids <35 mg L^{-1} and total phosphorus <2 mg P L^{-1}.

Summary and Recommendations

- Modelling based on nutrient load per population equivalent estimates show that the three WWTPs in the Lough Melvin catchment potentially contribute 890 kg of TP to the lake per year. Kinlough contributes 480 kg P yr^{-1} (without P removal), Kiltyclogher 130 kg P yr^{-1} and Garrison 279 kg P yr^{-1} (without P removal). The total contribution from WWTPs is equivalent to approximately 7% of the annual loading of phosphorus to the lake.
- This contribution has been lowered through the installation of P removal and will be further reduced significantly when full operation of P removal facilities takes place. The new WWTP at Kinlough in particular will operate to a very high standard of phosphorus removal and has capacity to accommodate future expansion of the village.
- The populations that these three WWTPs serve are much smaller than the mandatory size required for the installation of phosphorus removal under the Urban Waste Water Treatment Directive. The operators of the WWTPs have taken the initiative in installing or planning for P removal and the presence of phosphorus removal at such small population centres is therefore a mark of their commitment to improving water quality in the lake.

- If an 80% removal efficiency, equivalent to removing 700 kg P yr^{-1} is achieved then the contribution these WWTPs to the total phosphorus loading to Lough Melvin would be in the region of only 1%. Lowering loading by 700 kg P yr^{-1} is quite small in terms of the current lake loading but it represents approximately 25% of the loading reduction of around 3 tonnes P yr^{-1} that is recommended for the lake. On this basis, it is important that the new and upgraded WWTPs are completed as soon as possible.
- There are continued concerns about the performance of the old plant in Kinlough while the new plant is being built in the same location, considering the small size of the site. This should be closely monitored and concerns should be addressed through timely communication with the local community.
- Given the development in the village of Garrison and the probable localised adverse ecological impacts of the existing discharge that are evident in the lake, plans to increase the capacity of the WWTP and install phosphorus removal should be put in place in the near future. In addition, the variability in the sampling results from the WWTP should be investigated.

9.2 On site wastewater treatment systems (OSWTS)

In rural areas with low-density housing, sewer systems are not a viable option and on-site treatment systems are utilised. The most common of these is the septic tank, although Proprietary Effluent Treatment Plants are becoming more common.

Plate 10: Low density housing within the Lough Melvin catchment

The majority of single dwellings in Ireland are serviced by septic tank systems and within the Lough Melvin catchment, 62% of the population (nearly 2000 people) rely on an on-site wastewater treatment system to treat household wastewater. Due to the type of landscape and water logged soils within the catchment, it is considered unlikely that septic tanks in the Lough Melvin catchment are working to a satisfactory level. The impracticality of monitoring septic systems means that their contribution in terms of phosphorus loading to Lough Melvin is uncertain. However, it is commonly observed both in the Lough Melvin catchment and elsewhere that most septic systems discharge directly to surface waters, so that rural population per capita values for phosphorus from septic tanks cannot be very different from the per capita phosphorus loadings from WWTPs. It is estimated that septic tanks could contribute 1.12 tonnes P yr^{-1} or close to 10% of the total input of phosphorus to Lough Melvin.

In order to classify the specific issues and risks posed to water quality by septic tanks within the Lough Melvin catchment, a septic tank survey was undertaken in January and February of 2008.

A summary of some of the information collated is provided below.

- Two chamber septic tanks with percolation trenches or soak pits accounted for 72% of treatment systems in the survey.

- 46% of the systems were over 20yrs old. Older systems are likely to comply only with standards at the time of building, which would now be considered inadequate (e.g. having soak pits rather than properly designed percolation areas).
- 66% of septic tank effluent was discharged to a drain and 8% discharged to a stream. This means that the majority of septic tank effluent has a direct pathway to a nearby waterway.
- 38% of the households surveyed had their septic tank desludged, but the frequency was inadequate, with only 24% desludging in the last 5yrs. Only 12% had desludged in the last 12 months. Over half of the respondents stated that they had never maintained the tank and/or were unaware when it had last been maintained.
- In severe cases there were:
  - No percolation systems and effluent discharged straight to stream or drain
  - No stones in soak pit
  - Badly designed percolation areas
  - Tanks sited on very steep slopes (14% on gradients greater than 1:5).

Note: the term "soak pit" is used to describe a hole in the ground filled with stones through which septic tank effluent is directed. Soak pits are no longer considered suitable as a part of the treatment system and have been replaced by properly designed percolation areas. However, they were historically utilised and are found throughout the catchment.

Wastewater treatment system surveys undertaken on 80 dwellings in the Ballagh River catchment in 2003 indicated similar problems with systems, with over half of owners having never maintained their septic tanks. In addition, this survey identified a communal Bord na Mona Puraflow system servicing five council houses in Rossinver that is less than 10m from the Ballagh River in an area subject to regular inundation.

Summary and Recommendations

Septic tank systems in the catchment pose a significant risk to the water quality of the catchment's waterways and Lough Melvin due to their location, age and maintenance regime of systems and the catchment's characteristic poor soils, high water tables and high slopes. A safe generalisation based on these factors and on site surveys within the catchment, is that the majority of septic tank systems are not operating effectively and any phosphorus removal is extremely limited. Recommendations (not exclusive) on how the risk to water quality can be addressed are presented below:

- An education and awareness programme should be developed and implemented by the relevant authorities as a high priority in the short term. Many community members are unaware of the maintenance requirements for their wastewater treatment systems or issues with contamination of nearby waterways. This is considered to be a relatively low cost and effective option for reducing the pollution risk from septic tanks.
- Enforcement authorities in some cases do not have sufficient resources to undertake adequate inspections of treatment systems within the catchment. Resources should continue to be sought for additional enforcement capacity and the catchment should be prioritised as a target catchment for proactive monitoring and enforcement.
- Alternative and more effective methods of treating household wastewater should be investigated for sensitive and high risk catchments such as Lough Melvin. This could include the investigation of the use of constructed wetlands and willow beds on sites where treatment of effluent is insufficient.

- Householders should be required to update their wastewater treatment systems to meet required standards. This should be grant aided and considered a high priority as it is very probable that there are a significant number of antiquated systems within the catchment.
- Consideration should be given to the introduction of bye-laws for the control of pollution from septic tanks.
- Further investigation on the communal wastewater system servicing the 5 council houses in Rossinver and less than 10m from the Ballagh River needs to be undertaken and a new system installed if flooding of the system is evident or its location is deemed high risk.
- The location and suitability of the Lough Melvin catchment for one-off housing should be critically considered by the relevant authorities. This should be done with a "whole of catchment" perspective because it is the cumulative impacts of housing and wastewater within the catchment that is the major issue. One off housing should not be permitted or at the very least severely restricted outside sewered areas or locations where proprietary treatment systems with P removal facilities are not practicable.

10 Nutrient Trading and Auctions

Agri-environmental schemes are a well established approach to nutrient management within catchments. However, research suggests the success of these schemes can be limited, for example, by engaging farms already managed to minimise nutrient runoff, resulting in overcompensation of compliance costs and a relatively low level of additional environmental benefits. As a more cost efficient alternative, Market Based Instruments in particular Nutrient Trading and Land Management Auctions, which create incentives for behaviour changes through market signals, were investigated.

Nutrient trading typically takes the form of a 'cap and trade' system where an absolute limit on emissions is set. 'Permits', allowing a specified level of emissions, are allocated, before a market for trading is created. Those who exceed emission reduction can sell excess permits to those who find it more costly. Where insufficient permits are held to cover discharge levels, either additional permits must be purchased or discharges must be reduced through abatement or increased efficiency, otherwise a fine will be issued.

Benefits associated with trading schemes are cost efficiency, they facilitate economic growth, incentivise innovation to reduce pollution, can result in indirect environmental benefits, they are flexible and facilitate stakeholder engagement. Challenges include difficulty in monitoring diffuse sources of pollution, difficulty in ensuring trades have an equivalent impact on water quality, high levels of risk and uncertainty, difficulty in identifying a suitable regulatory agency and potentially high costs. Examples of water quality trading schemes that involve a high level of trades and have been operating for any considerable length of time are scarce. This may indicate the limited potential for application of a trading scheme in this context. However, case studies highlight that successful schemes tend to have low costs, local management initiatives, have a relatively simple design and stakeholder collectives to spread risks.

Auctions for land use management are used to select landholders that will be allocated payment for implementing management practices that reduce pollution output. Typically, farmers submit 'bids' to the regulator outlining compensation required for implementation of approved agri-environmental measures. Bids are scored using a weighting index to reflect benefits that are most highly valued by the agency. Those bids which offer most environmental benefit for least cost are awarded short term contracts. Through the competitive bidding process, true costs of participation are revealed resulting in more cost efficient allocation of funding. For this reason, they are considered to be less subjective. Auctions are more suitable where

nonpoint sources occur, they are flexible and transparent. Challenges include the potential for high administrative and transaction costs along with difficulty in identifying a suitable regulatory agency. The need to design the auction to suit the specific circumstances is essential to ensure success. Application of such schemes highlight the potential for considerable cost savings. Successful auction schemes tend to involve stakeholders from an early stage, provide support to assist landholders in constructing bids and reduce the cost of bid preparation and finally, adopt an auction design that is well developed through pilot and trials.

Plate 11: Cattle

Based on available information, the report suggests that nutrient trading is not a viable nutrient management approach for implementation in the Lough Melvin Catchment. Significant problems arise from the small number of point sources which contribute a relatively low proportion of phosphorus to the lake. Given the difficulties with trading between nonpoint sources, arising from the costs incurred from monitoring diffuse pollution sources, it is likely that the costs of operating such a scheme would significantly outweigh benefits. Furthermore, additional legislation would be required to impose a more stringent 'cap' on nutrient levels, which is likely to face opposition.

However, conditions in the Lough Melvin catchment appear to accommodate application of an auction approach, for example, in terms of numbers of potential participants, the range of nutrient reduction measures that could be implemented along with the ability to assess bids easily according to phosphorus contribution and finally, the potential for heterogeneous costs associated with implementation of proposed measures.

Plate 12: Consultation with farmers

Any auction approach should be consistent with existing legislation and run parallel to existing land management schemes. Ultimate government involvement will be required to ensure such adherence, to agree terms of the auction mechanism, to award contracts and handle funds. Whilst complicated by the cross border location, this could be achieved through establishing a Melvin Catchment Management Board with representatives from RoI and NI government bodies. The auctions should be managed at local level, to provide technical assistance, monitor and ensure compliance.

The next step towards successful implementation would involve economic field experiments with potential farmer participants to test and refine design, engage and involve stakeholders and provide training. The potential to engage point sources through a trading mechanism combined with an auction for nonpoint sources could be investigated.

11 Governance Framework

An understanding of controls and governance arrangements that are relevant to management of Lough Melvin is a key part of the catchment management process. A study was undertaken as part of the Lough Melvin Nutrient Reduction Programme to identify the most significant governance issues relevant to the catchment in both NI and the RoI. Gaps, barriers and constraints to the effective implementation of controls and governance were also identified, and recommendations for solutions or mitigation presented. The following provides a summary of the outputs of this study.

11.1 Key Governance Drivers

The most important drivers of management within the Lough Melvin catchment are EU Directives relating to water quality and biodiversity, and in particular:

Habitats Directive

Lough Melvin has been classified as a Special Area of Conservation (SAC) in NI and is a candidate SAC (cSAC) in RoI under the 1992 EU Habitats Directive (92/43/EEC). The SAC forms the heart of the catchment both in geographical/physical terms and in the context of governance and regulation. The Habitats Directive requires the key features of the SAC to be maintained at a favourable conservation status.

Water Framework Directive

The Water Framework Directive (2000/60/EC) is already having a considerable influence on governance within the catchment. It has provided a statutory basis for standardisation of water quality standards and monitoring across jurisdictions and a catchment-based approach to water management. It requires the waters of Lough Melvin to be at least of good ecological status by 2015. Basic measures relevant to the catchment will form part of the wider Draft North Western River Basin Management Plan, to be published for public consultation in December 2008. It is anticipated that these basic measures will include some of the measures identified in the Lough Melvin CMP. Such measures should be consistent with and contribute to the water quality (and other) objectives set under the Habitats Directive.

Plate 13: Lough Melvin

Nitrates Directive

Agriculture is an important land-use within the catchment, and the Nitrates Directive (91/676/EEC) is a key driver in regulating diffuse pollution from agricultural sources. The Directive does not require any specific targets for the catchment, but its measures assist both governments to meet their obligations under both the Habitats and Water Framework Directives.

11.2 Priority Governance Issues

Governance issues were identified for seven main categories: water management; agriculture; nature conservation; land-use planning; fisheries; forestry and general governance issues. Prioritisation was then undertaken via: a consultation process with 32 key stakeholders representing 17 different organisations; comments on draft reports provided by the Catchment Management Group, organisational stakeholders and the Steering Committee and; a stakeholder workshop. Twelve priority governance issues that impact most on the sustainable and integrated approach to management of Lough Melvin are outlined below:

1. Common Water Quality standards and monitoring should be agreed across the catchment. Enforcement capacity in the catchment is affected by resource constraints.
2. Agri-environment schemes have a key role in management of the catchment. Such schemes need to be enhanced to maximise their effect.
3. Transposition and implementation of the Habitats Directive within the catchment is often weak and generally variable across jurisdictions.
4. Two separate Conservation Plans exist for Lough Melvin SAC. Their status and level of detail differ significantly.
5. The quality of policy protection for Lough Melvin SAC differs significantly between jurisdictions.
6. There are differences in the transposition and implementation of the EIA Directive between jurisdictions.
7. Land use planning is a key catchment issue (e.g. in restricting one-off housing in sensitive parts of the catchment)
8. The existing regulations covering the introduction of zebra mussels, pike and other alien species are inadequate.
9. The role of other stakeholders (e.g. Angling clubs) in preventing their introduction to Lough Melvin is significant.
10. There is significant variation in the scope for EIA of forestry operations between NI and RoI.
11. Clearfelling within the catchment could have significant implications on water quality.
12. Stakeholders must ensure that the Lough Melvin Catchment Management Plan will be implemented.

11.3 Summary and Recommendations

Recommendations to address the twelve priority governance issues were developed and are presented below according to the timescales in which they could be implemented.

Recommendations which could be implemented in the **short term** are identified as follows:

- Training on the application of Article 6 of the Habitats Directive should be provided to all relevant authorities in both jurisdictions, including the planning authorities, forestry agencies, water services authorities, and fisheries authorities.
- Cross border agreement should be reached on what is required to fulfil an Appropriate Assessment under Article 6 of the Habitats Directive.
- An education programme for landowners whose activities could have an impact on the Lough Melvin SAC should be undertaken in both jurisdictions.
- Service Level Agreements may be required to formalise consultation between organisations on the need for Appropriate Assessment screening under the Habitats Directive.
- A single Conservation Plan should be prepared for Lough Melvin SAC, or at least a common approach taken to separate plans. This should include detailed favourable condition tables for all selection features.
- The review of Leitrim CDP 2003-2009 should include a robust policy, which accurately reflects the requirements of Article 6 of the Habitats Directive.
- Increased application of sub-threshold EIA should be considered by the planning authorities, particularly in RoI.
- Training and guidance on the interpretation of "significant effects on the environment" and other key issues, should be considered for appropriate authorities.
- Every effort should be made to involve planning authorities in the catchment management plan process.
- PPS14 policies should continue to be applied in the Lough Melvin catchment.
- Leitrim CDP 2009-2015 should include policies restricting one-off housing in sensitive parts of the catchment.
- In both jurisdictions, planning conditions should be used to require tertiary effluent treatment where necessary.
- Government agencies should support angling clubs and other stakeholders to take a proactive approach in alien species initiatives.
- A cross border contingency plan should be put into place to deal with the event of alien species introduction, including appropriate contacts and procedures.
- Initiatives should take account of the fact that some species alien to the catchment, such as pike, could have a particularly devastating impact on the wildlife interest of Lough Melvin.
- The application of discretionary EIA for sub-threshold projects should be expanded.

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- All major forestry operations in the catchment that may have a significant effect on Lough Melvin should be screened for appropriate assessment under Article 6 of the Habitats Directive.
- Agricultural agencies should establish a forum with the objective of agreeing a package of common agri-environment measures which can be targeted at the Lough Melvin catchment. Any agricultural forum for the catchment should also include the regulatory bodies such as Leitrim County Council and EHS.
- There should be active management of all forestry riparian buffer zones to reduce the potential impact of clearfelling, including machinery exclusion zones
- An Implementation Group of key stakeholders should be established to co-ordinate the implementation of key measures identified in the Catchment Management Plan.
- Representatives of any Catchment Management Plan group should be at a sufficiently high level in their organisations to facilitate implementation measures.
- A lead agency should be established for the Catchment Management Plan – possibly a Local Authority.

Recommendations that derive from issues that are considered important and urgent, but with feasibility restricted by various factors, are listed below. It is suggested that early addressing of these issues should provide results in the **medium term**.

- Agreement over water quality definitions for both chemical and ecological parameters is needed covering both jurisdictions.
- An agreed target for the total phosphorus concentration in Lough Melvin between all relevant agencies is required.
- A more precise and/or extensive monitoring regime for the catchment is required, including greater liaison between water quality and fisheries agencies.
- Agencies in both jurisdictions should reach agreement on a monitoring specification which meets both WFD and Habitats Directive requirements without duplication.
- An appropriate enforcement capacity should be sought, informed by the outcomes of existing studies and ongoing water quality monitoring, and taking account of the sensitive nature of the catchment. This should be pursued at a high level through the national budgeting and Programme for Government process. In the meantime, Lough Melvin should be prioritised as a target catchment for proactive monitoring and enforcement
- Unified agri-environment measures are required across the catchment. Research by the appropriate agencies suggests that this is best served by a catchment-specific scheme, available to all farmers in the catchment.
- There should be an increased level of inspection of participating farms in the catchment.
- Compliance with the Birds and Habitats Directives could be achieved by the introduction of National Planning Guidance on this issue.

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- PPS2 in NI is currently under review and should be amended to reflect the requirement for AA of Area Plans.
- A Thematic Local Area Plan for the Lough Melvin catchment should be explored in County Leitrim. Scope for a parallel or integrated approach with NI Planning policy to include the County Fermanagh portion of the catchment should be considered.
- Future forestry planning needs to take account of the potential impact of clearfelling and this should be reflected in buffer zones, open spaces, species composition and coupe sizes.
- Co-ordination to achieve a total annual clearfell limit for the catchment should be explored.

Longer term recommendations that derive from issues that are considered important and urgent are listed below.

- The EC (Natural Habitats) Regulations require further amendment to ensure compliance with the Habitats Directive, notably with respect to addressing strategic plans in RoI.
- Legislation relating to alien species introductions in both jurisdictions should be amended and harmonised
- Statutory requirement for re-planting of clearfelled areas under RoI Forestry Acts needs to be amended with respect to unsuitable areas.

11.4 Conclusion

This assessment, based on research and consultation with stakeholders, has culminated in significant consensus over the key governance issues in the catchment. In this context, the recommendations provided can be considered as "toolkit" for addressing the priority governance issues relating to water quality in the catchment.

12 Adaptive Management

Natural resource management relies on assessments and designs that in turn are based on various assumptions, and it is often difficult to predict precisely how the natural environment will respond to any intervention. Creating feedback mechanisms within an adaptive management framework ensures that catchment management is responsive to changing conditions both in the lake and the catchment. An outline of the adaptive management process is given in Figure 8. Currently the Assess problem and Design stages have been completed by the Lough Melvin Programme but the adaptive management cycle requires that not only the management measures designed to address the problem be implemented but that the effectiveness of these measures be reviewed, evaluated and adjusted as necessary, as new information becomes available. The monitoring and evaluation steps and their associated reporting, can also be important when they provide stakeholders and the community with information on the status of Lough Melvin and the progress and results of implementation of the CMP.

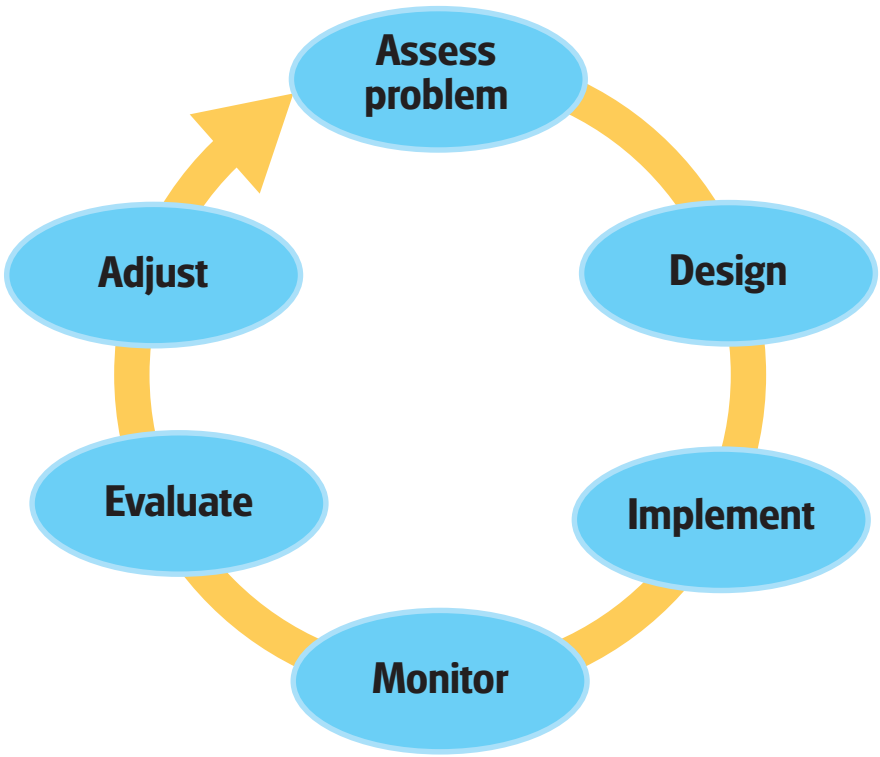

Figure 8: Adaptive Management Process

It is recommended that a holistic monitoring system is developed for Lough Melvin that integrates and links ecological values and objectives with implementation of actions. In addition, the establishment of a long term monitoring strategy for Lough Melvin, involving the use of remote sensing technology that is linked to a global database such as the Global Lake Ecological Observatory Network GLEON is recommended.

It is also recommended that evaluation against the recommendations outlined in the CMP is undertaken on a yearly basis by a cross-border Lough Melvin Management Group or Stakeholder Forum, with a more holistic and detailed review of the actual CMP to be undertaken on a five yearly basis. This review should be considered and adjusted accordingly in light of the development and implementation of the Water Framework Directive River Basin Management Plans.

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INTERREG IIIA

Comhshaol, Oidhreacht agus Rialtas Áitiúil
Environment, Heritage and Local Government

The Programme is funded by the EU INTERREG IIIA Programme for Ireland/Northern Ireland and the project partners; Northern Regional Fisheries Board; Agri-Food and Biosciences Institute (AFBI) Northern Ireland; Queen's University Belfast and; Teagasc.

Cover photo by: Doris Ammann