Teagasc Submission

on the

draft River Basin District Management Plans

and the

draft Fresh Water Pearl Mussel Sub-Basin Management Plans

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Introduction

Teagasc – the Agriculture and Food Development Authority – is the national body providing integrated research, advisory and training services to the agriculture and food industry and rural communities. Teagasc's goals, as outlined in its Statement of Strategy 2008 (www.teagasc.ie/aboutus/strategy/SOS_0810.pdf), include:

1. Improve the competitiveness of agriculture, food and the wider bioeconomy
2. Support sustainable farming and the environment
3. Encourage diversification of the rural economy and enhance the quality of life in rural areas.

Supporting sustainable farming and the environment is the main focus for Teagasc's soil, environment and good farm practice programmes. This will be achieved by providing farmers with the knowledge and skills to operate in a profitable, competitive and sustainable manner and by supporting policymakers in designing, implementing and evaluating environmental programmes targeted to different types of farms addressing issues such as climate change, water quality, biodiversity and soil quality. Emphasis is placed on the achievement of 'double-dividend' outcomes, so that future farming can be both commercially and environmentally sustainable.

Farmers, as custodians of the countryside, deliver a wide range of important and socially valuable agri-environmental products and services in 2030. These include protection of clean water, provision of clean air, protection of the biodiversity of species and habitats, preservation of archaeological heritage, maintenance of genetic diversity and mitigation of climate change. In recognition of the significant role and contribution of the agricultural sector to maintaining and further improving the quality of surface waters and groundwater in Ireland, Teagasc organized an international scientific conference on "Grassland and the Water Framework Directive" in Johnstown Castle in November 2008, bringing together scientists, policy makers and stakeholders from Ireland, the EU and beyond(www.teagasc.ie/publications/2009/20090106/).

In this context, Teagasc acknowledges that the Water Framework Directive provides an integrated and cross-sectoral approach to the sustainable management of one of Ireland's main environmental products, and Teagasc welcomes the fact that consultation is central to the implementation phase of the WFD.

Teagasc has now studied the draft River Basin District Management Plans (RBDPMs) with interest and concern. Teagasc welcomes the fact that, generally, the basic measures proposed for agriculture, equate to those currently implemented as part of the National Action Programme under the Nitrates Directive. However, Teagasc has a number of concerns, which are set out and discussed in this submission. Our principle concern is that there is a significant body of international scientific evidence that demonstrates that significant time (on the scale of decades) is required for the effectiveness of current agri-environmental measures to become apparent in improvements in water quality. In this light, the temporal targets for achieving good water quality for *all* waterbodies, as set out in the draft RBDPMs, appear extremely ambitious by international standards. Teagasc is concerned that, if the "lag-time" between implementation of agri-environmental measures and the improvement of water quality, is not sufficiently accounted for, the RBDPMs may prematurely accommodate the implementation of unnecessarily stringent supplementary measures for the agricultural sector.

In addition, Teagasc is seriously concerned about the draft Fresh Water Pearl Mussel Sub-Basin Management Plans. Teagasc acknowledges the national obligation to protect the fresh water pearl mussel (FWPM) and its habitat, and understands that in certain conditions, the application of the precautionary principle may be justified. Following communications with the National Parks and Wildlife Service, Teagasc understands that the FWPM plans will be implemented based on spatially targeted risk assessment, and Teagasc welcomes this approach. However, Teagasc is concerned that some of the suggested measures may be associated with disproportionate costs. This is particularly alarming in light of the large uncertainties surrounding the causes of the decline in pearl mussel populations, the roles of agriculture and forestry in this decline (as opposed to the role of other nutrient sources and other contaminant sources such as sediment), and the overwhelming uncertainties surrounding the probability of a successful stabilisation and reversal of the current downward trend in population viability for some of the Fresh Water Pearl Mussel Areas.

In relation to Forestry, it is Teagasc's position that implementation of Programmes of Measures (POMs) should be spatially targeted at high-risk sites and activities, since we expect that indiscriminate implementation of POMs as "blanket measures" would significantly increase costs without associated benefits for the aquatic environment. In this context, some vulnerable forests planted prior to the publication of the Forest Service Environmental Guidelines in 1990 should be prioritised. Furthermore, Teagasc is concerned about some of the proposed Supplementary Measures, since the consensus of the scientific literature suggests that impact of forestry on the aquatic environment is a function of forestry activities, rather than the extent of forest cover *per se*. In this light, Teagasc is concerned about the uncertainties surrounding the environmental effectiveness of some of the proposed Supplementary Measures. It is the Teagasc position that Supplementary Measures should only be considered following catchment-specific evaluations of the cost-effectiveness of proposed measures. This includes quantification of proven causal relationships between measures and impact, as well as a quantitative assessment of costs to stakeholders, particularly individual land-owners.

In summary, Teagasc recommends that the assessment of the effectiveness of the Action Programme under the Nitrates Directive should receive the highest priority in the short and medium term, and urges a highly cautious approach to the implementation of supplementary measures as part of the RBDMPs and FWPM Sub-Basin Management Plans. While Teagasc acknowledges the precautionary principle for certain scenarios, we recommend that measures of which the ecological effectiveness is surrounded by a large degree of uncertainty, are not considered where these involve disproportionate costs. Below, we elaborate on each of our concerns and recommendations. Teagasc is committed to contributing constructively and proactively to the discussions on the implementation of the Water Framework Directive.

Part 1. The Main River Basin District Management Plans: the role of the National Action Programme under the Nitrates Directive.

1.1 Current agri-environmental legislation

The draft RBDMP states that the National Action Programme under the Nitrates Directive (implemented in SI 378 of 2006 and SI 101 of 2009) will form the main Basic Measure for the agricultural sector, and that supplementary measures may be considered and introduced following the review of the implementation and effectiveness of the National Action Programme in 2009.

The National Action Programme (SI 378 of 2006 and SI 101 of 2009) was implemented at a national scale with a view to reducing these spatio-temporal interactions between pressure and transport factors. These controls are now legally binding for farmers, and breaches can result in both prosecution, and penalties in single farm payment through cross compliance. The legally binding measures in place since 2005 have placed restrictions on farmers regarding:

i. stocking rates;
ii. mineral and organic fertilizer application rates;
iii. spatial restrictions on mineral and organic fertilizer applications based on soil test results, and location of water bodies and water abstraction points;
iv. timing of mineral and organic fertilizer applications;
v. farmyard management and animal manure storage, including minimum storage capacity; and
vi. ploughing and the use of non-selective herbicides.

Since the introduction of these measures, farmers have been required to invest significantly in manure management facilities. This has been facilitated in-part by various National Exchequer- and EU-funded on-farm investment schemes. An estimated €2bn has been awarded in grant-aid for animal housing, manure storage, and manure management equipment since these regulations have been introduced. In some cases, the fertilizer rates now prescribed in law are lower than those in previous agronomic advice (Coulter, 2004). Also, restrictions on animal manure management, particularly storage capacity and spreading restrictions, have required a change in practice at farm level.

Teagasc wishes to emphasise that the review of the National Action Programme in 2010 is expected to focus on the evaluation of the implementation of the National Action Programme, *not* on its effectiveness. It is Teagasc's view that the effectiveness cannot be scientifically evaluated until at least the second review, due 2014, and that there is no scientific evidence to support the necessity or potential effectiveness of supplementary measures, based on the following grounds.

1.2 Expected response time of current agri-environmental measures

In light of these significant changes in nutrient management that have followed the introduction of the National Action Programme, it is Teagasc's view and expectation that these measures will significantly reduce nutrient loss from agriculture to water. However, depending on local hydrology and hydrogeology, nutrient loss to a waterbody can be a very slow process. As far back as 1985, Denmark was one of the first countries to adopt measures to reduce nitrate and phosphorus loss to water; however, improvements in water quality, particularly nitrate levels,

have only become evident in recent years, 20 years after implementation, with no improvement yet in phosphorus levels from diffuse sources (Kronvang & Grant, 2008). Similarly, several recent studies of agricultural catchments in Nordic and Baltic conditions have demonstrated that, especially in medium-sized and large catchments, the water quality response to reduced fertilizer application or to a decrease in agricultural intensity may be slow and limited (Löfgren *et al*., 1998; Stålnacke *et al*., 1999; Grimvall *et al*., 2000).

It is widely recognised that risk of nutrient loss from agricultural land to a waterbody occurs when and where pressure factors (e.g. excess nutrients) coincide with transport vectors (e.g. percolation, overland flow) (Gburek *et al*., 2005; Haygarth *et al*., 2005; Schulte *et al*., 2006); in some cases it may take a considerable time to elapse before current improvements in nutrient management will become apparent in the receiving waterbodies (Sharpley *et al*., 2009). This "lag time" involves both the lag time associated with reductions in nutrients pressures and the travel time taken for surplus nutrients to migrate conservatively in the sub-surface to a potential receptor (groundwater or surface water body).

1.2.1 Lag time associated with reducing phosphorus pressures

Following the introduction of the National Action Programme, nutrients applications must now take account of the soil nutrient status and crop nutrient requirements. For phosphorus (P), no artificial P-fertiliser is allowed on soils that have been identified as P-index 4, i.e. as containing P-reserves in excess of the agri-environmental optimum (Coulter & Lalor, 2008). However, Tunney *et al.* (2008), studying temporal trends in a long-term Irish P-trial under continuous grazing, found that following cessation of fertiliser P application, it is taking more than 10 years for P-Index 4 soils to return towards their agri-environmental optimum (Index 3). Similarly, Herlihy *et al.* (2004) reported that even in a best-case scenario of a continuous cutting regime, in absence of nutrient applications, it took at least four years for Index 4 soils to return to Index 3. In actual farming scenarios, longer time-periods may be expected as organic nutrients must be recycled, ideally on silage grounds (Coulter & Lalor, 2008), and grazing and silage operations are both required on each farm.

Similarly for the UK, Johnes *et al*. (2007) suggested that it is not possible to determine the length of time required for ecosystems to respond to measures for control of diffuse P pollution, due to the substantial reserves of P that have built up in soils and aquatic sediments in many areas. Grimval *et al.* (2000) stated that surface water P-concentrations may rapidly decline from high to moderate levels in response to the elimination of point sources and phasing-out of phosphatic detergents, as was observed in the Rhine in the mid 1980s (van Dijk *et al*. 1996). They concluded that a further lowering of P-concentrations in response to reductions in diffuse P-loss may take decades to become evident (Grimval *et al.*, 2000). Such time lags reflect the accumulation of high levels of P in soils and sediment and the complexity of P redistribution through catchments due to storage and remobilisation at intermediate locations between primary sources and catchment outlets (Boesch *et al*., 2001; Wang *et al*., 2002).

1.2.2 Lag time associated with reducing nitrogen pressures

Soil nitrogen (N) contents typically ranges from 5000 to 15,000 kg/ha in long-term permanent grasslands. This N has build up over many years of N, until eventually equilibrium is reached between N inputs and soil N content; it may take between 50 and 200 years for this equilibrium to be established (Whitehead, 1995). When nitrogen inputs (manure and fertilizer N) are reduced, it may take similar periods of time before a new equilibrium is reached again. During this time, the process of soil N mineralisation is an important N source (Whitehead, 1995) as reduced carbon and nitrogen inputs changes the soil C/N ratio, which may impact positively on soil N mineralisation. High rates of N mineralization has been observed under grassland systems with high soil N and C loadings, with rates reported to vary from 135 and 376 kg N ha^{-1} $year^{-1}$ for intensively managed grasslands in the U.K (Gill *et al*. 1995).The time required for soil N to equilibrate to systems with reduced N inputs should be considered when estimating the time required for waterbodies, affected by elevated nitrate concentrations, to reach good status. Indeed it has been emphasised in the literature that if large amounts of organic nitrogen have accumulated in soil during periods of higher application rates, nitrogen losses with agricultural runoff will decline very slowly, even though fertiliser inputs are reduced (Shen *et al*., 1989; Löfgren *et al*., 1998; Grimvall *et al*., 2000). For example, in several major Eastern European rivers, Grimvall *et al*. (2000) observed a remarkable lack of response to the dramatic decrease in the use of commercial fertilisers that started in the late 1980s, and they concluded that the water quality response to lowered input of N to a drainage area may be slower than the original response to the post-war increase in nutrient inputs.

1.2.3 Lag time associated with transport vectors to groundwater

Nutrients lost from the rooting zone migrate vertically in the unsaturated zone to the watertable and laterally along shallow flow lines to a surface water receptor, or vertically to the greater groundwater body. Due to this lag time, water quality improvement at a waterbody receptor may not occur for a long time even after mitigation measures have been introduced and experiments in the shallow sub-surface have shown positive trends. Factors affecting the response time of groundwater bodies to mitigation measures include the amount of recharge, the hydrology of the unsaturated zone (including matrix and preferential flow paths); the depth of the unsaturated zone; hydrogeological factors, such as porosity, storage and permeability; and the length of the pathway between recharge and discharge (Stark & Richards 2008). Fenton & Richards (2008) calculated that for Irish soils, lag-times may range from weeks to decades, depending on local geology and hydrology. Similarly, the British Geological Survey recently modelled aquifer response times for England and Wales and the results indicated a timescale of decades (8 and 46 years to reach 50% breakthrough in alluvial and chalk aquifers, respectively) for most aquifer classes during which time nitrate will continue to reach discharge points despite reductions in contemporary surface loadings (Jackson *et al*, 2008).

Teagasc is concerned that the draft River Basin District Management Plans do not specify the extent to which lag-time has been considered, or how it was calculated. For surface waters, it is noted from the draft River Basin District Management Plans that 19 rivers have been given an extended recovery timescale up until 2021. As stated in the draft River Basin District Management Plans, “The overall timescale for waters to achieve

good status will be dictated by the slowest response to basic and supplementary measures" (Western RBD, 2008, p. 75). It is the Teagasc view that groundwater bodies and waterbodies with significant groundwater inputs, too, should be considered under the heading of extended timelines.

1.3 Water quality standards and monitoring programmes

Teagasc is concerned about the approach and methodology used to define standards for nutrient concentrations in receiving waterbodies, and about the calibration of these standards against ecological water quality classes (Q-values). In recent years, Teagasc has conducted a series of research programmes studying the temporal and spatial processes of diffuse nutrient transfer from agricultural land to water. In both surface and groundwater systems, the importance of episodic, storm induced transfers is paramount and research sampling protocols have been biased towards this. From edge-of-field to catchment-scale rivers, it is widely recognised that the progress of diffuse transfers is associated with high-flow events. In Ireland and the EU, there is evidence that disregarding this bias will merely determine the ambient nutrient status of flowing waters which is likely, if impacted, to be caused by non-agricultural point sources at scales from 1st order to larger river basins at sensitive times (Withers and Hodgkinson, 2009; Javie *et al*., 2008; Arnscheidt *et al*., 2007; Foy, 2007). There are three principle concerns here:

1.3.1 Monitoring programmes

Our concern is that by continuing with the current, national river monitoring programmes for nutrient status in rivers (which do not provide the same temporal rigour with regard to diffuse transfer monitoring) and using these as standards for Programmes of Measures (PoMs) will not be sufficient for ensuring that the consequences of agricultural mitigation of diffuse nutrient transfer has been captured. At the scale of large river basin districts, for example, Foy (2007) concluded that ambient nutrient concentrations in EU rivers as captured by low frequency monitoring are likely to be due to inputs from municipal waste-water treatment works. Johnes (2007) also provides a comprehensive critique of the inadequacy of low-frequency river monitoring for chemical water quality.

1.3.2 Calibration of chemical water quality standards for surface waters

The very stringent reactive P standards that have been defined and linked to Q-status in rivers (compared, for example, with other studies – e.g. Bowes *et al*. 2007) are unlikely to be reflective of diffuse nutrient transfers in many catchments due to the timing of chemical sampling – i.e. Q-values are most likely to have been calibrated against low-flow conditions and certainly do not appear to delineate winter periods of high diffuse transfer risk and summer periods of high ecological impact risk. Teagasc is particularly concerned about the apparent paradox that may arise from applying the proposed "double EQS threshold to good status", i.e. the requirement that waterbodies must reach both good ecological status and good chemical status. If the chemical thresholds have been derived from calibration against ecological status, then cases where a waterbody reaches good ecological status but fails to meet good chemical status, could be interpreted as evidence that the calibration of the chemical status from ecological status has been imprecise. Indeed the EPA has pointed out that the relationship between chemistry and biology (as monitored simultaneously) in Irish rivers is associated with a

large degree of uncertainty (Lucy *et al*., 1997, Ch6. p106). We would expect this uncertainty to be factored into reviews of the EQS standards and the precise role of nutrients in terms of magnitude and season.

Furthermore, despite cross calibration of Water Quality standards between EU member states (McGarrigle, 2008), the proposed low molybdate-reactive P (MRP) standard of 30 µg L^{-1} for rivers in Ireland conflicts with the standards set in Scotland, a country with similar hydrology and hydrogeology to Ireland. In Scotland, the proposed standards for riverine Soluble Reactive P (SRP) for good status is set at 50 µg L^{-1} for lowland rivers, 40 µg L^{-1} for highland rivers and 120 µg L^{-1} for rivers with high alkalinity (>50 mg L^{-1} $CaCO_3$) (Anon., 2006 and 2008), see Table 1. It is worth noting that SRP, used in Scotland, represents a smaller fraction of the total P than MRP, in Ireland; therefore, even if identical thresholds were used, the Irish standards would be more stringent.

Table 1: Soluble Reactive Phosphorus standards for Rivers in Scotland (Anon., 2006) which sets higher Soluble Reactive P standards of 120 µg L^{-1} for good status rivers with high alkalinity (>50 mg L^{-1} $CaCO_3$). 3n and 4n refer to lowland (<80 m AOD) and highland (>80 m AOD), respectively. Source: Anon. (2008).

Proposed standard (annual mean[a])		Standards used for characterization (annual mean[a]) [All river types]			
River Type	High	Good	High[b]	Good[c]	
1n	30	50	20	Sil [e] 40	100[g]
2n	20	40			
3n[d], 4n	50	120		Cal[f] 100	

a annual mean is the average of all measured values during the year
b "High" value used for characterization and classification under WFD
c "Good" value used for characterization under WFD
d see comments in "typology" descriptions above
e "Sil" refers in WFD characterization (Article 5 report) to a river in a siliceous typed section (i.e. flowing over rock with high silica content such as sandstone) – low alkalinity river
f "Cal" refers in WFD characterization (Article 5 report) to a river in a calcareous typed section (i.e. flowing over rock with high calcium content such as limestone) – high alkalinity river.
g Existing standard in the Scottish Rivers Classification Scheme – applied to rivers

1.3.3 Calibration of chemical water quality standards for groundwater

Even in groundwater dominated catchments, the Q-nutrient relationships fail to indicate the very high levels of uncertainty that must surely exist in nutrient/ecology relationships in rivers. This last point was discussed at the EPA's recent workshop 'Ecological responses of streams to nutrient enrichment' (February 2009, University College Cork).

We would therefore be concerned at reviews of PoMs based on current ecological assessments and chemical monitoring that indicate a low ecological status or poor recovery in agricultural catchments without regard for the links between ambient (not episodic) riverine nutrient concentrations, their causes and the uncertainty of ecological consequences.

1.4 Monitoring of the effectiveness of current agri-environmental measures: the Agricultural Catchments Programme

To quantify the efficacy of the measures adopted under SI 378 (2006) / SI 101 (2009), Teagasc and DAFF have initiated and invested €10m into the "Agricultural Catchments Programme", which commenced in 2008 (not 2006 or 2007). This programme is a novel, ambitious, partnership-based project which integrates research and advice in an innovative and dynamic way. It operates in a group of catchments from five to eleven square kilometres in areas representing a range of environmental risks and farming systems. It will establish environmental, ecological, agronomic and economic baseline information on agriculture in relation to both the Nitrates and Water Framework Directives and evaluate the National Action Programme (NAP) measures as well as the derogation.

High resolution monitoring of the quality and quantity of water leaving the catchment will be carried out, and these monitoring programmes have been designed specifically to capture water quality during high-flow events. Furthermore, the Programme will not only measure water quality parameters at the outlet of the catchment; in addition it encompasses a detailed spatio-temporal assessment of nutrient pressure and pathway factors, with a view to capturing the impacts of reducing nutrient pressures and quantifying the lag-times involved in nutrient transport.

Factors influencing farmers' understanding and implementation of the measures will be investigated. Knowledge generated will be disseminated widely and advisers will help farmers to implement the measures and maximise economic returns from their businesses. The Programme will feed into the 2nd review of SI 378 (2006) and SI 101 (2009), scheduled for 2014, and may propose modifications to the NAP following scientific review, if necessary. For further information see www.teagasc.ie/agcatchments/

1.5 Conclusions on the Main River Basin District Management Plans

Considering the significant changes in agricultural practices that followed from the introduction of the NAP, and considering the wide international consensus on the significant time-lags that are required before changes in agricultural practices translate into tangible improvements in water quality, it is Teagasc's position that until the publication of the results of the Agricultural Catchments Programme, and until at least the 2nd review of SI 378 (2006) / SI 101 (2009), there will be a lack of definitive scientific evidence to support the view that the measures adopted under SI 378 (2006) / SI 101 (2009) would be insufficient to reach the targets of the Water Framework Directive. Similarly, it is our view that until at least 2014, there will be a lack of conclusive scientific evidence that the introduction of Supplementary Measures will accelerate the reduction in nutrient enrichment status in surface and/or groundwaters. Therefore, where extended timelines are assigned to waterbodies, this should not necessarily equate to implementation of supplementary measures; such consideration would require a full prior quantification of lag-time for contrasting geo-environments. Indeed a recent COST 869 conference concluded that in all other EU Member States, the current regulations adopted under the Nitrates Directive are proposed as the basic measures for the agricultural sector, and that no supplementary measures are being considered (Chardon & Schoumans, 2009). In addition, many countries expect that the Good Status will not be achieved in the short term (2015 or 2021), and in some cases are even doubtful if the goals can realistically be reached by 2027.

Part 2. Programme of Measures for Forestry in the River Basin District Management Plans

2.1 Forestry and the environment

The total forest area in Ireland stands at 10% of the land area. Of this, 57% is in public ownership and 43% is in private ownership. An estimated 43% of the total stocked forest estate is on peat soils (basin peat, raised bog, blanket peat and cutaway peat). Approximately 18,000 hectares of this is privately owned.

Forestry is a viable land use options for many farmers in marginal rural areas. The Government's strategic plan 'Growing for the Future' (DAFF,1996) sets a target of 17% of forest cover by 2030. Attaining this target is necessary to develop a critical mass of forestry necessary to sustain the forest processing industry in the long term. 22,500 jobs (direct and indirect) are sustained by the forest industry, many in rural areas where alternative employment is not available.

Attaining the 17% forest cover target is also essential for Ireland to achieve its objectives for wood energy in the Bioenergy Action Plan for Ireland (DCMNR, 2008). It is also dependent on harvesting existing forests. Biomass-related renewable energy targets include 30% co-firing with biomass in peat-fuelled power stations by 2015 and 12% of national heat provision through renewable sources by 2020. In addition, forests trap carbon emissions in a sustainable, environmental friendly way and thereby offer the potential of offsetting emissions from other sectors. The level of annual afforestation has fallen to 6,000 hectares per year. Any further decline in this level will change the status of Irish forests from being a net sequesterer of carbon to being a net carbon emitter (Hendrick, 2009). The consequent inability to meet Kyoto obligations would have environmental and financial consequences for the Irish State, as this would result in the obligation to buy more compliance credits in the future.

All new planting is now carried out by private landowners, mostly farmers. Teagasc's role in relation to farm forestry is to encourage the establishment of sustainable farm forests and the sustainable management of existing farm forests. Since 1996, the Teagasc forestry advisory, training and research programmes have promoted best environmental practices in farm forestry in Ireland.

2.2 Current Forest Service Environmental Controls

It is government policy that all new forests are established in a sustainable manner, achieving environmental, social and economic objectives. Environmental guidance documents were originally published by the Forest Service in 1990. Since 2000, the Forest Service of the DAFF has published a number of environmental guidelines to control these operations e.g. Forestry and Water Quality Guidelines (2000); Code of Best Forest Practice – Ireland (2000); Forest Harvesting and Environment Guidelines (2000); Forestry and Aerial Fertilisation Guidelines (2001); Forestry Schemes Manual (2003); and the Native Woodland Scheme Manual (2008). The implementation of the procedures outlined in these guidelines is overseen by the Forest Service Inspectors. The standards are regularly reviewed and updated.

The controls that are currently in place and administered by the Forest Service ensure the implementation of these high environmental standards. All new planting is controlled by the Forest Service. Planting approval may be denied or may be conditional on e.g. species, buffers, management practice. Grant penalties may be imposed for non-compliance with environmental guidelines. All felling is also controlled by the Forest Service and must be planned and carried out in accordance with Harvesting and Environmental Guidelines and limitations may be imposed on felling licenses e.g. prevention of felling in adverse weather conditions.

2.3 Teagasc observations on the draft RBDMPs

While the draft River Basin District Management Plans (RBDMPs) recognise that forestry and forest management can provide an opportunity for delivering positive ecological benefits, they outline concerns that forest operations may give rise to negative pressure on aquatic ecosystems, through the following mechanisms:

- Acidification
- Sedimentation
- Eutrophication
- Shading and light occlusion
- Hydrological flow changes

Some of the proposed measures would have a negative impact on the national afforestation programme and would have direct financial implications for both existing and potential farm forest owners without prior quantification of potential environmental effectiveness. In particular, proposals to apply a blanket policy of avoiding or limiting forest cover on *all sites* in acid sensitive catchments and on *all peat sites* raise a number of concerns. It is crucial that afforestation continues to be carried out to best practice in accordance with the Forest Service Guidelines so that environmental concerns are minimised or eliminated. Research is currently ongoing in a number of areas relating to forests and water quality which will feed into future updates of these Guidelines.

2.3.1 Observations on acidification

The proposed measures to mitigate acidification include avoiding or limiting afforestation on 1st and 2nd order stream catchments in acid-sensitive catchments and a revision of the Acidification Protocol. They also include remediation measures such as restructuring of existing forests and liming to mitigate acid impacts.

Teagasc is concerned that the mechanism of acidification is not fully understood and needs further research to validate existing data (Donnelly *et al.,* 2003; Forestry Commission, 2003). Geospatial datasets should be used to target specific vulnerable areas for site assessment so that measures to reduce or remediate acidity may be applied to greatest effect. Any change to the Acidification Protocol should be scientifically based, taking operational practicalities into account and consideration should be given to the implementation of protocols in other countries (Forestry Commission, 2003).

Furthermore, studies on the use of lime to mitigate acidification effects on water are limited to date and inconclusive in relation to beneficial impact (Donnelly *et al.,* 2003) and

raise issues in relation to negative impact on species including *Sphagnum* (Bragg and Clymo, 1995) and *Margaritifera* (freshwater pearl mussel) (Bauer *et al*., 1991; Skinner *et al*., 2003). Consideration also needs to be given to the practicality and the costs associated with adopting such measures.

2.3.2 Observations on eutrophication and sedimentation

The measures proposed in the draft RBDMPs include avoiding or limiting forest cover on all peat sites, along with changing tree species mix on replanting and limiting felling coup size. The draft plans propose the restructuring of older forests to include open areas and changing species mix. They also suggest sediment controls and the establishment of riparian zones prior to clearfelling.

The risk of nutrient loss occurs when and where pressure factors (e.g. release of nutrients during forest establishment or forest harvesting) coincide with transport vectors (e.g. overland flow/losses to drainage systems during establishment or harvesting operations) (Programme of Measures and Standards for Forest and Water, WFD, Western River Basin District, 2008). On this basis, measures to mitigate eutrophication and sedimentation should be aimed at forest operations (including forest establishment, roading, harvesting, and replanting) rather than the extent of forest cover within a catchment.

Since 1990, the implementation of the Forest Service Guidelines ensures that all forest establishment harvesting and road construction operations are carried out to minimize damage to watercourses and consequently these forests comply with the current environmental standards relating to restrictions in aquatic zones (Machava *et al*., 2005).The research conducted to inform these draft plans indicated that the problems were generally associated with forest stands planted before 1990. It is estimated that between 30 and 35% of total stocked forestry was planted before these environmental guidelines were introduced. Measures should be targeted at the most vulnerable of these pre-1990 forests as younger sites have been established in accordance with Forest Service standards.

US Studies (Sheridan *et al*. 1999; Broadmeadow *et al*. 2004) showed variability in the efficacy of riparian forest buffers to trap nutrients and sediments and mitigate stream acidification. The location, design and management of riparian buffers need further research. Recommendations on design and management of riparian buffers are presented by Giller *et al*. (2002), Forestry Commission (2003) and WRBD workshop on Riparian Buffer Management of Streams in Forested Catchments (2007). COFORD has also recently funded a new research project on native riparian woodland buffers and their efficacy.

Forestry Commission Guidelines (Forestry Commission, 2003) suggest that the generally higher nutrient status of lowland soils means that forests in these areas rarely require fertilizer applications. Nutrient inputs tend to be much lower compared with agriculture and thus riparian forest planting may help to protect water quality within sensitive areas.

Based on this research, Teagasc suggests that the most effective approach to changing species mix at the replanting stage, would be to concentrate the planting of broadleaves (that are more nutrient demanding) in the aquatic zone. There is significant merit in targeting measures specifically at riparian zones. This ensures that the economic benefit of the forest is optimized while the environmental impact of the measures is maximized as they are concentrated on the area of greatest impact on water quality.

2.3.3 Hydromorphological Measures

Proposed hydromorphological measures include managing and minimizing drainage in peat soils.

It is Teagasc's position that proposals to limit drainage should only be made on the basis of relevant research and should take the financial, practical and health and safety consequences into account. Few species will tolerate limited drainage which results in reduced crop productivity, excessive windblow and dangerous and inaccessible forests.

2.4 Conclusions on the Programme of Measures for Forestry

In summary, Teagasc wishes to emphasise the positive role of agro-forestry, not only in protecting water quality, but in addition to the wider environment, with specific reference to the role of forestry in offsetting carbon emissions from other sectors of society. In relation to the draft River Basin District Management Plans, it is Teagasc's position that implementation of Programmes of Measures (POMs) should be spatially targeted at high-risk sites and activities. We have concerns that the indiscriminate implementation of POMs as "blanket measures" would impact disproportionately on landowners while not achieving improvements on the most vulnerable sites. this context, forests planted prior to the publication of the Forest Service Environmental Guidelines in 1990 should be prioritised.

Teagasc is concerned about some of the proposed Supplementary Measures, as the consensus of the scientific literature suggests that impact of forestry on the aquatic environment is a function of forestry activities, rather than the extent of forest cover *per se*. In this light, Teagasc is concerned about the large uncertainties surrounding the environmental effectiveness of some of the proposed Supplementary Measures. It is Teagasc's position that Supplementary Measures should only be introduced following catchment-specific evaluations of the cost-effectiveness of proposed measures. This includes quantification of proven causal relationships between measures and impact, as well as a quantitative assessment of costs to stakeholders, particularly individual land-owners.

Part 3. The Fresh Water Pearl Mussel Sub-Basin Management Plans: the role of Supplementary Measures.

3.1 Protection should be prioritised over restoration

Teagasc acknowledges the national obligation to protect the fresh water pearl mussel (FWPM) and its habitat. However, the restoration of ecosystems to "good status" is an asymmetric process; this means that once an ecosystem has deteriorated, it may not always be possible to return it to its original state. This was one of the outcomes of an international scientific conference on "Grassland and the Water Framework Directive" (www.teagasc.ie/publications/2009/20090106/), hosted by Teagasc in November 2008.

The conference heard examples from Chesapeake Bay (USA) (Gilbert & Oliver, 2008) and Lake Sempach (Switzerland) (Stamm & Strauss, 2008) where, although it was found that nutrient reduction programmes were successful in reducing nutrient concentrations, and moderately successful in increasing species diversity, they had not resulted in restoration of the "original" ecosystems; in addition, genetic diversity remained low. Therefore, a consensus emerged from the conference that prioritising protection of ecosystems of "high status" over restoration of ecosystems that have already deteriorated, would represent the most cost-effective approach.

In Ireland, this is of specific relevance to attempts to restore the habitats of the pearl mussel. The FWPM Plans state that some of the current pearl mussel populations are considered "relic populations", which are no longer reproducing, but in which the adult individuals are still present as a result of their long life-span and higher resilience to changes in water quality. In light of the international experience, it is Teagasc's view that protection of viable pearl mussel populations, which have a plausible chance of sustained reproduction, should be prioritised over attempts to restore habitats for relic populations. While Teagasc is aware that the Habitat Directive does not facilitate exemptions on the basis of cost implications, we feel that this prioritisation would be highly relevant in the implementation phase of the FWPM Sub-Basin Management Plans, considering the disproportionate costs that would be involved in restoring relic populations that exists in intensive agricultural areas, such as the Munster Blackwater and the Nore catchments (see below).

3.2 Future supplementary measures should be targeted and developed in consultation with stakeholders

As outlined under item 1 above, the effectiveness of the National Action Programme will be reviewed in 2014. In the event that the scientific evidence at that time will conclusively support the need for supplementary measures either inside or outside the FWPM Sub-Basins, it is Teagasc's position that such supplementary measures should be based on a scientifically robust and proven understanding of the causal relationships between the farm management practices required, and its impact on mitigating nutrient loss to water. The scientific basis of the effectiveness of such measures should be based on, or derived from, the international scientific literature.

3.2.1 Targeting of supplementary measures.

Following communications with the National Parks and Wildlife Service, Teagasc understands that the FWPM plans will be implemented based on spatially targeted risk

assessment, and Teagasc welcomes this approach. This supports Teagasc's position that supplementary measures should only be implemented in areas or conditions where there effectiveness has been proven, taking account of the natural variation of the geo-environment and farm practices and farm systems. Supplementary measures should not be extended as "blanket measures" into areas or farm practices where their effectiveness has not been unequivocally established.

3.2.2 Stakeholder participation

In order to maximise the effectiveness of any potential supplementary measures, it essential that these are developed in close partnership with stakeholders from the agricultural industry (Watson *et al*., 2008; Doody *et al*., 2008), including farmers, agricultural advisors and researchers. For example, Campbell & Foy (2008) developed a catchment management plan for the Lough Melvin catchment (www.nrfb.ie/melvin/docs/LoughMelvinCMPExecutiveSummary.pdf), based on the extensive consultative and participatory involvement of 50 farmers in the catchment (see also Doody *et al*., 2007). They assessed potential measures as reported in the international literature for cost-effectiveness (see 3.3. above), total cost, total environmental impact, and popularity with farmers, and found that farmers contributed substantially to the assessment with their knowledge base on the practicality of individual measures and on specific local geo-environmental constraints. The project found that agricultural advice played a key role in the transfer of the necessary technology to farmers, and that advisors provide farmers with sound nutrient management advice based on the most up to date research information available. The integration of different forms of knowledge from farmers, advisors, scientists and policy makers was essential in the successful assessment of the effectiveness of individual measures.

3.3 Future supplementary measures should be evaluated for cost-effectiveness to avoid unnecessary and disproportionate costs

Teagasc is very concerned that the draft RBDMP makes little reference to, and does not make estimates of, the costs associated with the basic and supplementary measures, even though the assessment of cost-effectiveness is a key component of the Water Framework Directive (Finnegan, 2008). Collaborative research by Teagasc, the Northern Regional Fisheries Board and Queen's University Belfast (Schulte *et al*, 2008) demonstrated that the cost-effectiveness of common individual mitigation measures, expressed as cost (€) per kg reduction in phosphorus (P) loss, may vary by orders of magnitude. The authors evaluated the cost-effectiveness of 25 mitigation measures proposed in the international scientific literature, specifically for the geo-environmental context of the Lough Melvin catchment, and found that the cost-effectiveness of individual measures may range from less than €10 per kg P (e.g. provision of support for nutrient management planning and soil testing) to over €1000 per kg P (e.g. fencing off of water courses). Their analysis showed that 50% of the theoretically maximum reduction in P-loss to water could be achieved at as little as 5% of potential maximum costs. Internationally, similar approaches to nutrient source and transport mitigation measures are proposed by Smith *et al*. (2005) and evaluated by Haygarth (2004) and Haygart *et al*. (2009).

We are particularly concerned about the potential future economic impact of the FWPM plans in catchments that are characterised by productive agriculture (Figure 1). Teagasc's own

preliminary economic assessments suggest that the proposed designation of large proportions of some catchments into Fresh Water Pear Mussel Sub-Basins may have a large economic impact at local scale, and hence undermine the sustainability of the rural economy. For this submission, our WG has conducted a preliminary GIS modelling exercise to quantify the regional impact of potential measures that would be facilitated by this legislation.

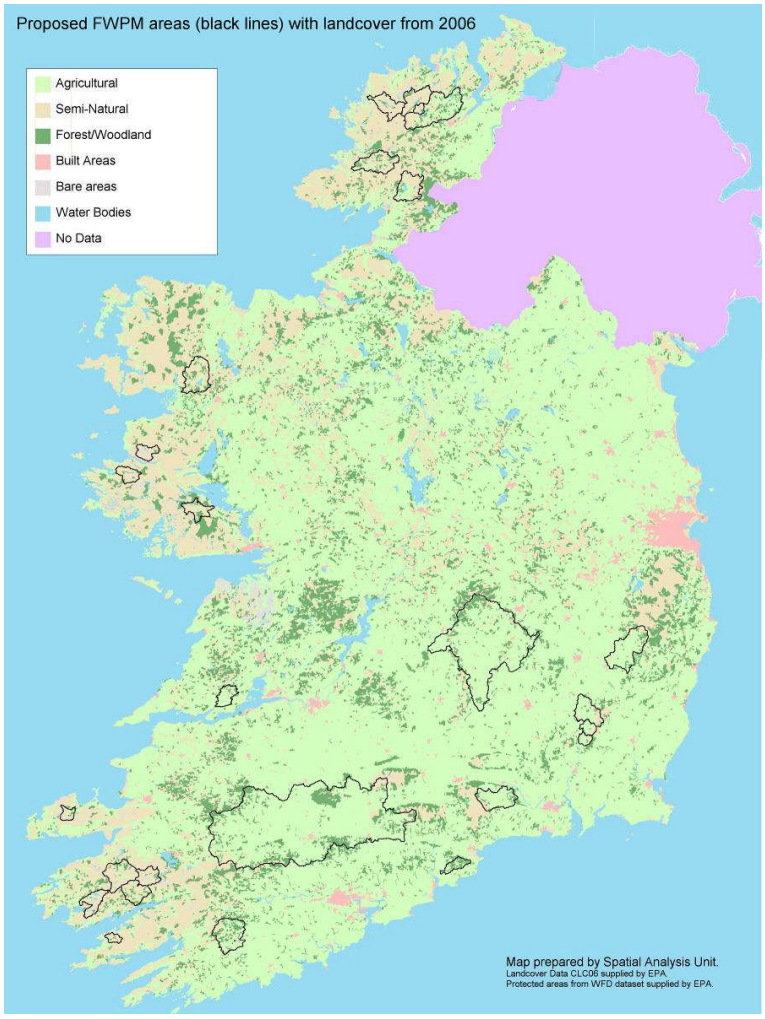

Figure 1: Proposed fresh water pearl mussel areas in relation to land cover (2006)

We evaluated the economic cost of potential supplementary measures for three case studies, i.e. the sub-basins of 1) the Munster Blackwater catchment; 2) the Nore catchment; 3) the Leanann catchment. For each of these case-studies, we assessed the costs associated with two potential supplementary measures, i.e. the implementation of a fenced-off buffer strip along all surface water bodies, and mandatory reductions in stocking rates (SR).

3.3.1 Economic costs of buffer strips

Costs associated with implementing a 10m buffer strip include the loss of revenue associated with taking land out agricultural production and the cost of fencing off the buffer zone on both sides of the river (€0.9 per meter spread over 5 years). Table 2 presents these estimated costs for each of the case-studies:

Table 2: Estimated annual cost to agriculture of implementation of a 10m fenced-off buffer strip along streams, expressed per ha and expressed per km stream length.

Case-study	Cost per ha (€ ha^{-1} $annum^{-1}$)	Cost per km stream length (€ km^{-1} $annum^{-1}$)
Nore	880	1,250
Munster Blackwater	890	1,220
Leanann	420	570

3.3.2 Economic costs of reductions in SR

We examined two scenarios for each case-study:

1) No derogation, equating to a reduction in SR to 2 LSU ha^{-1};

2) Severe mandatory reduction in SR: Reduce stocking density to 1.5 LSU ha^{-1}. Table 3 presents the estimated loss in revenue for each of the case-studies:

Table 3: Estimated annual cost to agriculture of implementation of restrictions on stocking rates

Case-study	Reduction of SR to 2 LSU ha^{-1} (€ ha^{-1} $annum^{-1}$)	Reduction of SR to 1.5 LSU ha^{-1} (€ ha^{-1} $annum^{-1}$)
Nore	10	59
Munster Blackwater	22	129
Leanann	0	0

Teagasc is particularly concerned that it would be likely that a large and disproportionate share of these costs / loss of income would be incurred by a relatively small number of landowners, i.e. those farmers and forest owners adjacent to water courses. Should this be the case, then this would be at odds with the general approach of the Water Framework Directive, in which no individual sector of society should be burdened with a disproportionate share of the costs of implementation (Finnegan, 2008).

3.4 Conclusions on the Fresh Water Pearl Mussel Sub-Basin Management Plans

In summary, Teagasc acknowledges the national obligation to protect the Fresh Water Pearl Mussel and its habitat, and understands that in certain conditions, the application of the precautionary principle may be justified. However, Teagasc is concerned that some of the suggested measures may be associated with disproportionate costs. This is particularly alarming in light of the large uncertainties surrounding the causes of the decline in pearl mussel populations, the roles of agriculture and forestry in this decline (as opposed to the role of other nutrient sources and other contaminant sources such as sediment), and the overwhelming uncertainties surrounding the probability of a successful stabilisation and reversal of the current downward trend in population viability for some of the FWPM Areas.

It is Teagasc's position that a thorough assessment of cost-effectiveness, specifically within the geo-environmental context for each individual FWPM sub-basin, is a prerequisite to applying the precautionary principle without invoking unnecessary and disproportionate costs. Teagasc is committed to contributing constructively and proactively to the discussions on the implementation of the FWPM Sub-Basin Management Plans.

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