Consolidated List – General Theme	Consolidated List – Questions to define Case Studies
Source-Pathway-Receptor Evidence	Bringing the evidence baseline for FIOs up to the standard of other pollutants
Source-Pathway-Receptor Evidence	Another major gap to add to your list is regarding the pollution contribution via drain flow. We know a lot of pollutant transfer happens via drains but have very limited / no effective measures to address this. Ideally we would like a range of sensible practical mitigation measures for this pathway to use in addition to those we have to address things at source. For example: IN ditch wetlands, 3d buffers, end of field corner wetland . I am aware of work at Newcastle University at Nafferton farm on the use of in ditch systems with p stripping but don't have the detail of this
Source-Pathway-Receptor Evidence	Can high risk contaminant sources in specific environments be identified (influence of soil types, hydrology, rainfall, cropping patterns, farming practices such as tillage and under-drains, topographic features such as slope and proximity to water courses);
Source-Pathway-Receptor Evidence	the fate and behaviour of specific contaminants in the environment (use, timing and methods of application, leachability, persistence, bidegradation etc)
Source-Pathway-Receptor Evidence	Can a consistent modelling approach be developed to look at sources of pesticides and their transport to receptors (e.g. surface water abstractions and boreholes).
Source-Pathway-Receptor Evidence	the need for more work on septic tank locations and their contribution to water pollution, on highways inputs, and on sub-surface land drainage systems, both from a Water Quality perspective but also in relation to their contribution to flood peaks.
Source-Pathway-Receptor Evidence	Limited information about the true status of our Trac waters and marine waters, and their connections to the river ecosystem
Source-Pathway-Receptor Evidence	Inaccurate records / insufficient means of recording structures, highways inputs, and INNS
Source-Pathway-Receptor Evidence	On good status / moderate, regarding P will depend on UKTAG definitions of respective P concs for given settings. Also for P if not good status then may not really make a difference because P need to be below a threshold – I don't think this is a linear relationship so need to be clear about the nature of the thresholds of P and N or others on removing limits on the growth of different nuisance species – I assume there are ranges for different organisms
Source-Pathway-Receptor Evidence	Need to be clear that problem is excessive biological activity not P conc per se. Therefore need to understand conditions leading to this. Account not just chemistry but residence times / temperature and light intensity – function of weather and shading. – any other factors?? E.g. seed populations coming from releases from ponds or canals of high residence then multiplying in river which was otherwise flushed clean.
Source-Pathway-Receptor Evidence	key question for ecological impact – under what circumstances will higher P result in excessive growth – models need to be able to predict this and correlate with WFD compliance. Even in the total biomas growth it may matter a lot exactly which organisms are going barmy – e.g. toxic blue greens much more serious than some macrophytes – is this so??, what are the other factors??

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Decision support	Need more emphasis on the ability to model the solutions such as farmscoper or the SAGIS IT tool for optimisation and economic impacts on multi sector basis against WFD standards (however they are expressed). The ultimate aim of all of this will after all be to use models to find the optimal solutions, cost them and get them in an agreed programme of measures
Source-Pathway-Receptor Evidence	We need more event based monitoring rather than more modelling This is especially true for ecological data, sediment and pathogens such as FIOs. With the new BW directive and tighter hygiene standards for Shellfisheries we need better coverage of FIO data and more event based FIO data, we only have these from academic research projects and detailed EA investigations. We need this sort of data u/s and d/s of mitigation measures at the farm and subcatchment scale.
Source Apportionment	Is good status achievable with all the other demands on the environment? E.g. is sustainable intensification achievable within WFD targets
Source Apportionment	How will climate change alter the baseline for “good” status?
Evidence of outcome	Can models help to target measures and provide an estimate of the level of confidence that they will work – no point in investing customers money if uncertainty high
Source-Pathway-Receptor Evidence	Can models be used to help decide where to invest in sampling and other evidence gathering?
Effectiveness of measures / mechanisms	How (cost) effective is catchment management at improving drinking water quality and maintaining water supply?
Model / data awareness, availability and application	How do we get repeatable outputs from models? Calibration, consistency, good practice, model development protocols, learning from other fields
Source-Pathway-Receptor Evidence	Develop’ protocols for risk assessment and mapping
Effectiveness of measures / mechanisms	Capture uncertainty in effectiveness of measures – understanding timescales of response and implications for economics
Source-Pathway-Receptor Evidence	How do measures affect peaks? (should monitoring be load or conc based to detect change?)
Source-Pathway-Receptor Evidence	What spatial scale should we be targeting for understanding processes and evaluating standards (don’t look at water quality in isolation – bigger picture)
Future pressures and extrapolation of impacts	What are the implications of climate change and agricultural intensification for water quality?
Contextualisation of the problem and solution	Conceptual model – persuasion there is a problem and why? Verification to support underlying beliefs. (Scored poorly)
Measures selection and optimisation	Land management and use/what do we target? Triage phase. (Not being dealt with elsewhere)
Measures selection and optimisation	What is the farmers role – what is the measure for each farmer to implement, when will the measure yield benefits, convince the measure will work, what level of uptake is required, what tools best achieve uptake of measures/buy-in?

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Measures selection and optimisation	What are the co-benefits – is there a tool to help persuade farmers to enact change?
Evidence of outcome	How can we achieve final sign off by the regulators, but focus on benefits?
Decision support	Decision Support Tool – Multi-sector/pressure/response with (or that can link to) cost-benefit/cost-effectiveness for appraising policy options. Needs to be spatially explicit and incorporate social models/behaviour change. 'Where do I get most bang for buck' - Scenarios a. Criteria (including social and legal) need to be agreed up front for model acceptability b. Baseline and temporal contingencies (i.e. incorporation of external factors) are a critical component e.g. links to WFD no deterioration requirement c. Need buy-in from audience at different levels/scales – how? What does Good Ecological Status mean in terms of recreation? Investment in achieving moderate status is likely to have greater benefits than getting to good
Source-Pathway-Receptor Evidence	Morphology is a major pressure – can models help e.g. predict link to ecology? (Is there a relationship between buffer width, typology and natural recovery)
Source-Pathway-Receptor Evidence	Land use and management change beyond agriculture e.g. forestry
Effectiveness of measures / mechanisms	When will my policy be successful? How will we know it has been successful? Need outcome indicators to show direction of travel as well as modelled prediction. Need to understand why there are deviations from modelled prediction
Future pressures and extrapolation of impacts	Future proofing – climate change and other impacts
Environmental economics / socio-economics	Social and economics important – optimising uptake
Effectiveness of measures / mechanisms	Catchment scale useful for optimising uptake – then upscale. What is the level of uptake required? And where?
Source Apportionment	Source apportionment and ecological impacts
Evidence of outcome	Time lags
Evidence of outcome	Link models to monitoring
Integration / focus / scaling	Link local and national models
Source-Pathway-Receptor Evidence	Biologial / ecological / chemical responses to pressures and measures
Evidence of outcome	How does the model output relate to actual effectiveness of measures? Is the model calibrated and verified? What evidence exists for these aspects?
Uncertainty, confidence and communication	How does using different input datasets affect the model outputs and hence the evidence base upon which to base action?

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Effectiveness of measures / mechanisms	How effective are the measures both within existing baseline regulations, existing delivery mechanisms and also outside of existing delivery mechanisms? How widely are measures currently being implemented and what more is needed / can be done in order to get us to where we need to be? Are the existing measures and mechanisms enough to deliver GES given the issues around applicabiliy to different catchments, uptake and implementation efficiency and uncertainty in outcome? ie what measures may be missing from RBMP 1? (requires accuate source apportionment)
Environmental economics / socio-economics	How far can we get for a given amount of money; how far do we need to get to and by when; what's the best way of getting there and what should we do first; what kind of magnitude of intervention is appropriate ;what are the costs and effectiveness of different measures applied at different geographical scales (local - national)?
Source-Pathway-Receptor Evidence	How much air nitrogen ends up in the catchment and subsequently in the lakes?
Future pressures and extrapolation of impacts	How will future land use and climate change affect pressures e.g. N,P,Sediment in water
Integration / focus / scaling	Integration of models across receptors / objectives to identify co-benefits and trade offs; to help justify / prioritise action depending on local objectives, priorities and characteristics
Contextualisation of the problem and solution	Making information available: reports, data, models, model outputs, evidence base for model verification; visualisation
Contextualisation of the problem and solution	Model outputs need to be usable for stakeholder engagement and this means making the outptus accessible to different audiences; including visualisation, communication and couching the outputs in a language different sectors understand whilst working off a common currency across the sectors. e.g. Cost impacts of specific pressures and the cost benefits of specific measures to different sectors
Decision support	Need to be able to combine model outputs across different pressures / receptors / objectives into a simple decision making tool that sets out and communicates the weight of evidence (scientific, economic and social), visualises the issues and potential solutions and is scalable geographically and can be used for stakeholder engagement
Inclusion of local catchment characteristics, objectives and data	Need to be able to use national / standard set of models and datasets but with the ability to run it on catchment specific data and local objectives rather than just national datasets. Use data used by regulators eg in designations.
Environmental economics / socio-economics	Social science and uptake of measures / motivation and how it affects outcomes
Source Apportionment	Source apportionment tools need to go into more detail than currently (sector responsible and loads); needs to go to specific activities and be expressed temporally so that it can be taken into context with flows, rainfall, and land use activity such that measures can be targeted appropriately (what measures, applied when, and likely outcome)Should source app be based on ecological impact?

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Source Apportionment	Source apportionment tools need to go into more detail than currently (sector responsible and loads); needs to go to specific activities and be expressed temporally so that it can be taken into context with flows, rainfall, and land use activity such that measures can be targeted appropriately (what measures, applied when, and likely outcome). Should source app be based on ecological impact?
Contextualisation of the problem and solution	Stakeholder engagement for a range of audiences
Model / data awareness, availability and application	What data and models are available, what do they do, when is it appropriate to apply them, what is the uncertainty around the datasets and model outputs? where can I go to for support, who should I speak to when there is a problem or I don't understand something?
Evidence of outcome	What is any given model output based on, what is the uncertainty associated with it's prediction and how do the outputs relate to different scales of application?
Effectiveness of measures / mechanisms	What is the actual outcome of different catchment management options in terms of Water Company deployable outputs?
Effectiveness of measures / mechanisms	What is the combined impact of multiple pressures, biological response, and the effectiveness of measures
Environmental economics / socio-economics	What is the cost-benefit of specific measures within sector and across sectors and at different spatial scales, incorporating a full range of Ecosystem services and natural capital; C/B in terms of ranges rather than absolute, reflecting the uncertainty in C/B
Effectiveness of measures / mechanisms	What is the effectiveness of measures to address pesticides in water company sources? (GW and SW)
Ecosystem Services	What is the outcome of a specific measure in terms of ecosystem services, and what do ecosysem services mean to different audiences / stakeholders? Note there is isterest from flooding policy in Scotland and Scottish Natural Heritage in links beteen RBMP implementation and habitat/biodiversity benefits
Uncertainty, confidence and communication	What is the uncertainty associated with modelling the different effectiveness of measures?
Environmental economics / socio-economics	What measures should we focus on, and in what order should we approach it, for a given amount of money in order to maximise our outcome?
Effectiveness of measures / mechanisms	Can we detect and forecast long term changes in raw water quality? Is there enough baseline data? Which parameters most susceptible? Spatial and temporal factors? Future risk araes?
	Can we evaluate the resilience of aquatic ecosystems and the probability of recovery?
Contextualisation of the problem and solution	Need understanding of coarse (in river) and fine sediment dynamics (links to morphology questions)
Contextualisation of the problem and solution	How can we target mitigation measures on a catchment and site specific basis? (impact of decline in advisory services?) (resolve challenges between the need to target and the difficulties in implementing a targeted approach?

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Source-Pathway-Receptor Evidence	There are significant uncertainties in many cases regarding ecological responses to pressures and as a result to measures, both in terms of the magnitude and the time scales of response.Can we demonstrate the link between land use and ecology on a catchment specific basis?
Source-Pathway-Receptor Evidence	We only have limited evidence about how pressures act in combination. As a result there are uncertainties regarding the effectiveness of measures in dealing with multiple pressures
Environmental economics / socio-economics	We are uncertain about the relative cost-effectiveness of measures to deal with many pressures. Uncertainties relate both to technical effectiveness and costs
Future pressures and extrapolation of impacts	We do not enough about how future trends of population and climate will affect pressures
Uncertainty, confidence and communication	It is difficult to know the extent to which ongoing research will close evidence gaps
Source-Pathway-Receptor Evidence	Links between P (in its different forms) and ecological responses are complex. This leads to uncertainty in deriving standards, and the need for a weight of evidence approach to confirming eutrophication.
Environmental economics / socio-economics	We lack contemporary information on damage costs of eutrophication and a recent assessment of costs versus benefits of control options. The latter in particular are needed, along with improved apportionment and options appraisal tools, to inform national deliberations about measures and alternative objectives
Future pressures and extrapolation of impacts	Potential effects of future trends such population growth, climate change; land use change, food security and nutrient supply need to be better quantified
Source-Pathway-Receptor Evidence	Measurements and predictions of nitrate loading to the environment, and the benefits of diffuse pollution control measures have a high level of uncertainty. We can measure nitrate concentrations in waters, but this doesn't necessarily help make the cause and effect link between sources and the effectiveness of measures
Effectiveness of measures / mechanisms	The extent of the gap between where current measures will take us and WFD objectives is not well quantified, and a large programme of investigations is ongoing
Source-Pathway-Receptor Evidence	There are currently no formal nitrate standards for lakes and other freshwaters within the WFD although there are thresholds in the Defra/EA methodology for the Nitrates Directive
Source-Pathway-Receptor Evidence	We know that sediment pressure acts in combination with other pressures such as morphology, chemicals and nutrients. However we do not fully understand how these pressures combine to affect ecological status
Effectiveness of measures / mechanisms	We have little field data to verify the effectiveness of measures across wide scales such as catchments, and the contributions of different pathways can make a significant difference to load reductions.

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Evidence of outcome	Sediment pressures are assessed by a link to biological element failures, we do not routinely monitor sediment run-off or in-river siltation, so there is limited collation of regional-to-national data available. This also relates to Natura 2000 sites
Source-Pathway-Receptor Evidence	Evidence is not available on the effectiveness of specific measures on reducing pressure from ammonia and BOD. For example the impact of Catchment Sensitive Farming and Environmental Stewardship schemes on reduced pressure from sanitary pollutants
Effectiveness of measures / mechanisms	It is not possible to assign the proportion of water company improvement that relates directly to reduced pressure from sanitary pollutants
Source-Pathway-Receptor Evidence	There is limited evidence to clearly link the long term effects of activities that cause sanitary pollution to ammonia and BOD pressures on the water environment.
Source-Pathway-Receptor Evidence	The majority of bathing waters and shellfish waters that have problems, have multiple diffuse sources of FIOs. The main evidence gap is identifying where the FIOs are coming from, which is very difficult as there are so many potential pathways and sources
Source-Pathway-Receptor Evidence	As the Environment Agency does not routinely monitor Drinking Water Protected Areas (DrWPAs) for bacterial contamination, we rely on water companies to monitor their supplies and alert us if they detect an issue. FIOs can cause pollution of drinking water sources and present a risk to human health
Source-Pathway-Receptor Evidence	The limitations of the monitoring programme means that our understanding of the presence or otherwise of chemicals in the environment is patchy, especially for those that enter watercourses via diffuse routes
Future pressures and extrapolation of impacts	Climate change impacts on river flow up to 2030–2050 are too uncertain to base any forecasts on impact on annual average concentrations in watercourses. The impact of forecast population change to 2030 needs further consideration although the current presence of ubiquitous chemicals from wastewater treatment works may mean that there will be little change to status
Source-Pathway-Receptor Evidence	There is a great deal more we can and are doing to improve our understanding of the nature and impacts of hydromorphological pressures on aquatic ecosystems
Source-Pathway-Receptor Evidence	There are currently significant gaps in our understanding of species/habitat/pressure relationships
Effectiveness of measures / mechanisms	There are currently significant gaps in our understanding of the costs and effectiveness of hydromorphological improvement measures
Source-Pathway-Receptor Evidence	This information is being updated but the lack of data on the extent and nature of physical modification pressures is a cause of major uncertainty
Source-Pathway-Receptor Evidence	Combinations of pressures – we need to understand more about the effects of pressures acting in combination on a water body (such as abstraction, barriers to fish migration and sediment).

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Source-Pathway-Receptor Evidence	We need to understand more about the role of, flow variability, in maintaining ecological integrity.
Effectiveness of measures / mechanisms	Flow regulation – we need to gather more evidence on the effectiveness of various mitigation measures for heavily modified river systems.
Source-Pathway-Receptor Evidence	We need to know more about how our (generally pressure based) WFD biological tools are affected by invasive species. The UKTAG alien species group is attempting to collate available evidence (even where anecdotal) with the aim of commissioning more work and filling in gaps
Measures selection and optimisation	Development of measures to control and mitigate the impacts of invasive species
Source-Pathway-Receptor Evidence	For all species we need more information on the pathways of introduction and ecological impacts
Evidence of outcome	There are still concerns over whether sustainable ecological recovery will occur. Water quality improvements have not always resulted in a corresponding recovery in freshwater biological communities. This lack of improvement has been linked to land management and peaks in acidity during rainfall events
Source-Pathway-Receptor Evidence	We need to develop a better understanding of how recovery is being compounded by other stresses such as land use change and climate change