



## Ecosystem Enterprise Partnership

# Developing a Delivery Framework for a Market Based Nutrient Offsetting Scheme for the Milford Haven and Cleddau Catchments

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# **1 PROJECT INTRODUCTION**

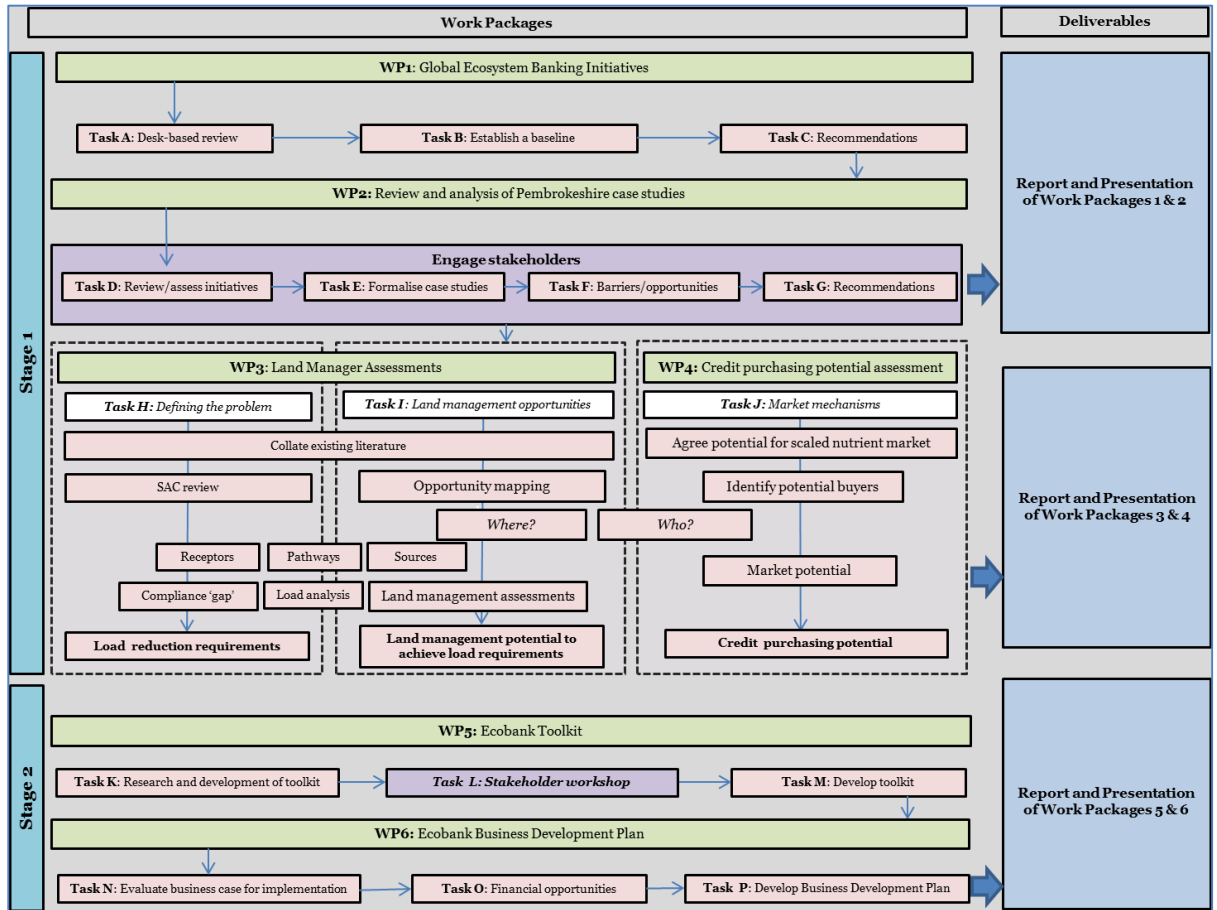
The Ecosystem Enterprise Partnership was one of 18 projects successful in securing money from Welsh Government's Nature Fund to tackle declining biodiversity and deliver benefits to communities. The funding was secured to develop a market based nutrient offsetting scheme for the Milford Haven and Cleddau Catchments. Currently nutrient loading into the catchments has been identified as a key issue and focus for action. The aim of the project was to create a framework which would allow the levels of nutrients within the waterbodies to reduce, thereby creating headroom and preventing any constraints on potential development projects (both industrial and housing).

The project aimed to identify an innovative market-based solution involving a partnership between land managers, industry, commerce, government and the third sector that provided a streamlined, consistent and robust nutrient assessment process for developing a rigorous and credible offsetting scheme.

This report has been developed on behalf of the partnership, by Cascade Consulting and ADAS, to help with the development of a nutrient offsetting scheme and provides further details of the work undertaken, the findings and main recommendations.

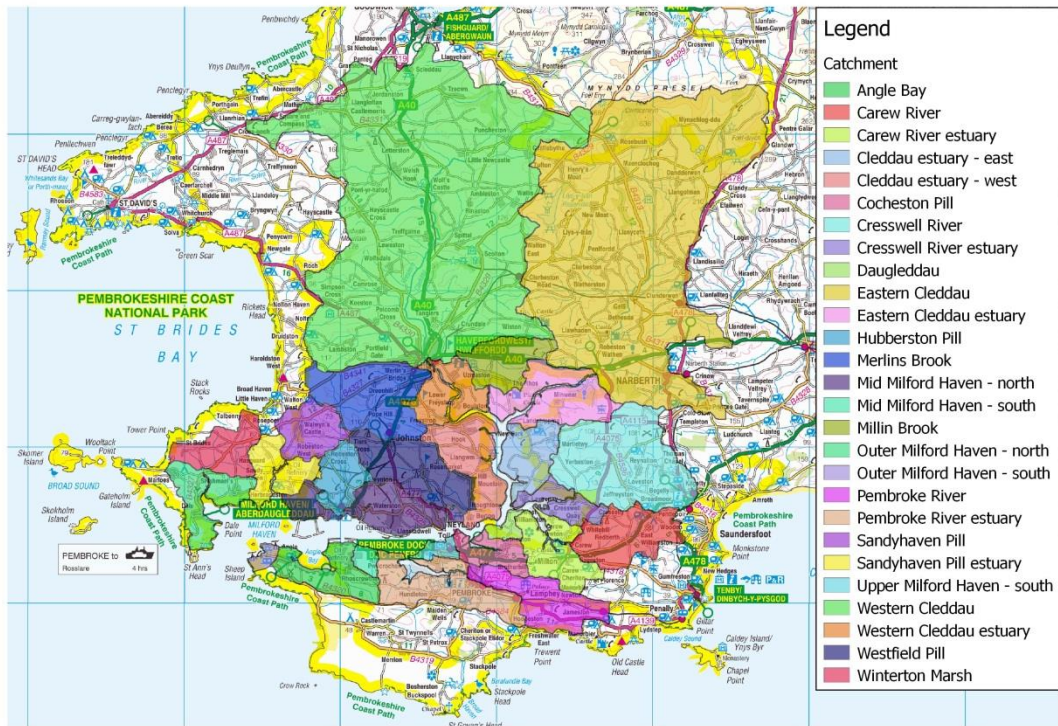
The report is laid out in Work Packages, which are listed below, and detailed further in Figure 1. This report is a collated version of all the deliverables associated with each Work Package.

- Work Package 1: Review of Global Ecosystem Banking Initiatives
- Work Package 2: Review and Analysis of Pembrokeshire Case Studies
- Work Package 3: Land Management Assessments (incorporating Defining the Problem and Land Management Opportunities)
- Work Package 4: Credit Purchasing Potential Assessment
- Work Package 5: Ecobank Toolkit
- Work Package 6: Ecobank Business Development Plan



**Figure 1: Project Approach**

The study area includes all areas of land within Pembrokeshire that drain into Milford Haven, either directly or via one of the Cleddau rivers (and tributaries). For the purposes of data analysis the overall catchment area has been split into sub-catchments and the total project area is shown in Figure 2 below.



**Figure 2: The Project Area**

## 2 WORK PACKAGE 1

### 2.1 INTRODUCTION

There are already a large number of offsetting schemes that have been attempted or successfully implemented around the world. This section details the results of a desk based review of current global ecosystem banking initiatives, using relevant elements from the Rapid Evidence Assessments methodology, as published by the UK civil service<sup>1</sup>. The review analysed published and unpublished literature and looked to evaluate the successes and failures of similar projects and how the relevant elements of each scheme could be applied to the Milford Haven Catchment.

This report sets out the results of this analysis and a list of recommendations and potential barriers which have fed into the development of the later work packages and the final proposed toolkit.

### 2.2 EVIDENCE REVIEW METHODOLOGY

A literature review was undertaken of published and unpublished literature that related to global ecosystem banking initiatives, nutrient trading and offsetting schemes. The main sources of information accessed included: Scopus<sup>2</sup>, the Collaboration of Environmental Evidence<sup>3</sup>, WorldCat database<sup>4</sup> and Open Grey database.

These schemes were divided into several categories depending on their content and these categories included: nutrient offsetting, Payments for Ecosystem Services (PES), multiple outcome schemes, or studies with a specific mention of habitat banking. The details of these different schemes were subsequently broken down and analysed, and will be discussed throughout this report.

In addition each study was broken down into a range of categories including: Year of publication, type (reference or case study), approach (practical or theoretical), buyer, seller, units of trade, successes/failures, description and role of broker, quality of reporting and justification & applicability. To establish the importance of each study to the current project, the studies were graded into 3 different categories depending on their quality, applicability and relevance. A basic 'traffic light' colour system was used where green were the most important schemes, amber moderate, and red the least important.

Studies that were designated as red were generally identified as being not applicable

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<sup>1</sup> <http://www.civilservice.gov.uk/networks/gsr/resources-and-guidance/rapid-evidence-assessment/what-is>

<sup>2</sup> <http://www.scopus.com/home.url>

<sup>3</sup> <http://www.environmentalevidence.org/Reviews.html>

<sup>4</sup> <https://www.worldcat.org/>

for the current study. This was mainly because they had little relevance, or were of poor quality. Amber studies were either of high quality, but low relevance, or high relevance but low quality. However, unlike the ‘red’ studies the majority of amber studies provided some useful background information to offsetting or ecosystem but without any practical applicability. Green studies provided information of schemes which were directly relevant, applicable and were of high quality.

Finally, while most of the studies were of high quality, the majority of reports were feasibility studies, or desk based pilots where the outcomes were still largely theoretical. These provided some relevant information but mainly indicated the difficulty and complexity of setting up schemes such as this and the need for the baseline data to be robust.

### **2.3 MAIN NUTRIENT TRADING SCHEME TYPES**

The analysis of global initiatives showed that whilst there are many nutrient trading schemes in operation, habitat banking is the most common initiative type currently in operation. Habitat banking was not considered by the stakeholders to be a viable solution to the particular problems within the Milford Haven and Cleddau catchments as it would not deliver the reduction in nutrient loading required.

Consequently, the review of global initiatives mainly focussed on nutrient trading schemes, but also recorded examples of good practice, useful tips etc. from other types of PES schemes. These findings have then been fed into the other Work Packages for this project.

For more information on the different schemes analysed please refer to the Reference list in Appendix 1. In addition, Appendix 2 includes further detail on specific schemes of interest including the Fowey, Poole Harbour and Chesapeake Bay in the US.

#### **2.3.1 Sole Source Offset**

Sole-source offsets are schemes where an increase in nutrient discharge is allowed at one point, as long as there is a reduction in nutrient discharges elsewhere (either on or off site). In all cases the nutrient reduction efforts are undertaken by the regulated body (i.e. the polluter) and must be done in the same catchment.

Schemes of this type are typically quick, and easy, as often only 1 party is involved. However it can be difficult to ensure that the increase does not have a greater impact than the reduction. Typically this can happen if the increase takes place in an area of higher risk/value than the equivalent area where the reduction is taking place which can result in an overall worsening of the catchment condition. In order to avoid this there needs to be a sufficient quantity of robust data available to be certain that there

will not be any unintended consequences of allowing greater levels of discharge at certain places.

### **2.3.2 Bilateral Negotiation**

Bilateral negotiations are trades characterized by one-on-one negotiations where a price is typically arrived at through a process of bargaining and not simply by observing a market price. This type of market can occur at any point as it is not limited by auction dates however, it generally has high transaction costs and requires those involved in the negotiation to have a sufficiently high level of knowledge about the required outcomes to develop environmentally effective, not just cost effective, solutions.

### **2.3.3 Clearing House**

A clearinghouse scheme is where an intermediary in a trading program aggregates credits from different sources with different prices and converts them to a fixed-price commodity that is re-sold. For example, a clearinghouse may aggregate point-source reductions for re-sale at a fixed price or be the central body to which point sources pay noncompliance fines and they in turn pay farmers to install nutrient-reducing management practices.

Commonly, the clearinghouse has been established as part of the trading program. Advantages of this, is that there should be reduced transaction costs which can facilitate an increase in demand that makes undertaking credit-generating projects more viable. Additionally, the 'buyer' can execute one credit purchase, as opposed to multiple purchases, if their credit purchase was sufficiently large, such that it entailed multiple credit sellers. A Clearinghouse would also manage the nutrient credit delivery risk and contract enforcement responsibilities.

Disadvantages of this type of scheme include: those wanting to buy/sell would need to work out in advance how they were going to save or use the traded entitlements, and then may fail to obtain or sell them in the auction. The cost of this process would need to be recovered from participants, or at the very least accounted for in the process, which reduces its cost effectiveness.

In addition, this scheme type requires the clearing house (i.e. a broker) to have the structures in place and the technical competency to aggregate credits and convert them into the fixed price commodity. This is not a simple process and is open to challenge if people do not agree with the price.

### **2.3.4 Exchange Market**

An exchange market is where buyers and sellers meet in a public forum (e.g. online)

with all commodities being equivalent and all prices observed. An exchange is characterized by its open information structure and fluid transactions between buyers and sellers.

This type of market is quick and easy to use and has been demonstrated through the Hunter River Salinity Trading Program, using an exchange market with real-time trading and the Maryland Nutrient Trading Program which uses bilateral agreements.

### **2.3.5 Reverse Auction**

A reverse auction is where the roles of buyer and sellers are reversed – the bidder is the seller and not the buyer. However, the lowest bid is not always the winner, most bids are different and weighting originates from service the seller is proposing. Many reverse auctions occur online, providing a useful platform for electronic procurement.

There are several varieties of auction – open bid and sealed bid. In an open-bid auction, information relating to the bids are shown in real time – this can be either the exact price, or a ranked position, while identities of bidders are hidden. In Sealed bid auctions, no information is available to any of the participants throughout the auction.

Advantages of online reverse auctions are based on time and price. Where price is a priority, they provide opportunities to obtain better prices, as the auction process quickly lowers prices. Additionally, they are generally quicker than other types of procurement processes, where there are quicker reactions to changing markets. As such, the auction is efficient, both for the buyer and seller; Sellers can focus time on direct proposals, and buyers can quickly find new business and customers.

There are disadvantages for both the buyer and seller. The buyer will often be subjected to the additional costs associated with setting up a reverse auction – through registration, subscription and commission fees. Moreover, as sellers compete with others, their profit margins may be reduced as they are forced to lower prices<sup>5</sup>.

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<sup>5</sup> Kuo, C-C., White, R. E. & Rogers, P. (2003) A critical review of online reverse auctions. Available from: <http://www.sbaer.uca.edu/research/swdsi/2003/Papers/091.pdf>

## **2.4 TYPICAL STRUCTURE OF A NUTRIENT TRADING SCHEME**

Successful PES schemes tend to have four principal groups involved; these are buyers, sellers, brokers and knowledge providers. In addition, the other main component of a scheme is the unit of trade and the costing of this unit across different areas and different stakeholders.

This section outlines the findings from the global initiatives analysis on these groups and the units of trade, and where possible, how they might contribute to a nutrient trading scheme in Pembrokeshire.

### **2.4.1 Buyers**

#### ***Background***

Typically in PES schemes buyers are considered to be: “beneficiaries of ecosystem services, who are willing to pay for them to be safeguarded, enhanced or restored”<sup>6</sup>. For a PES scheme to work there must be a clear demand for the service being sold and its provision must be financially valuable to the buyer(s). Without a willing and able buyer, there is no prospect of a PES deal.

Buyers tend to be broken down into three broad types:

- ‘Primary buyers’ (buyers who benefit directly from, and pay directly for, improved ecosystem service)
- ‘Secondary buyers’ (organisations that buy improved ecosystem service provision on behalf of sections of society e.g. water company)
- Tertiary buyers’ (organisation that buy improved ecosystem services provision on behalf of society as a whole e.g. government via agri-environment schemes)

#### ***Key Findings***

The majority of schemes analysed were aimed at mitigating the impacts arising from infrastructure schemes, extractive industries, industry and development projects. As a result, the buyers tended to be directly involved with these activities and typically they were what could be termed the ‘polluter’.

In the United States, where there is a well-established history of nutrient trading, the majority of the buyers are compelled to participate in trading schemes as a condition of their permit to operate. An advantage of this type of buyer is that it is always

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<sup>6</sup> Smith, S., et al. (2013). Payments for Ecosystem Services: A Best Practice Guide. Defra, London

present and therefore demand can be always be utilised, however, it can discourage potential buyers from investing in areas where these schemes exist, if other locations nearby do not have such requirements.

In many other countries, including the UK, schemes have focussed more on offsetting the loss of habitats as a result of development. As a result, many developers have been keen to invest in such strategies as it can help them achieve planning permission and they can discharge their environmental obligations transparently, and typically in a very few number of transactions.

Other types of buyer include individuals, who are often farmers. The advantages of this type of buyer is that there are low admin costs, as the program piggy backs onto existing organisations of farmers and systems of monitoring and record keeping. However, individuals are often unwilling to accept long-term contracts for PES measures which can reduce the uptake of such schemes. In addition, many schemes were looking for long contracts, including up to 30 years. Whilst this length of contract provides long term guarantees that the offsetting will continue the contracts, can turn out to be more expensive than outright land purchase or other solutions (e.g. end of pipe solutions in a sewage treatment works).

Governments both national and local, as well bodies funded by government often act as buyers. Such bodies are able to demonstrate transparently the suitability of their decision, including the ability to demonstrate an audit trail of the decision making process. However, all organisations relying on government money are being squeezed by the current financial climate and in many areas PES schemes are being attempted precisely because they provide the mechanism for achieving environmental improvements with little or no public money.

There are good examples of buyers being brought together, or joining together in successful PES schemes. The reasons why they do this is varied and dependent on the individual circumstances of the area under a scheme, however what is important is that the bundling of buyers together appears to work very well and increases the value of the buying fund beyond what any one organisation or individual can pay. This has the potential to deliver much greater benefits though it can also be difficult to ensure that there is no free riding occurring and that all buyers are contributing equitably in relation to the impact they are having.

Though there are a significant number of different types of PES schemes operating there are a relatively small number of buyers. Generally these are the polluters or developers (i.e. the actors causing, exacerbating or maintaining the problem) with a few others such as governments, environmental non-governmental organisations (eNGO) or individuals also occasionally involved.

Whatever the type of buyer however, the evidence seems to show that the most effective nutrient trading schemes have been successful because the buyers need to be compelled to enter into a nutrient trade. This is generally through regulatory action as either a condition of permitting or planning and should be carefully considered within the Pembrokeshire context.

#### **2.4.2 Sellers**

Under a PES scheme, sellers are generally identified as land, or other resource managers, who can secure or improve the level of an ecosystem service by maintaining good practice or amending other activities.

After completing the global initiatives review it appears that globally sellers tend to predominantly be landowners / land managers, especially those directly involved in agriculture. Though the farming sector is clearly the most common there were a range of other sellers including: Local Planning Authorities/Government Agencies; mitigation bankers; private sector reserves; indigenous groups; NGOs; and conservation land management companies.

An advantage of sellers being drawn mainly from the agricultural sector is that typically farmers can reduce contamination flowing into watersheds at a fraction of the cost of larger treatment plants. Some farmers are keen to participate in the scheme, as it is seen as a competitive advantage which tends to have the knock on effect of maintaining the flow of credits. However, conversely other farmers do not want to contribute, and are not prepared to diversify, even if the scheme could be more profitable to them as they do not want to compromise the future viability of their land for food production.

There is also the issue about paying farmers additional money to reduce activities that they could and should be reducing anyway. For example, there is a lot of opposition to mandating that developers entering into schemes to offset their nutrient contribution by paying farmers when it is typically agriculture that is causing the majority of the problem.

Globally there do appear to be other sellers, though they tend to be much less common. Other sellers include private sector reserves, which have drawn criticism by allowing publically funded best management practices (BMP) to generate pollution credits. This is not seen as providing an additional reduction in the overall nutrient load, as the public funding has already accomplished the reduction. As such, it wastes financial resources by providing double payments to the private sector for the same reductions. This not only hurts pollution goals, but also distorts the market by artificially deflating the price of a pollution credit. Entities receiving cost-share funds can undercut others who did not receive such funds by selling credits at a lower cost.

This places those who cannot or could not receive public money at a competitive disadvantage. This will likely limit participation in the market to a relatively small number of entries.

### 2.4.3 Brokers

The most successful schemes tend to always involve a trusted intermediary or broker who undertakes a wide range of activities, depending on the scheme being implemented and the specific circumstances surrounding it. Types of broker recorded included: NGOs; government agencies; private firms such as the Environment Bank; public sector bodies/regulators; and Local Planning Authorities.

Brokers tend to have very different roles, depending on the schemes. For example, they act as intermediaries between buyers and sellers; they bring a wide range of stakeholders together; they can assess the credit requirements of development sites; and they source receptor sites from their registration system that can deliver the credit. They also balance and stabilise credit prices through different techniques depending on the market situation. In a monopoly, bankers can set a competitive price for the credits, to encourage buyers. In an oligopoly, bankers can adjust the cost of credits to reflect the market. Other marketing techniques such as advertising or discounting of the credits can be applied<sup>7</sup>.

Impartiality and transparency is also crucial. A scheme set up by the Bristol Avon Rivers Trust to improve water quality from sewage treatment works by improving wetland became problematic when the broker was not impartial. Sellers of the scheme became challenging when they believed that the buyer had employed the broker, and only the buyer's interests were being recognised<sup>8</sup>. Advantages of using a broker, is the ease of use, however, there are also likely to be high transaction costs.

### 2.4.4 Knowledge Providers

The fourth main actor in a PES scheme is the knowledge provider which tends to be a group of bodies, organisations or experts. All successful schemes appear to be predicated on a wide stakeholder base that includes, from the outset, well informed, impartial knowledge advisors.

These are typically specialists whose responsibilities and expertise can help facilitate scheme development. Knowledge providers tend to include: scientists; resource management specialists; statutory environmental bodies (eg English Heritage,

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<sup>7</sup> Vaissière, A-C. & Levrel, H. (2015) Biodiversity offset markets: What are they really? An empirical approach to wetland mitigation banking. *Ecological Economics*. 1 (10), pp.81-88

<sup>8</sup> Defra (2014) Defra Payments for Ecosystem Services (PES) Pilot Projects: Review of key findings of rounds 1 and 2, 2011-2013. Available from: [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/368126/pes-pilot-findings-141028.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/368126/pes-pilot-findings-141028.pdf)

Environment Agency, Forestry Commission, Natural England); local authorities; agricultural and rural valuers; and representative bodies including the National Farmers Union (NFU) and the Country Land & Business Association (CLA).

However, it should also be acknowledged that knowledge providers are as varied as the number of PES schemes and any potential scheme in the Milford Haven and Cleddau catchments should, especially at the outset, be open to working with as many potential knowledge providers as possible.

#### **2.4.5 Units of Trade**

All trading schemes are characterised by a consistent unit that is mostly the pollutant or nutrient causing the problem. As would be expected the units of trade were not consistent across the schemes and different units were used depending on what was being offset. Examples units included:

- Habitat hectares (habitat score x area),
- ecosystem & species credits,
- biodiversity credits,
- compensatory mitigation credits,
- pounds of nutrient pollution avoided/sedimentation avoided,
- tonnes/yr, kg/year of individual determinands
- environmental improvement score of the project
- money per unit area

Most of the aspects being offset, such as biodiversity, are inherently difficult to measure and define – and as such, metrics are used to calculate the offset credits. When undertaking the biodiversity offset pilots, Defra devised their own biodiversity offsetting matrix, based on both habitat distinctiveness and condition. Each band of habitat distinctiveness (high, medium, low) and condition weighting (good, moderate, poor) have numbers associated with them. When these two factors are used together, they provide the number of biodiversity units per hectare, which can be used to calculate baseline biodiversity values of the site<sup>9</sup>. It may be necessary to develop specific metrics for the Milford Haven and Cleddau catchments depending on the final scheme design.

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<sup>9</sup> Defra (2012) Biodiversity offsetting Pilots: Guidance for offset providers. Available from: [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/69530/pb13742-bio-guide-offset-providers.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69530/pb13742-bio-guide-offset-providers.pdf)

Additionally, other schemes may use other means of establishing what and how to offset. For example, in the South Nation Phosphorus Trading Program, the number of credits that need to be bought depends on both the amount phosphorus the polluter contributes, and the ratio of phosphorus required by the Provincial Ministry of the Environment (MOE) to be removed. The MOE requires a 4:1 offset ratio –i.e. 4kg of phosphorus has to be removed from non-point sources for every 1kg of phosphorus discharged by the polluter. Different schemes have different offset ratios. In this instance, the offset ratio was set relatively high – this reflected the novel scheme and the lack of knowledge on phosphorus transportation through the water course<sup>10</sup>.

## **2.5 DISCUSSION**

### **2.5.1 Key Findings and Consideration Points**

Determining the nutrient offset requirement is crucial for improving the quality of the area. There are multiple examples of schemes not reaching the required offset, due to uncertainty and time discounting of conservation value<sup>11</sup>. As biodiversity interacts spatially, its value is dependent on other biodiversity components elsewhere<sup>12</sup>. As such, there can be limits to what can be offset through a nutrient trading scheme and these schemes cannot always mitigate for all issues.

In addition, it has been argued that offsets are simply a mechanism for pricing in certain negative environmental externalities into development projects, often without attempting to reduce an impact at the outset<sup>13</sup>. Moreover, it is difficult to monitor sources, pathways and receptors accurately enough to establish robust baselines and equivalence, and to be able to assess success meaningfully. Initial surveys and ongoing monitoring programs can be prohibitively expensive and these are not always accounted for in the project costs<sup>14</sup>.

In areas affected by the project, all stakeholders should be included in decision-making processes. However, the process needs to be efficient enough to encourage participation, but also rigorous enough to ensure appropriate consideration of biodiversity impacts. A PES scheme in the English upland areas found that working

<sup>10</sup> O’Grady & Wilson (no date) Phosphorus trading in the South Nation River watershed, Ontario, Canada. Available from: <http://www.envtn.org/uploads/ontario.PDF>

<sup>11</sup> Moilanen, A., van Teeffelen, A. J. A., Ben-Haim, Y., Ferrier, S. (2008) How much compensation is enough? A framework for incorporating uncertainty and time discounting when calculating offset ratios for impacted habitat. *Restoration Ecology*. 17 (4) pp470-478.

<sup>12</sup> Dreschler, M. & Watzold, F. (2009) Applying tradable permits to biodiversity conservation: Effects of space-dependent ecological benefits and cost heterogeneity on habitat allocation. *Ecological Economics*. 68 (4), pp. 1083-1092.

<sup>13</sup> Bull, J. W., Suttle, K. B., Gordon, A., Singh, N. J. & Milner-Gulland, E.. J. (2013) Biodiversity offsets in theory and practice. *Oryx*. 47, pp. 369-380.

<sup>14</sup> Bekessey, S. A., Wintle, B. A., Lindenmayer, D. B., McCarthy, M. A., Colyvan, M., Burgman, M. A. & Possingham, H. P. (2010) The biodiversity bank cannot be a lending bank. *Conservation letters*. 3, pp. 151-158

across areas with fragmented land ownership was difficult, and that an integrated local delivery framework was needed, similar to one in the Cotswolds<sup>15</sup>. Additionally, one of the failures of a PES scheme in Luton was the exclusion of the local planning authority from the development of the policy framework. This would have allowed the scheme to be fully integrated and adopted into the Local Plan<sup>8</sup><sup>16</sup>.

It is necessary to ensure that the nutrient trading policy is flexible enough to allow for schemes to be established in ecologically significant areas while still ensuring there is demand for credits.

There is no clear understanding of what is an appropriate timescale that offsets should be managed for, and by whom. Defra reports suggest that offsets should be managed ‘in perpetuity’<sup>17</sup>, and further reports have clarified that it “means forever in this context, rather than a finite number of years”<sup>18</sup>. However, in other documentation, Defra imply that costs should in large be paid by the developer, and their calculations imply it should be managed for a minimum of 25 years.

The scheme needs to be economically viable. There needs to be a sufficient and varied market for the sale of credits – ideally the trade of credits needs to be amongst a number of sources. “Private companies need to be willing to develop new biodiversity based business models. When creating a bank, proponents often lack guarantees about the timing of bank approval and demand for credits, which can make investment returns and profitability uncertain”<sup>19</sup>.

There are often heavy dependence on government and international donors for both start-up costs and payments themselves. To set up a PES scheme requires a lot of information, and thus there are high transaction costs. Before the scheme can commence, there are high costs for negotiation, baseline assessments and system designs. When the scheme becomes operational, the costs are smaller and relatively cost effective, however it is crucial that budget is factored in for monitoring, enforcement/sanctioning and administration.

It is also vital that the right determinand is being traded – whether this is

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<sup>15</sup> Defra (2014) Defra Payments for Ecosystem Services (PES) Pilot Projects: Review of key findings of rounds 1 and 2, 2011-2013. Available from: [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/368126/pes-pilot-findings-141028.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/368126/pes-pilot-findings-141028.pdf)

<sup>16</sup> Ibid

<sup>17</sup> Defra (2012) Biodiversity offsetting pilots: Guidance for offset providers. Available from: [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/69530/pb13742-bio-guide-offset-providers.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69530/pb13742-bio-guide-offset-providers.pdf)

<sup>18</sup> Defra (2011) Biodiversity offsetting: Summary of responses to discussion material on biodiversity offsetting. Available from: [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/218683/110714offsetting-discuss-response.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/218683/110714offsetting-discuss-response.pdf)

<sup>19</sup> Bovarnick, A., Knight, C. & Stephenson, J. (2010) Habitat banking in Latin America and Caribbean: A Feasibility Assessment. United Nations Development Programme.

phosphorus, nitrogen or others. This reinforces the need for effective and robust monitoring pre-scheme commencement and also throughout the life of the scheme to ensure it is achieving its outcomes.

In addition, the majority of pollution comes from non-point sources, which are less easily monitored, and give opportunities for free-riding where some farms might actually increase their discharges because they know others are reducing the overall load. Depending on the relative size of each polluter this may make the situation worse. However, a robust regulatory baseline, along with an ongoing monitoring programme, should be sufficient to prevent any increases in discharge levels.

Consideration should also be given to the willingness of farmers to contribute to such schemes. Water quality trading programs have highlighted that farmers will be key actors in the trading scheme, due to their lower costs of abatement. Therefore they will need to be convinced that change could be a feasible alternative. Some have argued that farmers will be less willing to shift their livelihood, even if it is proved to be more profitable. Their argument echoes their desire to retain future integrity of the land; many farmers don't want to compromise the future viability and flexibility of their land for food production by degrading its agricultural potential through other means. Moreover, farmers at a PES scheme in Poole Harbour were unwilling to take on the risk of a long-term contract as they consider the long term impacts of their farm above and beyond the potential of any short term income.

In addition, offsetting schemes are argued to improve the welfare of the poor in the developing world through its positive impact on wage rate and land rent prices. However, start-up costs can be relatively high, increasing the difficulty of breaking into the market. Additionally, offsetting schemes, such as PES, can have a negative effect on food prices – where the poor consume inelastic locally produced food<sup>20</sup>.

There is an opinion that money derived from such offsetting schemes or global ecosystem banking initiatives function more like a support or bonus, rather than a real incentive for land use change.

### **2.5.2 Potential Benefits to Milford Haven and Cleddau Catchments of a PES Scheme**

PES schemes can provide many environmental and economic benefits, through improvements in biodiversity, land and water quality. These benefits often cascade, and provide positive feedback loops, where one leads to another synergistically. For example, measures to reduce nutrient loads through fencing off grazing animals can also reduce suspended sedimentation levels.

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<sup>20</sup> Zilberman, D., Lipper, L. & McCarthy, N. (2008) When could payments for environmental services benefit the poor? *Environment and Development Economics*. 13, pp255-278.

Economic incentives arise from the significant economies of scale experienced when adopting programmes on large scale. Additionally, farmers could potentially receive higher returns with greater security through diversification of income. However, due to possible start-up costs, and changes made throughout pilot stages, profits may only be seen after several years. The long term view has to be considered above any short-term issues.

There are also benefits to those buying credits, namely private companies. For example, buying credits and subsequently offsetting any impact can remove the companies' long term liability for any damage caused, assuming the agreement was followed. There is much debate to whether this effectively gives companies a 'license to trash', however it does increase awareness of conservation.

By placing a value upon nature, it introduces incentives for managing the environment, and for increasing conservation projects. This can strengthen conservation partnerships and promoting stakeholder engagement and public support for conservation. Pumlumon project by the Montgomeryshire Wildlife Trust had success in engaging stakeholders through presentations and site visits<sup>21</sup>. This has the capacity to catalyse further improvements within environmental legislation, which could further baseline ecological knowledge and scientific capacity.

### **2.5.3 Key Lessons from the Initiative Review**

Studies showed that regulation and monitoring of schemes are crucial. Enforcement would ensure maximum participation, but this is less feasible. It has also highlighted the importance of understanding the market. In Africa, several watershed payment schemes were planned to be set up, however there were many difficulties in getting these started. The main issue was the lack of buyers – there seemingly wasn't a suitable market for credits. Additionally, institutional and regulatory frameworks were seen to block any compensation for watershed services. A total of 4 out of 10 schemes seen in 2010 are no longer in operation, with many others abandoned in the development stages<sup>22</sup>.

There are trade-offs in policy design: tight restrictions on those who are eligible to trade may also limit the cost savings that may be realised from the trades. A regime that maximises market participation might fail fully to achieve the environmental goals of an offset or trading policy. Perverse incentives also need to be eliminated from the system.

Clear, measurable objectives need to be set, so that progress can be monitored. To

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<sup>21</sup> Montgomeryshire Wildlife Trust (2015) Pumlumon Project. [Online] Accessed 10<sup>th</sup> March 2015. Available from: <http://www.montwt.co.uk/what-we-do/living-landscapes/pumlumon-project>

<sup>22</sup> Bennett, G., Carroll, N. & Hamilton, K. (2013) Charting New Waters: State of Watershed Payments 2012. Available from: <http://www.ecosystemmarketplace.com/reports/sowp2012>

accompany this, adequate guidance should be given – written in language that is easy to read and apply, especially to non-scientists.

There is uncertainty in the data that can be collected, a lot of the data is hard to measure accurately, or based upon proxies. A project to develop a UK Peatland Carbon Code, found that there was a need to identify and quantify social benefits as well – as these services are less tangible<sup>23</sup>.

A PES scheme in Luton found that the complex urban system needed a more holistic approach than initially considered. Therefore there is a need for better and consistent methods to map, measure and value ecosystem services at a multiple scales. Regular monitoring schemes and programme evaluations would allow for trends in the data to be established and reflection upon progress. Prior knowledge of the system is required to be able to react appropriately and efficiently to change. Temporal changes, especially from seasonality, need to be taken into account – particularly in water quality trading programmes where levels of pollutants rise and fall.

## **2.6 RECOMMENDATIONS**

- A trading scheme should be compliance based, either through permit or planning permission as these are the most effective. This however is likely to take time and this should be taken into account when developing the scheme
- Stakeholder engagement should be seen as a priority and involve as broad a spectrum of stakeholders as possible
- Most schemes have a heavy dependence on government for both start-up costs and payments themselves. Early discussions need to be had with potential funders to understand the likely appetite for involvement and potential funding levels
- All organisations with permitting or planning permission responsibility need to identify how the requirements of the scheme could be incorporated into the relevant processes in order to make membership of the scheme a requirement of receiving a permit or permission
- The buyers and sellers need to be identified early on in the project to understand the likely size of any trading scheme. Currently buyers seem to be more problematic and need to be identified as a matter of urgency

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<sup>23</sup> Reed, M. S., Bonn, A., Evans, C., Joosten, H., Bain, B., Farmer, J., Emmer, I., Couwenberg, J., Moxey, A., Artz, R., Tanneberger, F., von Unger, M., Smyth, M., Birnie, R., Inman, I., Smith, S., Quick, T., Cowap, C., Prior, S. & Lindsay, R. A. (2013) Peatland Code Research Project Final Report, Defra, London. Available from: [http://randd.defra.gov.uk/Document.aspx?Document=11658\\_DefraPESPilotPeatCodeFinalReport2.pdf](http://randd.defra.gov.uk/Document.aspx?Document=11658_DefraPESPilotPeatCodeFinalReport2.pdf)

- A pilot study should be completed prior to commencement of the scheme to ensure that the assumptions about buyers and sellers are borne out and that the project aims are achievable
- Detailed, accurate and extensive scientific data is required throughout the project both to ensure it is targeting the right determinand, to the right level and to demonstrate to external parties that the scheme is achieving its overall aims
- Monitoring should include:
  - Identification of changes that may be required
  - Assessment of determinand loading reduction
  - Identification changes in water quality
  - Review of targets and changes of water quality against modelled forecasts
  - Background levels of loading
- The scheme needs to be flexible enough to respond to changes in the market, farming costs, level of development etc.
- There may be innovative ‘end of pipe solutions’ at water treatment sites that could help with aims of the scheme more cost effectively than a true PES scheme and should not be ignored
- Successful schemes tend to work at a landscape scale/sub-catchment scale or at the very least look to implement similar efforts on adjacent farms to deliver greater benefits. It may be necessary to incentivise adjacent farmers to organise and apply together
- There is evidence that schemes are more successful when they have a credit insurance pool, where a percentage of the money goes into this fund to protect the scheme, and this should be considered further
- The period over which farmers have to comply should be short enough to be attractive but must still deliver benefits over a longer period. For example, a farmer may sign up to a 10 year scheme but this should be designed to deliver savings equivalent to a 25 or 50 year scheme
- All schemes have suffered from vulnerability to national/international economic trends. This can be avoided by ensuring the program sets rates based on the actual costs of providing nutrient load reduction credits. This

may require rate setting to be done at least annually and potentially quarterly if income and expenses for the program show significant discrepancies.

## **2.7 WORK PACKAGE 1: CONCLUSIONS**

The review of global ecosystem banking initiatives has clearly shown that it is possible to instigate a functioning PES scheme in discreet areas such as a river catchment or catchments. The evidence suggests that there are a few key requirements (stakeholder support and engagement, robust data, adequate funding, sufficient buyers) that typically have to be in place in order to deliver the required benefits. Without all of these the schemes tend to falter or do not achieve their stated outcomes and are consequently not viewed as successful.

There appear to be many of the required elements in place within the Milford Haven and Cleddau catchments, however there are also areas where further analysis is required in order to avoid the issues commonplace with failed schemes.

For example, even at this early stage it is clear that important stakeholders, such as: Natural Resources Wales; Welsh Government; Dwr Cymru Welsh Water; Pembrokeshire County Council; and Pembrokeshire Coast National Park, all of whom have permitting or planning permission related responsibilities, need to identify how they could build the requirements of a PES scheme into their policies and processes.

Whilst there is clearly a lot of best practices that can be taken from these schemes the characteristics of the scheme area mean that no single scheme could be copied in its entirety. There are schemes, especially in the US, that have similar problems as those experienced in the Milford Haven catchment and have implemented very successful solutions however these have been applied at a much bigger scale across a much larger area and crucially with a significant number of buyers.

## **3 WORK PACKAGE 2**

### **3.1 INTRODUCTION**

Over the previous ten years there had been a number of projects developed and funded within Pembrokeshire which appeared to be delivering some form of PES. These were suggested as case studies for review to identify useful information which could be utilised in the development of an eco-bank toolkit.

ADAS undertook a review of five completed or current projects (listed below) and the reports of this work can be found in Appendix C. A summary of the work undertaken and main findings is included in the next section.

The summary outlines the main areas of interest including; costs, effectiveness of schemes, participants and stakeholders, value and innovation. Each of these sections also outlined the potential implications for a PES scheme in the Milford Haven and Cleddau catchments.

The Pembrokeshire case studies analysed for this work were:

- First Milk
- Bluestones
- Llys-Y-Fran
- Deepford Brook
- Castlemartin

### **3.2 KEY FINDINGS**

#### **3.2.1 Costs / Finances**

The review of the 5 case studies has not identified the total costs of any scheme and therefore it is not possible to offer any financial guide at this stage. The Deepford Brook project used a simple maximum contribution of £10k with the average contribution by the farmer exceeding this match fund several fold. While this scheme is simple administratively, it is not always adequate to incentivise capital works and explains in part the scheme's disappointing uptake. There were also delays caused by procurement rules. This model is not sufficiently flexible to reflect the varying costs of action across multiple sites.

In addition, the varying revenue foregone as a result of change of management approach or land use is not addressed. There was also a failure to account for the

costs of monitoring work. Costs and resources associated with the engagement of stakeholders were also significant and underestimated at inception.

The costs are known for the First Milk scheme, but have not been made available for this report due to concerns of commercial sensitivity. Costs for Bluestone have also been inferred. Where costs are not known, it is not possible to assess value for money. Lack of clarity on financial support can also be caused by allowing payment in kind. Any risk of failure of a project delivering value for money is problematic, especially in cooperative models or where volunteer/third sector organisations are involved.

### ***Implications for PCF Ecobanking***

The value of financial contribution, time, equipment, laboratory analysis, training expertise and technical expertise can be overcome. The invoicing profile, costs or value or equivalent for payment in kind should be quantified and measured. However an agreement needs to be put in place to establish the value, resource and quantity of each service. This would allow a comparison across the sectors and an open offer of value for each contribution made. An example would be an hourly rate for each organisation, analysis costs and equipment hire costs. For many volunteer/third sector organisations, access to IT/phones/cameras/PPE equipment may not be available and may have to be accounted for, and costed, within the proposal.

Appropriate monitoring and allowance for associated costs for data collation, interpretation and dissemination should be incorporated within PES. Realistic costs of participant and community engagement also need to be considered at inception. Revenue or costs forgone should also be part of the pre-deal analysis, and these should have dynamic ranges to reflect variation in input costs.

Use of public sector money creates limits and constraints in terms of what costs can be compensated. Where private sector buyers are engaged there may be more flexibility to allow for costs to be fully offset.

### **3.2.2 Effectiveness of Scheme**

It has been difficult to draw lessons about the effectiveness of each of the case studies as most of the schemes have started relatively recently and as such have not delivered sufficient data to allow evaluation from an environmental perspective. There are however, some initial observations that First Milk and Llys y Fran have been successful but it is too early to be conclusive.

The results for Deepford Brook, which is an older scheme are somewhat disappointing. A follow up inspection found that where capital monies were spent, actions undertaken appeared not to resolve the environmental problems. For example, there was insufficient attention given to the placement of buffer strips (should be at strategic locations and be of a certain width dependent on land topography to prevent run-off to the watercourse). Another problem with this project is that no baseline data was recorded and post-project data was insufficient to show any improvement. However, even if the results were to be obtained in full, the actual beneficial impact would be small as the area entered into scheme was very low relative to the catchment.

Concerns have also been raised about the effectiveness of using chemical water quality monitoring alone to establish effectiveness. In many of the cases considered, there are also issues around a lack of data sharing, notably with the regulator. The use of other methods of monitoring (such as remote sensing) have been suggested as alternative mechanisms. The management of environmental information is key in the understanding of the effectiveness of a PES scheme and the task of undertaking this role should be costed within the PES scheme.

It may also be debatable whether the water quality improvements considered and delivered in the case studies meet the additionality criterion of a PES scheme. Payments should only be made above and beyond the legislative baseline. Both Deepford Brook and Castlemartin rely to some degree on government financing, whilst all of the schemes are potentially vulnerable to changes in regulatory requirements. In theory if any of the catchments becomes a Nitrate Vulnerable Zone (NVZ), the regulations would require farms to reduce the risk of nitrates losses to the river as a statutory requirement and hence they should not be compensated under a prospective PES scheme.

Some of the schemes may also have effects on other ecosystem services beyond those relating to improving water quality. There is potential for some to deliver GHG emissions abatement, habitat provision, bioenergy production and flood risk management. Deepford Brook and Llys y Fran did not consider this potential, but the other schemes have to some degree.

### ***Implications for PCF Ecobanking***

Pollution mitigation methods proposed under any future PES scheme should be both appropriate for local farming systems and of maximum beneficial use for the environment. This would include a target for land area and the implementation of the appropriate measures with optimal placement, both spatially and temporally.

The use of a broad suite of monitoring tools is needed to verify schemes' effectiveness and environmental monitoring techniques are advancing very quickly. The use of an independent auditing tool e.g. First Milk's use of the Farmscoper modelling tool, within the compliance pack can support the accuracy of monitoring.

The Catchment Sensitive Farming study revealed a need for clear demarcation and guidance between the rules and requirements under environmental regulations, agri-environment schemes (AES) and a PES scheme as any confusion or ambiguity risks seller and buyer participation. Further, environmental legislation and best practice can change within the life of a PES scheme and can vary across regions e.g. England and Wales. Therefore any future PES scheme must be flexible and adaptable to allow for such changes and differences.

PES interventions or offsets will rarely have an effect on just one ecosystem service in isolation and schemes should consider the potential to bundle services as may open up a wider source of buyers and/or sellers. This has particular advantages for sellers but requires that appropriate monitoring is proposed from inception.

### **3.2.3 Participants and Stakeholders**

The Welsh Government (directly or through NRW) was actively involved in all schemes as a regulator. In some cases it was also the initiator and project driver, and in Deepford Brook and Castlemartin it was also the buyer (which raises questions of additionality). Indeed a common factor in all five cases is the lack of any commercial buyer for the offset or ecosystem services delivered: Bluestone and First Milk are paying for the work themselves to satisfy a permit requirement, whilst the funds for Llys y Fran derive from the private sector (utility company). The sustainability of any of these models is therefore questionable.

There are many opportunities in the literature for private funding. These include power companies as a potential buyer of nitrate credits and water companies in catchments within a source protection zone area. Other models include using tourists for investment in heritage, landscapes. Landowners and businesses in the area may be interested in funding work from a CSR perspective while construction and related sectors may be required to offset the environment impact of development.

While some PES schemes focus on a limited set of sellers i.e. farmers in the relevant catchments, Castlemartin cast the net wider involving the Ministry of Defence, RWE npower, Baker Brothers, Valero and The National Trust but the objectives of this project were also broader.

Only the First Milk scheme made significant use of third parties to facilitate the recruitment of farmers, delivery of nutrient planning on farm and helping to

undertake independent audits of the data on all of the participating farms. In the other case studies, the monitoring, design, and advisory work was managed by the scheme instigators or the regulator itself. Deepford Brook did engage with senior figures in the Farming Union and Agri-Food partnership. There was a strong sense that the use of independent third parties in the engagement and monitoring aspects of these schemes improved the buy-in from farmers and may also improve effectiveness. Indeed, for First Milk there was some regret that an independent third party was not engaged to act as a land agent and deal with some of the planning and land contract issues which arose.

It is noticeable that none of the schemes employed a separate “broker” to put the deal together, which may be perhaps why the commercial buyers were absent and the sellers in some examples were only a small subset of possible participants.

Community engagement could have been improved across all of the case studies. In general this challenge was underestimated and under-resourced in terms of time, personnel and material. Again, this might have improved with the use of an independent third party to manage this aspect of the deal.

### ***Implications for PCF Ecobanking***

The roles and responsibilities for each participant within the PES scheme must be clearly defined and referenced throughout the PES scheme. There is a risk of “Project drift” and deals should be well structured with more clearly defined buyer, seller, regulator, and third party roles and contractual responsibility, along with independent monitoring, land agency, and engagement roles. This intermediary step within the PES scheme needs to be accommodated and costed for as part of the project initiation, duration and closure and in some instances post closure of a PES project.

Engagement of potential buyers, sellers, and the wider community needs to happen earlier and needs to be managed by an appropriate agency. A broader set of buyers and sellers needs to be considered to reduce the reliance on public and charitable funding.

#### **3.2.4 Value**

In all the schemes considered, it is possible to identify the value to all the participants of reducing the nitrate load to the river. In particular to the regulator charged with the environmental objectives who can point to legal targets (WFD) to meet, but also to economic values that are associated with improvements in water quality to the general public. The values to participants vary in the degree to which they are transparent and can be elucidated.

In one case (Deepford Brook) participants are partially compensated up to a point for work they have done to reduce nutrient loading and so can be assessed on a cost basis. In two cases (Bluestone and First Milk) the value is linked to receiving a permit or continuing business operations, which is a more complex consideration, but is still amenable to valuation. In the case of Llys y Fran the value is in terms of the advice received and what it could return the farmer in longer term efficiency savings (reduced fertiliser costs). The main focus of the Castlemartin project is for mapping and so it is perhaps unfair to attempt to assign financial values to it.

A criticism of the schemes is that the financial value was not made explicit to all participants. Despite this, it is encouraging to note that those having to deliver reductions in nutrient loading seemed to have done so, even though in many cases they were not fully compensated for their costs. This suggests some sense of environmental responsibility and/or that PES/offsetting can be consistent with wider business objectives. Even though the First Milk scheme required no financial transaction to take place, as milk suppliers to a farmer cooperative company, both parties have an implicit incentive to make it work; this may be difficult to replicate.

Other schemes could have been improved if there was a more sound financial argument presented at inception. This was particularly true of Deepford Brook where the limit on the funding available and the lack of a cost/benefit justification to farmers reduced the number who were willing to participate. In the case of Bluestone, the scheme owner would require a monetary incentive in place as part of establishing a formal offsetting scheme before additional investment for water treatment could occur. The Llys y Fran case is not yet complete but the value of providing feedback to the landowners should not be underestimated as a measure to encourage future participation. .

A broader question which has not been evaluated in these schemes is to what extent the value created is equitable amongst all the stakeholders. In two of the schemes (Deepford Brook and Castlemartin) government money directly funded some of the work which may have led to benefits in water quality experienced by utilities companies. A similar point can be raised about the private money spent in the Llys y Fran scheme. This is not an issue for the two permit-related schemes where presumably overall nutrient loading would not be affected. However, there is a case to argue that the housing development in First Milk is a 'free rider' beneficiary from the work done to offset its discharges. How equitable the value created in this last case is between the processing part and the farmers is also not clear.

### ***Implications for PCF Ecobanking***

It is possible and advisable to appeal to participants' business priorities as well as their environmental values when marketing a PES/offsetting scheme. However, it is

also important to demonstrate and market the financial justification to those who must incur costs or change practices. The more straightforward and transparent the scheme, the easier this will be. In this regard, making sure that participants can be fully compensated for their efforts, beyond the regulatory baseline, is important. Certainty should also be created for those incurring costs now, in lieu of future compensation.

Scheme design should also consider issues of value equity. Potential ‘free-riders’ should be identified and encouraged to commit funding. Cooperative schemes should consider mechanisms to incentivise or financially reward farmers where there may be a risk of dropout.

### **3.2.5 Innovation**

The Catchment Sensitive Farming scheme, or Deepford Brook, was comparable to an agri-environment scheme due to the use of state funding. Castlemartin is an example of collaborative environmental enhancement funded by the Welsh Government’s Nature Fund. As such, neither can be considered highly innovative in the context of the evolution of PES schemes. The other case studies did show some element of innovation or novel approach in relation to PES or offset schemes:

Bluestone is an example of a “banking” scheme where work could be done in advance to generate credits which can then be sold at a later stage to those seeking to offset their own pollution. Such banking schemes are not new in the context of offsetting, but this scheme is novel in that there is no guarantee that the credits will be recognised and that the owner will be able to recoup their “investment”.

The Llys Y Fran case study does appear to be a unique partnership between regulator, industry and third sector. Whilst the project is not yet complete, a more formal approach may have avoided some misunderstandings of roles and responsibilities between partners, the confusion associated with the mix of financial and payment in kind contributions and reduced the risk of “project drift”.

First Milk also differed from the standard PES model in that there was no actual financial consideration passing between the buyer and seller, but was instead a cooperative effort where farmers and their buyer (First Milk) both recognised the greater economic rationale of keeping the processing centre in business and were willing to invest their own money to achieve this. However, this arrangement is not necessarily replicable in catchments where there is a weaker (or less monopolistic) relationship between buyer and seller, as well as raising questions of equity.

### ***Implications for PCF Ecobanking***

Organisational and contractual certainty are preferable, especially if the scheme is intended to generate credits for future offsetting where those engaging in work now should be assured that their efforts will be eligible.

Cooperative models may appear to be virtuous and may have stronger “buy-in” but may present problems in voluntary schemes if participants lose interest or are dissuaded by better, commercial offers. They may be suitable for sub-schemes within smaller parts of the catchment where relationships between buyer and seller are stronger.

### **3.3 WORK PACKAGE 2: CONCLUSIONS**

Appropriate monitoring and allowance for associated costs for data collation, interpretation and dissemination should be incorporated within PES.

Realistic costs of participant and community engagement also need to be considered at inception.

Revenue or costs forgone should also be part of the pre-deal analysis, and these should have dynamic ranges to reflect variation in input costs.

It is vital that measures funded by scheme funds need to be agreed and planned with the help of experts to avoid issues such as poor placement of buffer strips.

The recording of baseline data is vital as is ongoing or post-project data in order to demonstrate improvement.

There are concerns about the effectiveness of using water quality monitoring alone to establish effectiveness. The use of other methods of monitoring (such as remote sensing), have been suggested as alternative mechanisms.

PES interventions or offsets will rarely have an effect on just one ecosystem service in isolation and schemes should consider the potential to bundle services

A common factor in all five projects studied was the lack of any commercial buyer for the offset or ecosystem services delivered, therefore the sustainability of any of these models is questionable.

The use of independent third parties in the engagement and monitoring aspects of these schemes improved the buy-in from farmers and may also improve effectiveness.

It is noticeable that none of the schemes employed a separate “broker” to put the deal together, which may explain why the commercial buyers were absent and the sellers in some examples were only a small subset of possible participants.

Community engagement could have been improved across all of the case studies. In general this challenge was underestimated and under-resourced in terms of time, personnel and material. Again, this might have improved with the use of an independent third party to manage this aspect of the deal.

Engagement of potential buyers, sellers, and the wider community needs to happen earlier and needs to be managed by an appropriate agency. A broader set of buyers and sellers needs to be considered to reduce the reliance on public and charitable funding.

The value of providing feedback to landowners should not be underestimated as a measure to encourage future participation.

It is vital to demonstrate and market the financial justification to those who must incur costs or change practices.

Scheme design should also consider issues of value equity. Potential ‘free-riders’ should be identified and encouraged to commit funding.

## **4 WORK PACKAGE 3**

### **4.1 INTRODUCTION**

This work package has two main parts, the first part sought to define and understand the problems within the Milford Haven and Cleddau Catchment in order to understand what the required load reduction targets within the waterbodies would be. The second part was designed to identify where the land management opportunities are within the catchment areas in order to achieve the required nutrient loading reduction.

In order to ensure the end scheme is based on sound data we collated and reviewed available information on the catchments including; nutrient loads, SAC condition, known pollution sources and data on nutrient load analysis. Subsequently this information has been analysed to better understand the local nutrient reduction requirements and how these might be delivered by initiatives across the catchment.

Due to the absence of a known threshold to which the initiative could work towards, additional work has been undertaken to identify the most appropriate thresholds based on the data, to use.

In addition, the second element of work for this work package sought to identify potential buyers and sellers within the catchment. This has been established by utilising “Farmscoper” to undertake land management assessments, from which to identify opportunities for land to enter the nutrient offsetting programme.

### **4.2 PEMBROKESHIRE MARINE SPECIAL AREA OF CONSERVATION (SAC)**

There is significant concern that many of the Pembrokeshire Marine Special Area of Conservation (PMSAC) features are in unfavourable conservation status and nutrient loading into the Milford Haven has been identified as a key priority action. Existing actions within the PMSAC management scheme adopted in 2008, are not in themselves adequate to address this loading and the ecological impacts this has on the ecosystems.

Between 2002 and 2006 a review of all Environment Agency Wales (EAW) regulated discharges, potentially impacting on the Pembrokeshire Marine Special Area of Conservation (SAC) was carried out under the EU Habitats Regulations. The Regulations require that Agency-licensed activities must not adversely affect the integrity of any Natura 2000 site.

Since the Review of Consents in 2006, increasing concern has been expressed about the occurrence of opportunistic macroalgae on inter-tidal mudflats and sandflats

within sheltered bays and inlets in the waterway. Although there appeared to be little evidence linking increasing macroalgae growth to nutrient inputs to the waterway, the concerns around this increase prompted further investigations and more rigorous assessment of new discharges.

Currently, NRW consider that due to the level of nutrient loading within the waterway it should be considered as “full” with no headroom in the Milford Haven catchment for additional loading. This is seen as presenting a significant barrier to development and therefore a robust solution is required.

#### **4.2.1 SAC Information**

The Pembrokeshire Marine SAC covers an area of 138,069 ha. The site extends from near Abereddy to Manorbier and includes the coast of the islands of Ramsey, Skomer, Grassholm, Skokholm, the Bishops and Clerks, and The Smalls (21 miles offshore). It also encompasses almost the entire Milford Haven Waterway. The landward boundary of the SAC mostly follows the extreme high water mark.

Pembrokeshire Marine SAC is a multiple interest site that has been selected for the presence of eight marine habitat types and associated wildlife (Habitats Directive Annex I habitat types) and seven Annex II species (Habitats Directive Annex II species).

It is considered that the potential impacts arising from nutrient enrichment could affect all but two of the designated habitat features. The features likely to be impacted include:

- Estuaries
- Large shallow inlets and bays
- Coastal lagoons
- Mudflats and sandflats not covered by seawater at low tide
- Atlantic salt meadows (*Glauco-puccinellietalia maritimae*)

#### **4.2.2 Impact of Nutrient Loading on SAC Features**

The designated features described above can be negatively impacted by diffuse pollution causing a worsening in the quality of the water. These effects are largely due to the potential impacts upon the physical and chemical factors impacting upon the feature habitats and therefore the species they support.

A 2009 CCW report<sup>24</sup> stated that the coastal waters are considered to have raised levels of nutrients, predominantly as a consequence of diffuse agricultural sources. It does note that nutrient and contaminant levels are also variable and often contaminant levels are below detectable limits because of the highly dynamic water movement within Milford Haven and the Daugleddau estuary. However, the report clearly concludes that the issue is likely to be more pronounced in the sheltered low energy areas within the marine system which are likely to experience much greater impacts as a result of eutrophication.

Nutrient enrichment that results in major ecological changes has the potential to disrupt ecosystems including the delicate balance between invertebrate populations, biomass, waterfowl populations, sediment flats and salt marsh structure, function and community structure. The Atlantic salt meadows feature is at particular risk as increased nutrients may cause algal mats or blooms of green algae to form, smothering their normal functioning.

A 2014 NRW Report<sup>25</sup> suggests that nutrient loading can have direct or indirect impacts on the wider site designated features including:

- Where algal mats are sufficiently dense, the salt marsh vegetation and other communities including cockle, mussel, polychaete worm and amphipod communities beneath could potentially die. This would result in increased microbial decomposition of organic matter and increased oxygen demand.
- Increased nutrients can cause increased above-ground growth of vegetation, while also causing reduced root growth; this can then cause banks and sediments to become less stable.
- Reduction in salt marsh species diversity or change in species composition in favour of more nitrogen loving species.
- Loss of habitat for overwintering wildfowl
- Reduction in salt marsh species will impact upon the invertebrate communities present.
- Loss of salt marsh habitat resulting in exposed substrates, destabilized sediments causing sedimentation, increased turbidity and further habitat erosion.

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<sup>24</sup> Countryside Council for Wales (2009). Milford Haven Waterway, Pembrokeshire, Water Quality Issues – Ecological Indicators and photographic Evidence of Excess Nutrients.

<sup>25</sup> NRW (2014), Environmental Pressures on Milford Haven Waterway

- Loss or change of geomorphological features resulting from reduced geomorphic stability can change species communities, species composition and increased sediments.
- Algal blooms can also reduce water clarity or cause smothering effects, which to varying degrees will affect the distribution and species composition of the mosaic of habitats in the other features of the site.

Cefas was commissioned by Environment Agency Wales in 2011 to model the impact of nutrient inputs to the Milford Haven waterway and the likely effectiveness of nutrient removal scenarios in controlling macroalgal and phytoplankton growth (Aldridge *et al*, 2011)<sup>26</sup>. The main conclusions from the model outputs were as follows:

- For nitrogen, direct loadings from rivers and sewage treatment works (STWs) are the dominant sources.
- Changes of  $\pm 25\%$  to direct nutrient loadings of nitrogen (N) and phosphorus (P) were predicted to give rise to relative changes in average summer chlorophyll concentrations in the range  $\pm 6\%$  and to relative changes in average summer macroalgal biomass in the range  $\pm 9\%$ .
- For phytoplankton, natural light was predicted to be the limiting factor during spring, autumn and winter.
- An analysis of summer nutrient concentrations was not able to establish clear evidence for nitrogen limitation, nor did it suggest regular phosphorus limitation.

#### **4.2.3 Summary**

There remains some uncertainty over whether the nutrient loading within the Milford Haven and Cleddau waterbodies is of a significant enough level to prevent the SAC achieving favourable conservation status. The water quality data shows that there are elevated levels of nutrients, however there is little robust evidence to show that this is impacting on the SAC via hyper-eutrophication and the growth of macro-algae.

Further surveying has taken place in 2014/2015 and the results of this are due to be published soon. Anecdotal evidence suggests that this may contain sufficient robust

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<sup>26</sup> Aldridge, J. and Painting, S. (2012) Milford Haven: Modelling Assessment. CEFAS Report Commissioned by Environment Agency Wales.

data to confirm what the current situation is and show the impacts of nutrification on the SAC features.

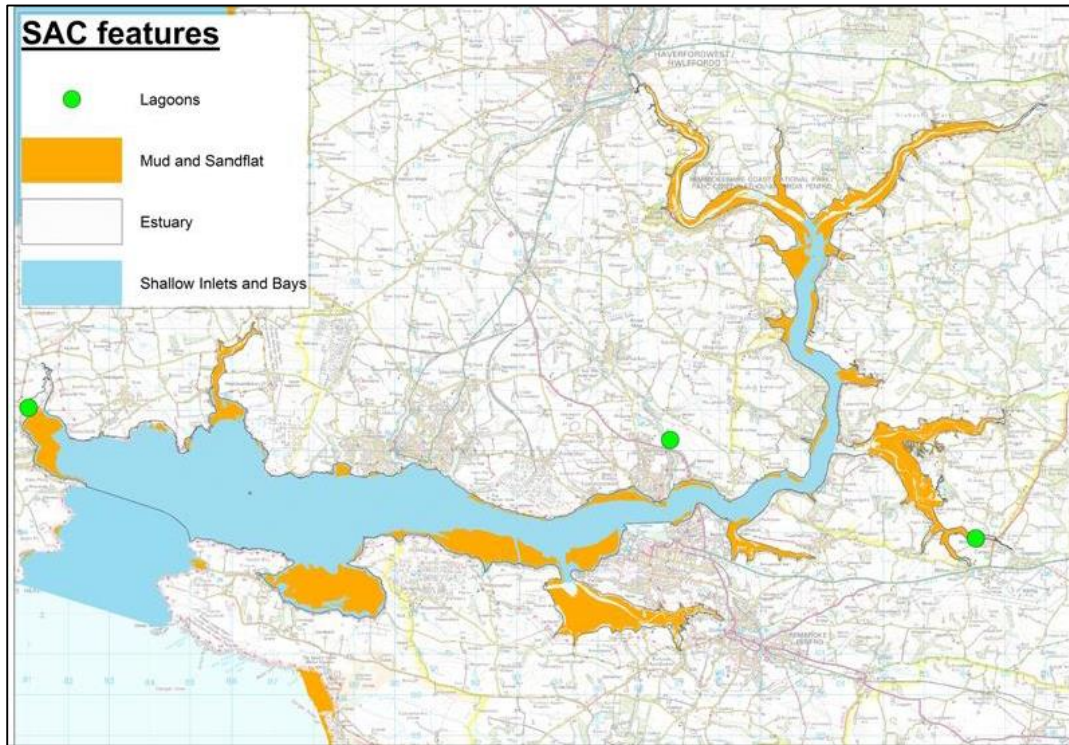


Figure 3: Location of Annex 1 Habitats

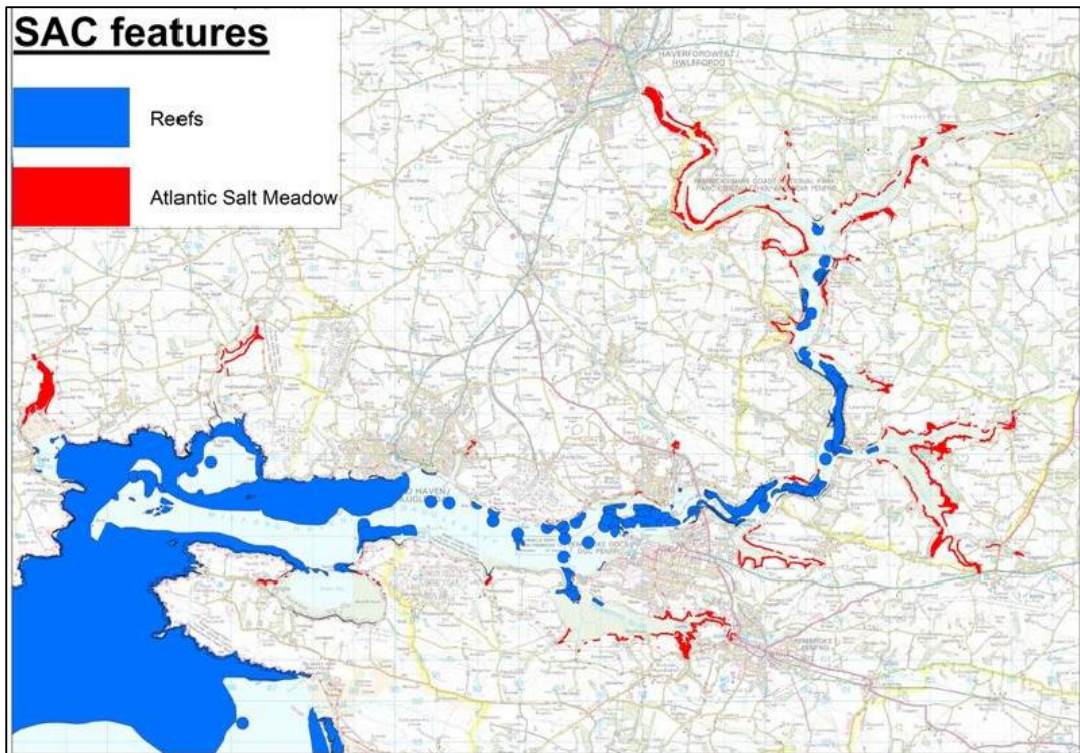


Figure 2: Location of Annex 1 Habitats

## 4.3 NUTRIENT LOADING IN THE MILFORD HAVEN AND CLEDDAU CATCHMENTS

### 4.3.1 Introduction

The overarching purpose of the project is to reduce the nutrient loading within Milford Haven, with the assumption being that this is best achieved through reducing nitrogen inputs onto catchment land. In order to establish the scale of the issue, define the scale of the remedial measures required and to test the success of the approach it is necessary to define the scale of the nitrogen problem. To date a detailed review of available water quality data (both provided by NRW / Welsh Government and from other sources such as NRW reports) has been completed. This has supported a clearer understanding of the current position, likely future increases and the levels to which nutrient loading should be reduced in order to deliver habitat improvements.

### 4.3.2 Data Analysis

The current River Basin Management Plan identifies the estuarine transitional waters of Milford Haven as being of WFD "Moderate status due to the Dissolved Inorganic Nitrogen (DIN) level, although all other elements are classified as at least of "Good status" (Natural Resources Wales, 2014<sup>27</sup>). In addition:

- WFD investigations have concluded that agricultural and rural land use practices are likely to be the primary diffuse pollutant sources to Milford Haven, particularly DIN
- Environmental Permitting Regulated installations only have limited DIN input and insignificant Dissolved Inorganic Phosphorus (DIP) inputs
- STWs discharging into the estuary account for 5% of total DIN and 34% of total DIP

In order to implement a trading scheme for nutrients within the Milford Haven catchment, the nutrient contribution for DIN needs to be understood at least at the catchment scale and a threshold target established. This can then be used to guide reductions in nutrient loadings to the estuary and contribute towards improving the current condition of the estuary and the ecology that it supports.

The key steps required to identify nutrient thresholds and reduction targets are outlined below:

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<sup>27</sup> NRW (2014) Environmental Pressures on the Milford Haven Waterway: Report A&R/SW/14/1

1. Produce a detailed source apportionment of both DIN<sup>28</sup> and Dissolved Inorganic Phosphorous (DIP) within the catchment from point and diffuse sources.
2. Analysis of all long term river, estuary and marine water quality data, river flow data and STW and industrial effluent discharge data. Specify the annual reduction target for DIN and DIP using this analysis.
3. Calculate the DIN and DIP loading from all catchment sources.
4. Identify impacts of future population growth in DIN and DIP loadings for each STW.
5. Determine reductions in nitrogen leaching from agricultural land required to meet annual reduction target and identify range of measures to accomplish this target.
6. Identify mitigation measures to ensure neutral impact of future development on nitrate and phosphorus loading.
7. Undertake a Cost-Benefit Analysis of mitigation measures suggested for agriculture and future development in the catchment.

#### **4.3.3 Understanding the Nutrient Loading Problem**

Although it is accepted by stakeholders that the Milford Haven catchment is suffering from hyper-eutrophication it has been difficult to identify robust publicly available data to confirm this and the true situation is still unclear.

The latest publicly available report on the environmental pressures of Milford Haven (NRW 2014) states that there is an opportunistic macroalgae issue within the Milford Haven Inner water body, with large algal mats covering areas of available intertidal habitat (AIH).

This is based on surveys carried out for WFD monitoring purposes in Milford Haven Inner water body during 2009 and 2011 (using a 'true colour' technique) and 2012 (using a more accurate high intensity Compact Airborne Spectral Imager (CASI) technique but over a smaller area). Aerial imagery was gathered and ground truthing quadrat surveys carried out to obtain information on biomass, extent, percentage cover and entrainment of opportunistic macroalgae.

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<sup>28</sup> For the purposes of this study DIN is taken as equivalent to Dissolved Available Inorganic Nitrogen (DAIN). Where DAIN = Total Oxidised Nitrogen (TON = nitrate + nitrite) + NH<sub>4</sub> (ammonium).

The survey results varied due to the techniques used but essentially they suggested that opportunistic macroalgae fell within the WFD Moderate class with an Ecological Quality Ratio score of 0.5 - 0.53, depending on the technique used to gather the information<sup>29</sup>. In percentage terms the two survey techniques suggested a cover of AIH of between 12.7% and 40.8%. This latter figure was extrapolated from a smaller survey area but is considered to be more accurate than the lower figures obtained from the 'true colour' technique.

The situation for the outer Haven is less of a concern with surveys undertaken in 2011 and 2013 demonstrating that there is no ecological effect in this area caused by the elevated DIN. Macroalgae extent in the outer Haven extended to 8.7% (well below the 15% threshold) of the AIH and the biomass was well below the 500gm<sup>2</sup> threshold.

In addition a seasonal biomass survey has been established at two sample stations in Pembroke River and one at Cosheston Pill. The survey gathers biomass and percentage cover estimations being gathered for alternating months for a minimum of three years. This survey commenced in September 2012. UKTAG Guidance (2007) states that 'consistent algae cover over the winter months in excess of 50g/m<sup>2</sup> would trigger concern'. Available data from 2013 found average biomass values did not exceed this threshold.

#### **4.3.4 Establishing a Reduction Target**

Typically when a Natura 2000 site is concerned the reduction target would allow for the site (in this case the Pembroke Marine SAC) to achieve "favourable condition". However, the SAC Conservation Objectives state<sup>30</sup>: "flow regime, water quality, and physical habitat should be maintained in, or restored as far as possible to, a near natural state". At the time of writing there is no information publicly available that details what a "natural state" should look like in terms of nutrient loading. Given the vital importance of defining clear measurable objectives to be achieved for a PES scheme, alternative measures have therefore been identified.

There are no WFD standards for nitrogen in rivers, however there are standards for Transitional and Coastal (TRAC) Waters (essentially estuaries) and Coastal waters. Coastal waters are defined as being located within 1-3 nautical miles off the coast or having a salinity of 30-34.5ppt. TRAC waters have a salinity of less than 30ppt. Only

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<sup>29</sup> When carrying out a WFD biological assessment, each biological quality element defined in the WFD is required to give a statistically robust definition of the 'health' of that element in the sampled water body. The 'health' of the element is assessed by comparing the measured conditions (observed value) against that described for reference conditions (minimally disturbed). This is reported as an (EQR).

<sup>30</sup> Countryside Council for Wales (2009) Pembrokeshire Marine European Marine Site: Advice Provided By The Countryside Council For Wales In Fulfilment Of Regulation 33 Of The Conservation (Natural Habitats, &C.) Regulations 1994

one site in Milford Haven is classified as a Coastal water, namely Mid Channel Angle Peninsular, the rest are TRACs.

The most appropriate standard measure identified was the UK Technical Advisory Group (UK TAG) on the Water Framework Directive. This body has set thresholds, outlined in the UK Environmental Standards and Conditions 2008, for nitrogen loading within Transitional and Coastal (TRAC) waters. The threshold value for the boundary between WFD "High" and "Good" status of both coastal and transitional was chosen as the concentration figure to which any nutrient trading scheme would ultimately aim to achieve.

Whilst the WFD requires that waterbodies meet at least Good status the choice to use the boundary between High and Good was chosen (rather than Good to Moderate) because it was felt that the scheme should be aiming to deliver the greatest environmental benefit and this could only be achieved by choosing the more stringent threshold. In addition, the relative difference between the two thresholds, when considering nutrient loading and required reductions is not sufficiently large to make a material difference in the reduction targets. Consequently, the decision was made to keep the more challenging target at the outset.



**Figure 5: WFD Coastal Waters**



**Figure 6: WFD TRAC Waters**

For TRACs, the DIN standard threshold for High/Good quality is  $20\mu\text{mol/l}$ , whilst for the Good to Moderate threshold this is  $30\mu\text{mol/l}$  (both for winter mean values from December to February). The coastal water DIN standards for High/Good quality are  $12\mu\text{mol/l}$ , whilst for the Good to Moderate threshold this is  $18\mu\text{mol/l}$  (again, for winter mean values).

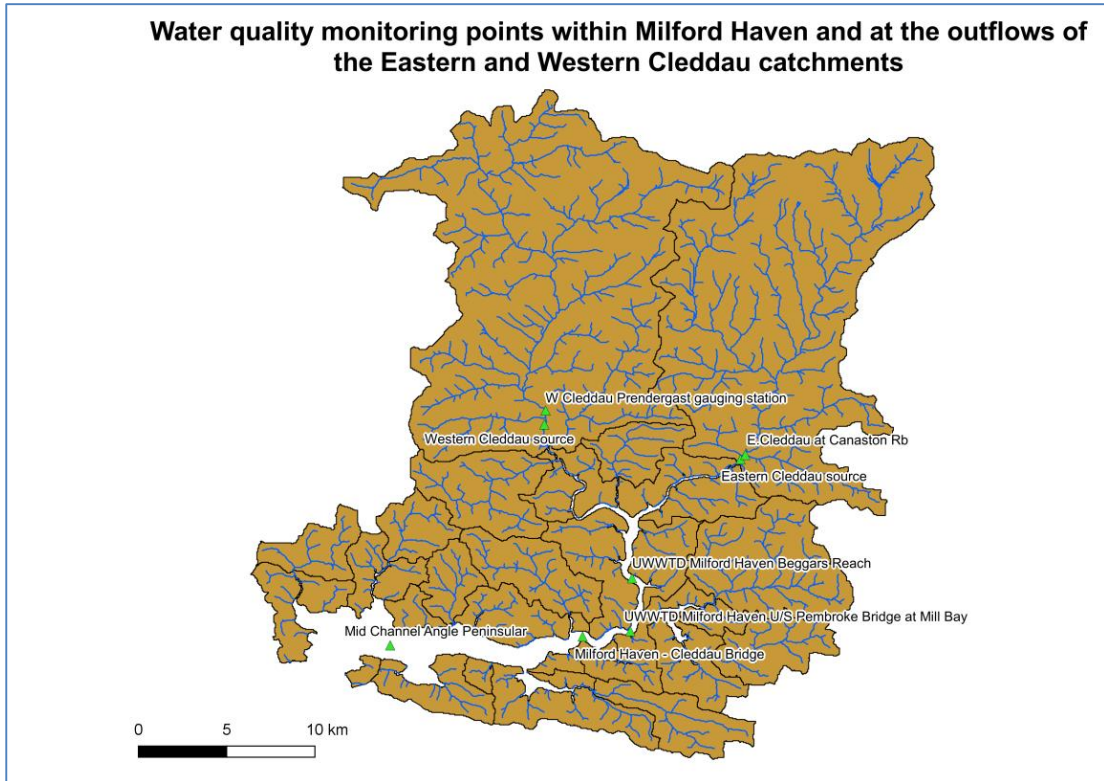
#### **4.3.5 Findings**

As the aim of the project is to manage diffuse catchment nitrogen inputs into Milford Haven, an understanding of current nitrogen loads and a required target for reduction is required. This has been calculated using two key steps: identifying current nitrogen loadings to the estuary from the catchment using water quality data; and determining a reduction target using these data.

Existing NRW water quality monitoring data recorded between 2010 - 2015 has been used to calculate; Dissolved Inorganic Nitrogen (DIN) in the Eastern Cleddau, Western Cleddau and Milford Haven. In late June 2015, NRW provided further water quality monitoring data as far back as 1990 for some sites. This data has been analysed and does not indicate any significant change in condition between 1990 and 2015. It is particularly difficult to analyse this data as it is incomplete for some monitoring points and switches between monitored determinands at others.

Consequently, there appears to be no reason why the 2010 – 2015 data cannot be the main source of data used for this work.

The location of the water monitoring points is shown in Figure 5.



**Figure 7: Water Quality Monitoring Points**

**Data Analysis**

The data (see Table 1) show that average DIN levels in the Eastern and Western Cleddau where these rivers flow into Milford Haven is 153.6µmol/l and 252.0µmol/l respectively. At the top of Milford Haven (UWWTD Milford Haven Beggars Reach), this declines to 48.2µmol/l and continues to decline to 14.4µmol/l at the mouth of Milford Haven (Mid channel Angle Peninsular). Based on the WFD standard, most of the winter mean statistics for the estuary samples fall within the WFD Moderate and Poor standards.

For reference the DIN standard threshold value for WFD High – Good in transitional waters is 20µmol/l, (the Good to Moderate threshold is 30µmol/l) whilst the same threshold value for coastal waters is 12µmol/l (Good to Moderate threshold is 18µmol/l)

**Table 1      DIN measured in the Eastern and Western Cleddaus and Milford Haven (all data in µmol/l)**

<b>Statistics</b>	<b>Western Cleddau Source</b>	<b>E.Cleddau At Canaston Br.</b>	<b>UWWTD Milford Haven Beggars Reach (Daugleddau)</b>	<b>UWWTD Milford Haven U/S Pembroke Bridge At Mill Bay</b>	<b>Milford Haven - Cleddau Bridge</b>	<b>Mid Channel Angle Peninsular</b>
Average	252.0	153.6	48.2	37.1	32.6	14.4
2010-2011 winter DIN mean	310.1	206.4	102.2	67.9	51.2	20.5
2011-2012 Dec-Feb DIN mean	323.4	188.7	70.0	52.5	58.1	18.9
2012-2013 Dec-Feb DIN mean	208.8	157.9	116.2	86.0	72.8	22.1
2013-2014 Dec-Feb DIN mean	301.6	181.9	67.5	58.3	60.9	37.5
2014-2015 Dec-Feb DIN mean	-	217.3	81.9	44.1	52.9	29.0

### ***Determining a Reduction Target***

Using water quality data collected at the end of the Western and Eastern Cleddau rivers, DIN load was calculated using flow data measured at the Eastern Cleddau at Canaston Bridge flow gauge. No flow data were available for the Western Cleddau (although a flow gauge is located at Prendergast Mill). In the absence of measured flow data on the Western Cleddau, the Eastern Cleddau flow data were scaled by the difference in catchment size (the Western Cleddau measuring 197.6km<sup>2</sup> at the flow gauge whilst the Eastern Cleddau is 183.1km<sup>2</sup> at the flow gauge).

This is considered an appropriate approximation in the absence of flow data since the catchments have similar hydrological properties and rainfall, although checks will be undertaken if flow data becomes available. DIN loads in the Western Cleddau were calculated using this scaled flow. Current DIN loading calculations for the Eastern and Western Cleddau catchments are presented in Table 2 and Table 3 respectively.

Nitrogen reduction targets were assessed by comparing the current loads to what is assessed, with respect to all available evidence, as the background nitrogen loading in the upper Eastern Cleddau (as measured at the Eastern Cleddau above Glandy water quality monitoring site). The catchment above this site is essentially moorland and woodland with some grassland, only a small proportion of which appears to be used for grazing. Average DIN values at this site are around 0.7mg/l. From this value, loads were calculated for both the Eastern and Western Cleddau catchments and these were taken to represent background values in the absence of agricultural practices. By subtraction of the current loads from the background loads, a target reduction load was established for both catchments. These are displayed in Table 2 and Table 3.

**Table 2** DIN loads and reduction targets for the Eastern Cleddau

	Average current load (2010-2012)	Average load with "background" DIN in E. Cleddau	Reduction required to meet background	Reduction per hectare (t/ha/yr)	Total percentage reduction
<b>Total (kg/yr)</b>	454708.9	143682.5	311026.3	16.987	68.4
<b>Total (t/yr)</b>	454.7	143.7	311.0	0.017	68.4

**Table 3** DIN loads and reduction targets for the Western Cleddau

	Average current load (2010-2012)	Average load with "background" DIN in W. Cleddau	Reduction required to meet background	Reduction per hectare (t/ha/yr)	Total percentage reduction
<b>Total (kg/yr)</b>	923396.3	155061.0	768335.3	38.883	83.2
<b>Total (t/yr)</b>	923.4	155.1	768.3	0.039	83.2

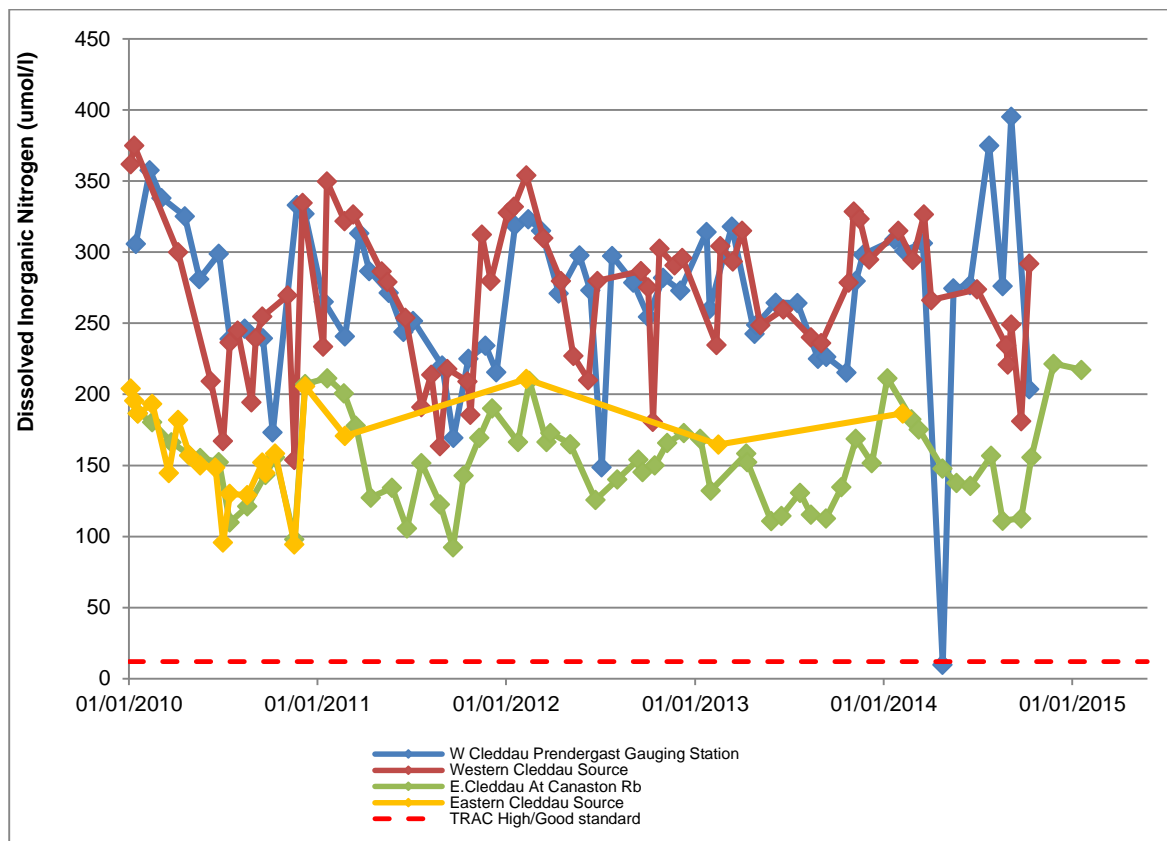
#### 4.3.6 Results

In the Eastern Cleddau (Table 2), this method specifies a DIN reduction target of 311t/yr or 0.017t/ha/yr. In the Western Cleddau (Table 3), this method specifies a DIN reduction target of 768.3t/yr (or 0.039t/ha/yr). This equates to an average reduction of DIN for all catchments of **539.6t/yr**.

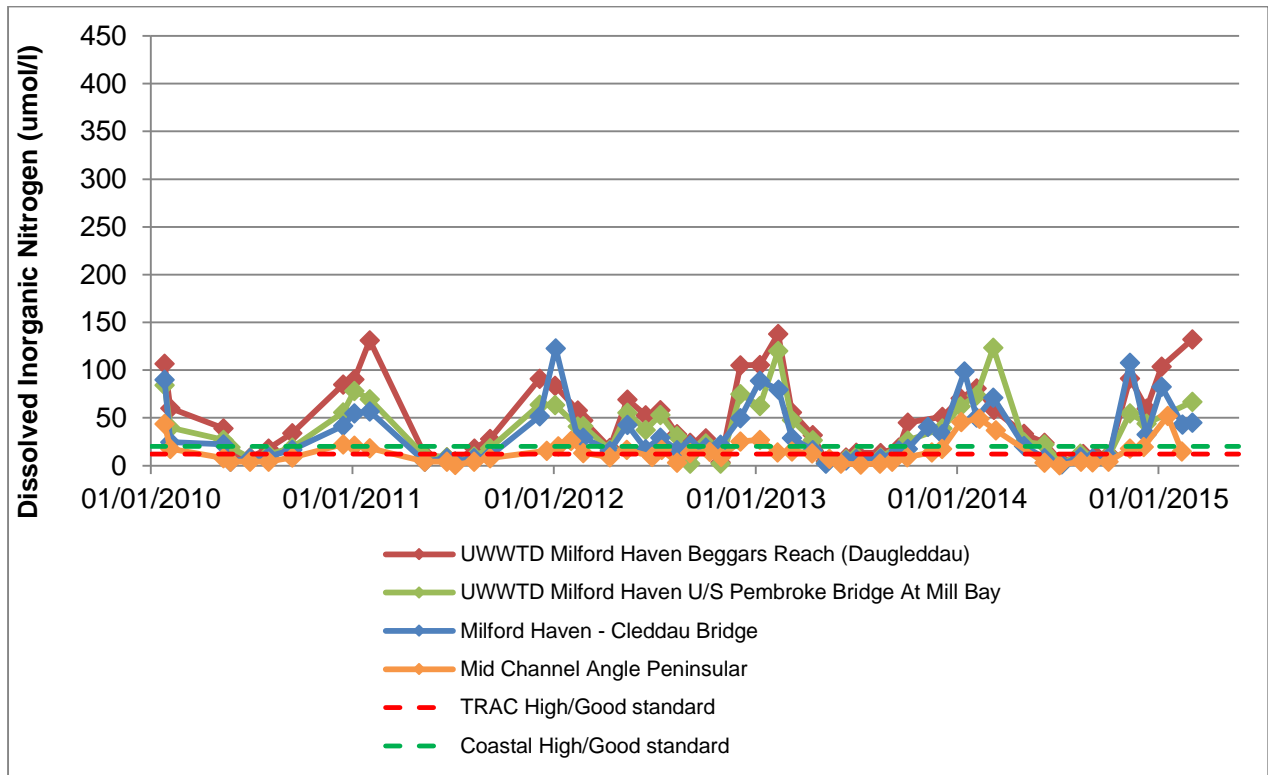
This value has been taken as the target reduction for DIN within the Milford Haven catchment and represents the best balance between pragmatic techniques for N reduction and environmental benefits.

When plotted on a graph (see Figure 8), the data clearly show that at all water monitoring points (with the exception of one anomalous recording) the transitional waters significantly exceed the TRAC High/Good standard.

The situation in the coastal waters is slightly more encouraging with the data (Figure 9) showing that the TRAC standard is achieved, or is much closer to being achieved, throughout the year. This clearly indicates that the river catchments are the main source of N loading within the wider system and these are the areas that should be focussed on.



**Figure 8 – Nutrient Loading in Transitional Waters Compared to WFD**



**Figure 9 – Nutrient Loading in Coastal Waters Compared to WFD Standard**

**4.3.7 Potential Alternative Nutrient Reduction Targets**

Due to the large difference between the WFD TRAC waterbody thresholds and the current nutrient loading within the Milford Haven and Cleddau rivers the EEP requested in early June 2015 that additional analysis was undertaken of the water quality data. This analysis attempted to identify what the condition of the waterbodies would be with a percentage reduction in nutrient inputs, rather than a reduction to the TRAC waterbody threshold.

Table 4 below illustrates what the reduction targets for inputs would be with a range of decreases from 5% to 100%, in 5% steps. The 0% reduction is the current level of loading whilst the yellow highlight represents a 20kg / ha reduction across the catchment. This figure has been chosen as it is generally considered to be the absolute upper limit of what the land management measures could deliver per hectare.

This figure suggests that for the Eastern Cleddau, if an average reduction of 20kg /ha was achieved, it would be possible to get approximately a 65% reduction in loading, whilst for the Western Cleddau a catchment wide 20 kg /ha reduction would deliver a 35% saving. Whilst these would appear to be achievable targets it indicates the level

of problem within the catchments as such reductions do not get the waterbodies close to the WFD TRAC threshold.

In late June 2015 NRW provided additional water quality data for the catchments extending back to 1990. This data did not cover all the monitoring points but was considered to be of interest because it provided an opportunity to try and identify and understand what the conditions were like in the catchment pre-SAC designation.

It was felt that analysis of this data might provide an alternative loading threshold to that provided by the WFD. As discussed above the threshold for TRAC waterbodies, even when including a background load, is prohibitively high which may prevent a scheme ever achieving its main aim. If the older data provided an alternative threshold value, especially if this was lower than the WFD threshold, this might be more achievable via the land management mechanisms available. It would also help define, in terms of nutrient loading, what favourable conservation status is for the Pembrokeshire Marine SAC.

Unfortunately however, after extensive analysis the data has not provided us with the necessary information to either identify the load at SAC designation or an alternative threshold. Consequently, the WFD threshold for TRAC waterbodies will continue to be used.

**Table 4: Percentage Reduction Calculations for the Eastern and Western Cleddau**

E. Cleddau						W. Cleddau					
% Decrease	Ave. current load after % reduction (kg/yr)	Reduction required to meet background	Ave. current load after % reduction per hectare (total catchment) (kg/ha/yr)	Load per hectare (agri land, 82% catchment)	Reduction per hectare required to meet % reduction (agri land)	% Decrease	Ave. current load after % reduction (kg/yr)	Reduction required to meet background	Ave. current load after % reduction per hectare (total catchment) (kg/ha/yr)	Load per hectare (agri land, 82% catchment)	Reduction per hectare required to meet % reduction (agri land)
0	454708.90	311026.30	N/A	N/A	N/A	0	923396.3	768335.3	N/A	N/A	N/A
5	431973.4	288290.9	23.6	28.8	1.5	5	877226.5	722165.4	44.4	54.1	2.8
10	409238.0	265555.5	22.4	27.3	3.0	10	831056.7	675995.6	42.1	51.3	5.7
15	386502.5	242820.0	21.1	25.7	4.5	15	784886.9	629825.8	39.7	48.4	8.5
20	363767.1	220084.6	19.9	24.2	6.1	20	738717.0	583656.0	37.4	45.6	11.4
25	341031.7	197349.1	18.6	22.7	7.6	25	692547.2	537486.2	35.0	42.7	14.2
30	318296.2	174613.7	17.4	21.2	9.1	30	646377.4	491316.4	32.7	39.9	17.1
35	295560.8	151878.2	16.1	19.7	10.6	35	600207.6	445146.6	30.4	37.0	19.9
40	272825.3	129142.8	14.9	18.2	12.1	40	554037.8	398976.7	28.0	34.2	22.8
45	250089.9	106407.3	13.7	16.7	13.6	45	507868.0	352806.9	25.7	31.3	25.6
50	227354.4	83671.9	12.4	15.1	15.1	50	461698.2	306637.1	23.4	28.5	28.5
55	204619.0	60936.5	11.2	13.6	16.7	55	415528.3	260467.3	21.0	25.6	31.3
60	181883.5	38201.0	9.9	12.1	18.2	60	369358.5	214297.5	18.7	22.8	34.2
65	159148.1	15465.6	8.7	10.6	19.7	65	323188.7	168127.7	16.4	19.9	37.0
70	136412.7	0.0	7.5	9.1	21.2	70	277018.9	121957.8	14.0	17.1	39.9
75	113677.2	0.0	6.2	7.6	22.7	75	230849.1	75788.0	11.7	14.2	42.7
80	90941.8	0.0	5.0	6.1	24.2	80	184679.3	29618.2	9.3	11.4	45.6
85	68206.3	0.0	3.7	4.5	25.7	85	138509.4	0.0	7.0	8.5	48.4
90	45470.9	0.0	2.5	3.0	27.3	90	92339.6	0.0	4.7	5.7	51.3
95	22735.4	0.0	1.2	1.5	28.8	95	46169.8	0.0	2.3	2.8	54.1
100	0.0	0.0	0.0	0.0	30.3	100	0.0	0.0	0.0	0.0	57.0

\* Nutrient load is measured in river whilst the figure for load per ha comes from ADAS report which states that on average 30.3kg/ha N is leached out in the catchment

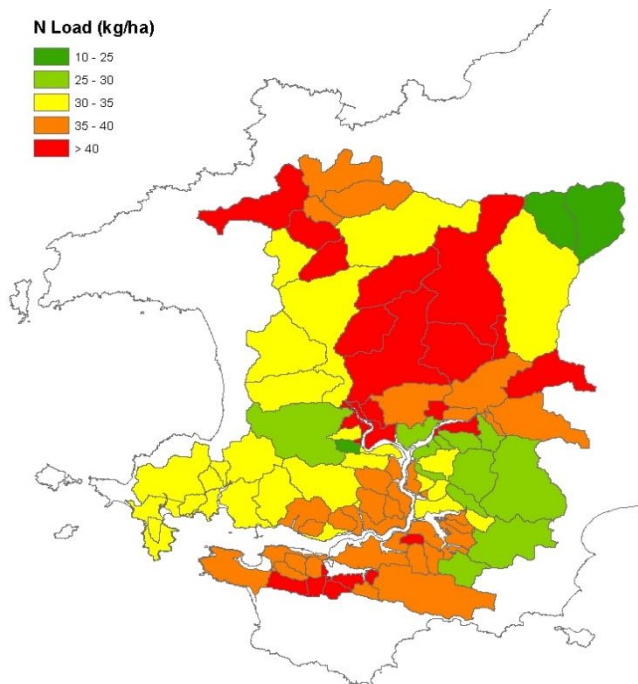
## **4.4 POTENTIAL POLLUTION SOURCES WITHIN THE CATCHMENT**

### **4.4.1 Agriculture**

Agricultural nitrate loads for the Cleddau catchments are taken from Anthony et al (2012), who developed a spatially explicit modelling framework to calculate emissions for a suite of pollutants in order to determine the impacts of the Welsh Agri-Environment schemes. The framework was stratified by robust farm type and reported emissions separately for each of the Water Framework Directive river catchments in Wales.

The modelling framework used a combination of process based and inventory models, with nitrate losses calculated using the N-CYCLE, NITCAT and MANNER models (Scholefield et al., 1991; Lord, 1992; Chambers et al., 1999). The results of Anthony et al (2012) are based upon livestock and cropping from the 2004 June Agricultural Census, along with farm management data (fertiliser practice, livestock management etc.) based upon recent survey data, and reflecting both conventional and organic management.

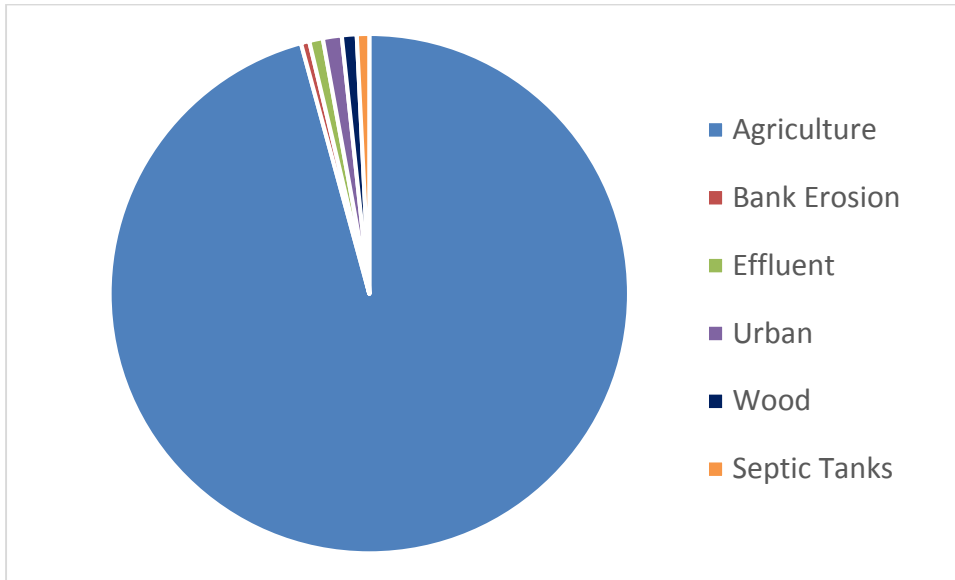
The calculated total nitrate load from agriculture being delivered to watercourses was 2.4 kT N per year. This works out at an average nitrate load of 35 kg ha<sup>-1</sup> per year. Figure 10 shows how this varies footprint varies across the Cleddau catchments, with greatest loads (over 40 kg ha<sup>-1</sup>) found in the north and centre of the catchment, where farming is dominated by dairying, and the lowest loads (under 25 kg ha<sup>-1</sup>) where the catchments are dominated by rough grazing and the National Park to the North East.



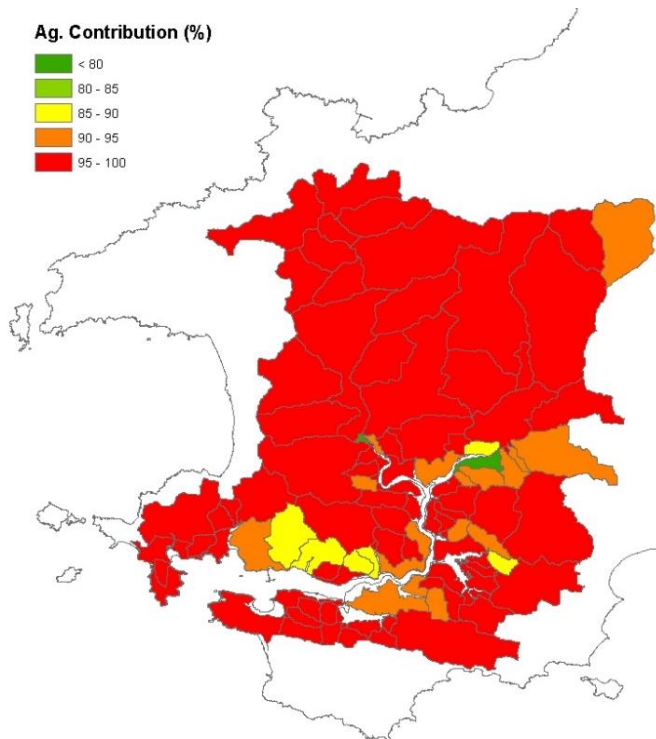
**Figure 10 – Agricultural Nitrate Load per Hectare of Agricultural Land for Each Catchment**

#### **4.4.2 Sector Apportionment**

Anthony et al (2012) also calculated the nitrate losses from non-agricultural sectors, allowing for an assessment on the importance of the agricultural load. Figure 11 shows that the other sectors are small in comparison to agriculture, which contributes over 95% of the total load. Note that this data does not include sewage treatment works discharging directly to the sea or the impacts of any within stream retention, although this would not significantly change the relative importance of agriculture. Figure 12 shows that, even at waterbody scale, agriculture is always the dominant source, with only a few catchments where the agricultural component of the total load is less than 90%.



**Figure 11 – Sector Apportionment for Nitrate in all WFD Waterbodies within the Catchment**



**Figure 12 – Agricultural Contribution to the Total Nitrate Load, for each WFD Waterbody within the Catchment**

### 4.4.3 Housing and Development

In contrast to the figures above, existing and projected housing would appear to have little impact on the condition of the watercourses.

The review of consents study undertaken by EAW showed that approximately 61% of the dissolved inorganic phosphorus (DIP) load could be accounted for by Stage 3 continuous discharges from the following Dwr Cymru Welsh Water sources: Milford Haven sewage treatment works (STW), Pembroke Dock STW, Merlin's Bridge STW, Neyland STW, and Narberth STW. In contrast, approximately 95% of the dissolved inorganic nitrogen (DIN) load to the Milford Haven waterway came from sources other than the Stage 3 continuous discharges. Consequently, NRW (2014) estimates that only 5% of the DIN loading can be attributed to DCWW sewage treatment works (STW) as a result of existing housing stock.

Reviewing Local Development Plans and population forecasts, it has been calculated that by 2021 an additional 10.65t N will enter the catchment (or approximately 1t per year) as a result of potential new housing development. In addition, by 2035 this increases to 16.58t N, or an average of 0.83t per year. These calculations are based on the projected increase in population (8800 between 2011 and 2021; and 13,700 between 2011 and 2031), multiplied by the assumed average nitrate loading per population equivalent (PE). This is generally accepted to be 1.21kg/N/Yr/PE and is derived from the average load that is discharged to rivers based on STW operation and permit conditions. In the absence of alternative figures, this is considered to be appropriate for the Milford Haven and Cleddau catchments.

Additional calculations were completed based on development rates and typical house sizes and extended to cover a 50 year period, in order to account for continued long term reductions in N loading. The basic calculation used to identify the long term impact of housing on N loading is:

**S x A x Q x T** where; S is the size of development i.e. number of houses, A is the average number of bedrooms<sup>31</sup>, Q is the accepted multiplier per population equivalent<sup>32</sup> and T is the time period over which the reduction is to be delivered.

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<sup>31</sup> According to the Office for National Statistics (ONS) the average house has 3 bedrooms so this is the figure used here. For individual housing developments this number could be amended to provide the actual average figure based on the planning application.

<http://www.ons.gov.uk/ons/rel/census/2011-census/detailed-characteristics-on-housing-for-local-authorities-in-england-and-wales/short-story-on-detailed-characteristics.html>

<sup>32</sup> It has been assumed for the purposes of this example that each bedroom would be occupied by one person (i.e. one population equivalent). Whilst a relatively crude simplification of housing dynamics it is sufficient to help demonstrate the gap between what new housing would likely contribute to the problem vs. diffuse rural pollution. If required (for example if the scheme was trying to achieve nitrate neutral developments), a more detailed calculation could be completed based on the specifics of an individual development

In the 100 unit example this would equate to an additional **18,150kg** of N over 50 years (**100 X 3 X 1.21 X 50 = 18,150kg**). This equates to 181.5 kg per house or 3.63kg per house per year. These figures are insignificant when compared against the 454.7 tonnes average loading in the Eastern Cleddau and 923.4 in the Western Cleddau and illustrate the size of the problem when trying to reduce nutrient loading via development.

The relatively low level impact of existing housing and new development may also cause complications if developers are viewed as "buyers" in any PES scheme and seen as a source of income to offset the impacts of agriculture. It is likely that asking people, who have limited impact on the problem, to pay for those who have a significantly larger impact to change their practices will not be popular and may limit the attractiveness of the scheme.

It may be possible to engage developers, through this process, in order to deliver nitrate neutral developments within the catchment areas. This would depend however, on the likely increase in construction cost (and hence sale price) of each unit as a result of such an initiative, and this cannot be accurately determined at this time. It is recommended therefore that developers are considered key stakeholders and they should be contacted and engaged as early as possible to identify what might be achievable via an offsetting scheme.

#### **4.4.4 Other Sources**

There is little evidence to suggest that alternative sources of nutrient enrichment exist within the catchment. Whilst there is significant amounts of industry within the catchment areas ADAS estimated that only 9737 kg N/year or <0.5% of the total estimated load in the waterbodies. It is considered unlikely that this would materially change in the short term and if another source of nutrients applied for planning permission or permits these are likely to only be agreed if nutrient loading did not increase.

### **4.5 LAND MANAGEMENT OPPORTUNITIES**

#### **4.5.1 Introduction**

The main aim of this work package was to identify the potential opportunities, within the catchment, for delivering the load reduction requirements via farm based measures. This work was undertaken by ADAS using their Farmscoper tool and used a range of data to model the potential contribution from the 'average farm' types for this area of Pembrokeshire.

#### **4.5.2 Data Analysis and Modelling**

In order to achieve this analysis three datasets were obtained from Welsh Government to allow the Farmscoper tool to be applied to the Milford Haven and Cleddau catchments.

The Land Parcel Information System (LPIS) provided the individual field boundaries for all fields in the project area, along with a unique identifier for the farm that they belong to. For each of these fields, the crop type was taken from the Integrated Agricultural Control System (IACS) records, and for each of the farms, the farm type (according to the Robust Farm Type (RFT) definitions) and livestock counts were available from the June Agricultural Census. These data make it possible to determine an average farm type, in terms of crop areas and livestock counts, for each of the RFTs.

The nitrate losses for each of these average RFT farms was calculated using Farmscoper, for each of the climate and soil types recognised by the tool that are found within the Cleddau catchments. Other farm practices (e.g. manure management) were based upon the default assumptions within Farmscoper.

The calculated nitrate losses are expressed in terms of kilograms lost per hectare, and these unit area losses were then be mapped back on to the LPIS field boundary data, based upon farm type, using the results for the soil and climate most representative for that field. The data was then used to calculate the overall load (this is a “baseline load” in the absence of mitigation) per measure / activity.

Any mitigation method which resulted in a reduction of over 0.1% on at least 1 farm was included in the analysis though please note that not all methods impact on each farm type.

The farm types were based on the 9 farm types previously used by ADAS for catchment modelling, which had been derived from the census data. Additional farm types were also added, primarily to allow for more variation in livestock. This has allowed us to be incredibly detailed and meant we can include information for an upland farm with cattle and sheep (the typical upland farm type), as well as one with just cattle and one with just sheep. Further additions include farms without livestock but where manure was being imported again to reflect the situation on the ground as closely as possible. However, even with 20 different farm types we are unable to reflect the wide variation of farm types in Pembrokeshire.

#### **4.5.3 Results**

Due to the complexity and size of the modelling undertaken for this work package it

is not possible to present all of the findings of this work in this section. However, what the work has shown is that depending on a number of factors (farm type, rainfall, soil type, fertilizer application rates etc.) the available land management measures are capable of delivering between a 17% reduction and a 4% increase in N loading<sup>33</sup>. It is unlikely that this would be sufficient to reduce loadings to the level required by the WFD threshold however; it will deliver substantial savings which will deliver headroom in the catchment.

One point to note is that as more mitigation methods are implemented on individual farms or areas of catchment there is a tendency to achieve diminishing beneficial returns as the measures, though different, are trying to control the same sources. As a result, the total impact of a collection of methods is generally less than the sum of their individual impacts.

Appendix 4 includes the outputs from the modelling detailing the likely percentage reduction in nitrogen loading from the 100 or so measures available. Please note this Appendix is over 280 Pages long and is an MS Excel table with important cell functionality included. Consequently it is recommended that this is only viewed electronically and not printed.

#### **4.5.4 Work Package 3: Conclusions**

Though there remains some uncertainty over the impact of nutrient loading within the Milford Haven and Cleddau Catchments there is no uncertainty over the challenge to reduce nitrates to an accepted level under WFD. The work undertaken for this Work Package demonstrates the level of the problem and suggests a threshold level with which to measure success. This threshold is challenging and the initial modelling suggests a purely land management approach is unlikely to deliver sufficient savings.

The following Work Packages detail the potential structure of a nutrient trading toolkit however, it may be necessary to consider additional measures in order to reduce the loading sufficiently. A specific measure that might be beneficial is encouraging farms to reduce stock numbers in order to reduce the amount of fertilizer required as well as the quantity of farmyard manure and faecal matter which are currently a major contributor to N loading.

Destocking has not been explored in great detail as part of this work as it is very difficult to assign a robust value to the amount of N that would be reduced due to the

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<sup>33</sup> We are not suggesting that farmers should be allowed to choose measures that would result in an increase in loading, indeed any measure which had a negative effect would likely be unavailable on the farms where this effect is likely to occur. However, the measure would still remain available in the overall option list as other farms may be able to implement such a measure and achieve significant load reductions.

number of variables involved. However, it may be something that is taken into account if a Nitrate Vulnerable Zone (NVZ) is put in place in these catchments. An NVZ designation is likely to be relatively onerous for farmers and to meet the thresholds destocking might have to be an option. It is probably more acceptable if a requirement for reducing stock numbers is driven by a legal requirement rather than this scheme. The benefits however, should not be ignored and are likely to assist the loading reduce closer to the WFD threshold than would be possible via this scheme alone. The likely impact of the NVZ as well as reducing stock numbers should be explored in any further work phases.

## **5 WORK PACKAGE 4**

### **5.1 INTRODUCTION**

The purpose of this work package was to bring together the findings from previous work, primarily WP3, to identify the potential for a PES scheme within the Milford Haven and Cleddau catchments. This section details the main actors within a PES scheme as well as the types of structure which are most likely to deliver a functioning PES scheme.

### **5.2 ROLES FOR BUYERS, SELLERS AND BROKERS IN PEMBROKESHIRE**

Successful PES schemes tend to have four principal groups involved; these are generally; buyers, sellers, brokers and knowledge providers. This section provides further detail on the roles of three of these groups (buyers, sellers and brokers) and how they might interact with a nutrient offsetting scheme in Pembrokeshire.

It has been assumed that for this scheme the knowledge providers are well known enough, and work closely together enough not to be further detailed here. The Ecosystems Enterprise Partnership and RAG, combined with wider stakeholder groups (e.g. Marine Energy Pembrokeshire, PLANED, PSAN), have sufficient knowledge and capability within the local area to undertake the role of knowledge provider, with support from others, without requiring further details to be outlined in this report.

### **5.3 THE ROLE OF A BUYER IN A PEMBROKESHIRE PES SCHEME**

#### **5.3.1 Potential Buyers**

Typically in PES schemes buyers are considered to be: “beneficiaries of ecosystem services, who are willing to pay for them to be safeguarded, enhanced or restored”<sup>34</sup>.

Buyers tend to be broken down into three broad types:

- ‘Primary buyers’ (buyers who benefit directly from, and pay directly for, improved ecosystem service)
- ‘Secondary buyers’ (organisations that buy improved ecosystem service provision on behalf of sections of society e.g. water company)
- Tertiary buyers’ (organisation that buy improved ecosystem services provision on behalf of society as a whole e.g. government via agri-environment schemes)

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<sup>34</sup> Smith, S., et al. (2013). Payments for Ecosystem Services: A Best Practice Guide. Defra, London

A review of potential buyers in Pembrokeshire identified the following organisations / sectors as the most likely to perform the buyer role:

#### Primary Buyers

- Industry
- Developers
- Port of Milford Haven
- Farmers
- Ministry of Defence (MOD)
- Highways Agency
- Holiday Resorts
- Recreational Groups

#### Secondary Buyers

- Dwr Cymru Welsh Water
- Pembrokeshire County Council / Pembrokeshire Coast National Park Authority

#### Tertiary Buyers

- NRW
- Welsh Government

### **5.3.2 Buyers in the Pembrokeshire Context**

For a PES scheme to work there must be a clear demand for the service being sold and its provision must be financially valuable to the buyer(s). Without a willing and able buyer, there is no prospect of a PES deal. Whilst the scheme must be financially valuable to the buyer(s) they must also be in a position to at least cover the costs incurred by the seller(s) in providing the service over the life of the agreement. Therefore typically from a buyer's perspective, if the payments to secure a service are less than those associated with any alternative means of securing the desired service, the PES scheme would be beneficial.

In the context of Pembrokeshire the relationship between the buyer(s) and the

ecosystem services, in the majority of cases, are different to a more typical scheme. The generally accepted definition of such a scheme is a ‘voluntary transaction where stakeholders enter into PES agreements on a voluntary basis’<sup>35</sup>. With the exception of water companies and perhaps recreational groups, the potential buyers identified above are not likely to be directly relying on improving water quality to continue with their business or activities.

As a result, instead of the buyer being a beneficiary of ecosystem services, who is willing to pay for it to be maintained, the buyer in this context would be paying for an ecosystem service to be improved that benefits wider society<sup>36</sup>.

They would take on the role of buyers in the absence of an alternative because it has been mandated by the regulatory bodies, either through planning permissions or the permitting regime. For this reason it is unrealistic to expect the buyers to interact with the scheme voluntarily. In addition, as demonstrated by WP3, the level of nutrient loading originating with developers / industry / water companies, compared to farming, was so low that it would be difficult to see what the incentive would be for non-farming buyers to voluntarily join a scheme.

### **5.3.3 Lack of Buyers and the Impact on a PES Scheme in Pembrokeshire**

Since the inception of this project, a major concern has centred on whether there are sufficient buyers available within the catchment to generate and sustain a PES scheme. Whilst the list in 2.1.1 is relatively extensive and includes a lot of potential buying ‘activities’ very few of these will impact on the nutrient load within the waterbodies.

There has always been a clear steer from the Ecosystem Enterprise Partnership that this research should focus on Nitrogen (in all forms) only. Consequently, an organisation could only be viewed as a buyer if they were responsible for increasing the N levels within the catchment. This would reduce the potential pool to development<sup>37</sup>, new industry, changes to industrial processes or additional industrial processes, farming practices and very few others.

In addition, due to the characteristics of the catchment (low population levels, largely rural, highly developed industrial base but with little prospective increase in N

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<sup>35</sup> Smith, S., et al. (2013). Payments for Ecosystem Services: A Best Practice Guide. Defra, London

<sup>36</sup> The ultimate aim of the project is to ensure that the SAC (and SSSI sites) are not prevented from achieving favourable condition due to nutrient loading. As a result, the ultimate beneficiary of this is UKPLC because moving towards or achieving favourable status prevents the European Commission raising an infraction against the UK for not complying with community law. This could ultimately result in a financial penalty which would have to be paid for by wider society through the tax system.

<sup>37</sup> Water companies typically calculate that the average load into sewage treatment works is 1.21kg of N per population equivalent per year. This figure has been used, when calculating potential increases in load from development, based on Welsh Government and Local Authority projections.

loading) the likelihood of a significant enough buyer emerging that would support and drive a PES scheme appears to be relatively remote. As a result, buyers, or lack of them has been a major consideration when undertaking additional work around the type and structure of the ‘toolkit’ itself.

## **5.4 THE ROLE OF A SELLER IN A PEMBROKESHIRE PES SCHEME**

### **5.4.1 Potential Sellers in Pembrokeshire**

Under a PES scheme sellers are generally identified as land, or other resource managers, who can secure or improve the level of an ecosystem service by maintaining good practice or amending other activities. Sellers within Pembrokeshire are predominantly drawn from the following industries and sectors:

- farmers
- agribusinesses
- Dwr Cymru Welsh Water
- Pembrokeshire County Council / Pembrokeshire Coast National Park Authority
- Non-agricultural landowners (e.g. MOD, forestry businesses, National Trust)
- environmental non-governmental organisations (eNGO)
- shoreline owners and management authorities

Unlike the buyers side there does not appear to be a shortage of sellers. The water quality analysis undertaken in Work Package 3 showed the probable contribution to nutrient loading from agricultural sources. There are over 1000 agricultural holdings within the catchments and whilst it is clear not all would be interested this still provides us with a significant pool of sellers.

In addition, the contribution to reducing nutrient loading provided by other types of seller listed above should not be ignored. There are potentially sizeable land holdings under the management of these alternative sellers which could provide areas for relevant measures to be put in place without being subject to the issues usually encountered with farmers.

At a minimum, sellers are expected to comply with existing regulatory requirements (for example, farmers must keep their land in Good Agricultural and Environmental Condition (GAEC)). However, there is also a case to be made that in certain circumstances, where good environmental practices is the norm, payments would be

focused on more far-reaching interventions with corresponding ecosystem service benefits.

The impact of the proposed interventions on sellers may vary. For example, some interventions may provide benefits to both buyers and sellers. Installing fencing to prevent livestock from entering watercourses, for example, may benefit both buyers (through enhanced water quality) and sellers (through reducing the loss of lambs or the incidence of foot disease in cattle). In these instances, a match-funding approach may be appropriate with sellers co-funding the intervention. In other cases, interventions may have a clear adverse effect on outputs from the land or resource and payments will need to cover the full costs to the seller. In some instances, cash payments might be accompanied by in-kind payments such as the provision of capacity building, advice on best practice or help with accessing government grants.

#### **5.4.2 Nutrient Reduction Measures Available to Farmers**

In a PES scheme the sellers are responsible for securing or improving the level of an ecosystem service by maintaining good practice or amending other activities. In order for the system to work effectively all sellers would be required to take up a range of measures from a standardised list. For the purposes of this work the measures that we would propose offering to farmers is the same ADAS list of measures that form part of the First Milk scheme.

The main reason for choosing these measures, and the N reduction they deliver, is that they are accepted by NRW, which removes the need to identify alternative measures and get them agreed. Consequently, we are confident that these measures will be capable of delivering significant reductions in N application, as well as leaching from catchment land contributing to a reduction in nutrient loading in the waterbodies over the next few years.

A list of potential measures, along with the projected N reduction and associated cost reductions is included in Appendix 5.

#### **5.4.3 Potential Issues with Sellers in a PES Scheme**

Though it appears clear that there is a sufficiently large pool of sellers this does not automatically mean a PES scheme would be successful. A scheme is only going to be attractive from a seller's perspective if the payments received at least cover the value of any returns foregone as a result of implementing the agreed interventions. This can be especially difficult with changing agricultural prices and profits over long contract periods, as demonstrated by agri-environment schemes such as Glastir.

## **5.5 THE ROLE OF A BROKER IN A PEMBROKESHIRE PES SCHEME**

Under any PES scheme the role of the Broker or Brokers is crucial and schemes benefit from being coordinated by an independent, trusted broker, such as a local conservation trust, social enterprise or farm adviser. However, a body taking on the broker role needs to have both a technical understanding of the problems and solutions, an ability to manage large volumes of money, and already has or can build relationships with Buyers and Sellers as well as the scientific and regulatory community.

The evidence from the literature review clearly shows that a trusted local intermediary will be the most suitable body capable of mobilising and sustaining the required dialogue between stakeholders. Indeed there are examples of pilot schemes that have struggled or underachieved because of the lack of an independent broker. However, stakeholders involved in a scheme must be careful not to assume that an organisation that appears to fit the requirements of a broker would be able to perform that role. For example, in the Fowey Project, the Fowey Harbour Commission was seen as an ideal broker given its perceived longevity in the area and well regarded technical knowledge however, the Commission was less sure as it considered itself to have limited environmental and land management expertise and little knowledge of parts of the catchment.

In the context of a scheme in Pembrokeshire it is envisaged that a broker or brokers would have to be capable of delivering the following activities:

- liaising with buyers and sellers and stakeholders holding oversight functions such as RAG and Welsh Government
- identifying baskets of potential measures that will deliver service provision;
- aggregating multiple landowners / farmers to form a group of sellers capable of delivering joined up, landscape scale interventions;
- assisting in determining prices, accessing grants, structuring agreements and agreeing a mutually acceptable payment regime;
- scheme implementation and administration including; assisting landholders develop plans; application evaluations; payment of credits; maintaining sufficient load reduction if sellers withdraw; certification, and verification
- handling disputes; and
- enforcing the delivery of the land based measures.

## **5.6 TYPES OF MARKET MECHANISM**

### **5.6.1 Introduction**

The previous work packages have clearly demonstrated the need for some solution to the high levels of nutrient loading within the Milford Haven and Cleddau catchments. This section presents and outlines two potential scheme structures that would, based on the outputs from the previous Work Packages, provide the most likely chance of success in delivering improvements in water quality.

Two options are being presented here as they both have advantages and disadvantages and an understanding of each is important to help ensure that an informed choice on the most appropriate scheme can be made.

### **5.6.2 Nutrient Offsetting via an Ecobank**

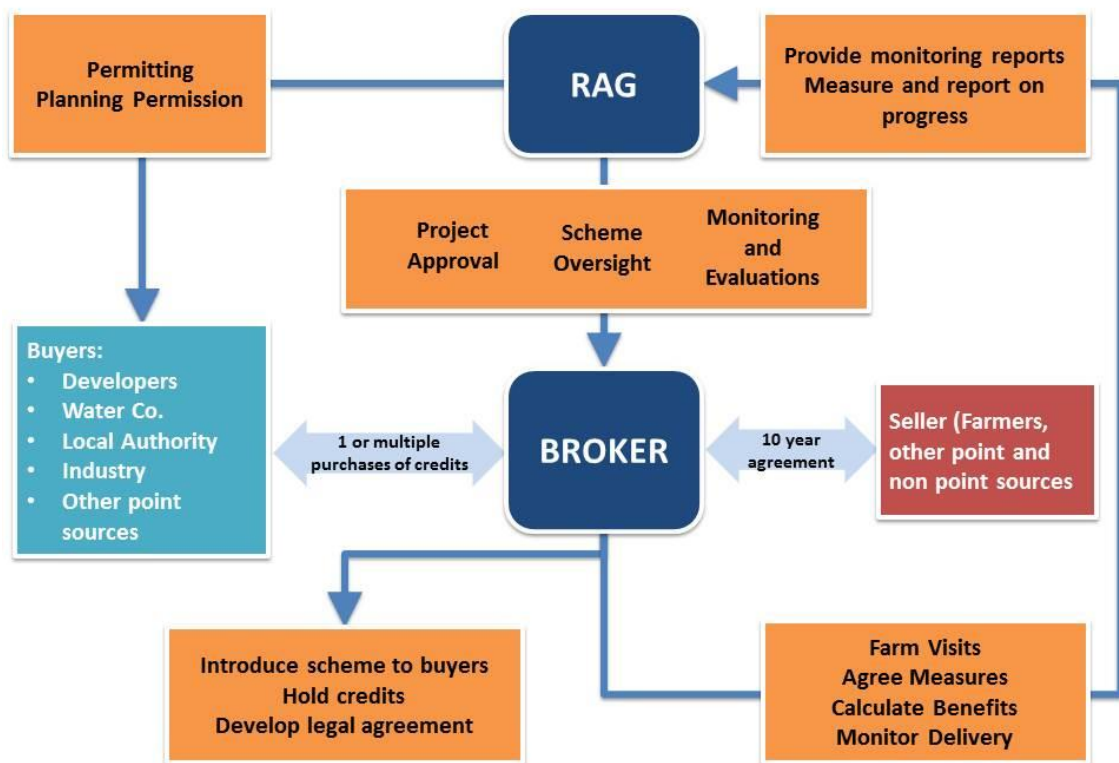
Nutrient offsets occur where a party seeking to undertake a development activity (a buyer), contracts another party (a seller) to undertake an activity or activities to reduce the amount of nutrient in the catchment equivalent to the additional pollution arising from the development plus an additional percentage so the nutrient load reduces rather than remains static.

In such a scheme an independent central body, i.e. the broker (under guidance from the RAG), would bring together buyers and sellers in order to set up and manage the trade of credits. Sellers would agree, in principle, with the broker the measures they would be happy to implement on their farm. The broker would then be able to calculate the likely benefit of each potential seller and have a 'bank' of credits waiting until a buyer entered the scheme.

Based on the findings of the literature review and discussions with the regulators in Pembrokeshire, it is suggested that regulation (either in the form of planning permission, Section 106<sup>38</sup> or permitting) would be the mechanism for involving the buyers. Once the buyer or buyers is known, the broker would be responsible for setting up the agreement, and managing the legal and financial elements. A visual representation of how a nutrient offset would work is shown in Figure 13.

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<sup>38</sup> Section 106 of the Town and Country Planning Act 1990 (as amended)



**Figure 13: Offsetting Scheme Structure**

In order to achieve a sufficient reduction in nutrient loading it is suggested that the agreement with the seller is a contract that lasts 10 years (to bring this in line with most agri-environment schemes it would probably require the option of a 5 year break clause). As most buyers will be undertaking schemes with an asset life beyond that initial 10 years, the level of investment (i.e. the number of credits that need to be purchased) would reflect the nutrient increase over a longer period. Based on current Treasury rules this is likely to be 25 years, though 50 years might be more appropriate considering the length of time environmental improvements take to materialise.

It may be possible to include a break clause at 5 years for the sellers, however this would be strictly controlled by the broker. In order to maintain the nutrient reductions a pool of replacement sellers would need to exist with sufficient nutrient reduction measures to ensure no worsening of the nutrient load status as a result of one or multiple farms pulling out.

### **Advantages**

This system utilises a market based approach to generate economically efficient outcomes. A trade will occur when one party values polluting at a higher level than it

costs another party to reduce it elsewhere. These differences in values will result in a trade. This approach is generally considered to be a cheaper (for society) method of reducing pollution than through blanket regulation because pollution will be reduced by for those for whom it is cheapest to do so.

In addition, the cost of reducing the nutrients is borne by the private sector, not by public finances which are currently under so much pressure. Setting up the system may be borne by a third party (private or public) but the cost of offsetting is faced by the private sector. Therefore the polluter pays principle is adopted. Those causing additional pollution are required (where regulated) to pay for the right to do so.

This mechanism is also an effective way of preventing development projects, and therefore the local economy, being impeded by nutrient control activities, as long as there is no net impact (as an absolute minimum) in the catchment.

### ***Disadvantages***

Due to the contribution made by farming to the elevated nutrient loading in the catchments a PES scheme can be seen as essentially a vehicle for subsidising farmers who are producing the most pollutants. The benefit of a nutrient trading scheme is questionable when the majority of pollutants originate from farms. It is also difficult to introduce and regulate an offset scheme to farmers, when they have been previously undertaking the same activities for free. These difficulties are typically why farmers are considered to be sellers, which contravenes the polluter pays principle. Any reduction in farm pollution is determined by the scale of the buyers.

In order to achieve a sizeable reduction in nutrients in the catchment, sufficient buyers must exist to drive the market and these developments must be of sufficient size (therefore sufficiently large offsets) to make the administrative burden in setting up the scheme look attractive. If only a small number of trades/offsets take place the costs of the scheme will not be worth the administrative requirements.

Voluntary offset regimes have been undertaken for biodiversity in the past with mixed success. Regulation and planning approval could compel any buyers to offset as a condition of development. But in Pembrokeshire the vast majority of pollutants come from activities that are unregulated under the status quo and are unlikely to be regulated in the future.

Determining the levels of nutrient loading associated with developments, and the associated activity to offset these emissions is complicated.

Non-point pollution sources are difficult to measure and therefore determining the required actions to offset any development is difficult. Substantial modelling may be required to understand required activities for offsets.

Trading between nonpoint sources (farmers) is unlikely to be viable because no variability exists in the costs of reducing pollution (Cockerill and Hutchinson, 2007). Therefore not only are farmers difficult to regulate, or to engage on an offset scheme, they also may not present the economic fundamentals required for such a scheme.

## **5.7 AUCTIONING NUTRIENT REDUCTION CONTRACTS**

A reverse auction is where the roles of buyer and sellers are reversed – the bidder is the seller and not the buyer. Each seller calculates the cost to them of implementing a specific scheme and tenders a bid accordingly. The budget allocated to an auction is typically provided by a public body and represents the amount of funding that interested parties will allocate to achieve a specific environmental target.

Once a budget is set and the management actions designed to deliver the benefits have been identified, the sellers construct bids which provide details of the compensation cost required in order to deliver specific land management measures. The payment or compensation required to carry out these changes will be dependent on the land characteristics, productivity of the landholder, the level of environmental awareness, income, size of landholding, etc. The lowest bid is not always the winner, as most bids are different and weighting originates from service the seller is proposing.

There are several varieties of auction – open bid and sealed bid. In an open-bid auction, information relating to the bids are shown in real time – this can be either the exact price, or a ranked position, while identities of bidders are hidden. In Sealed bid auctions, no information is available to any of the participants throughout the auction.

When all bids from Sellers have been received the bids are assessed according to cost efficiency. Usually relative weights are applied to individual benefit variables to reflect those benefits that are most highly valued. Management actions proposed in individual bids will be scored accordingly. Bids will then be ranked in terms of environmental benefit per unit of cost.

Contracts will be awarded to the Sellers who have submitted bids that offer most environmental benefit per unit cost, up to the point where the budget is exhausted. The Seller will then implement the management activities outlined in their bids, in return for the agreed payment.

Auctions can operate to meet a fixed target or fixed budget depending on circumstances. The former auction awards contracts to bidders who submit the most environmental benefit per unit cost up to the point where the environmental target has been reached. Conversely, the latter type will award contracts up to the point where the budget has been spent.

Both types have weaknesses namely the cost of meeting the target will be unknown when a fixed target needs to be met, whereas the total environmental benefit will be unknown in the when the scheme is constrained by a fixed budget.

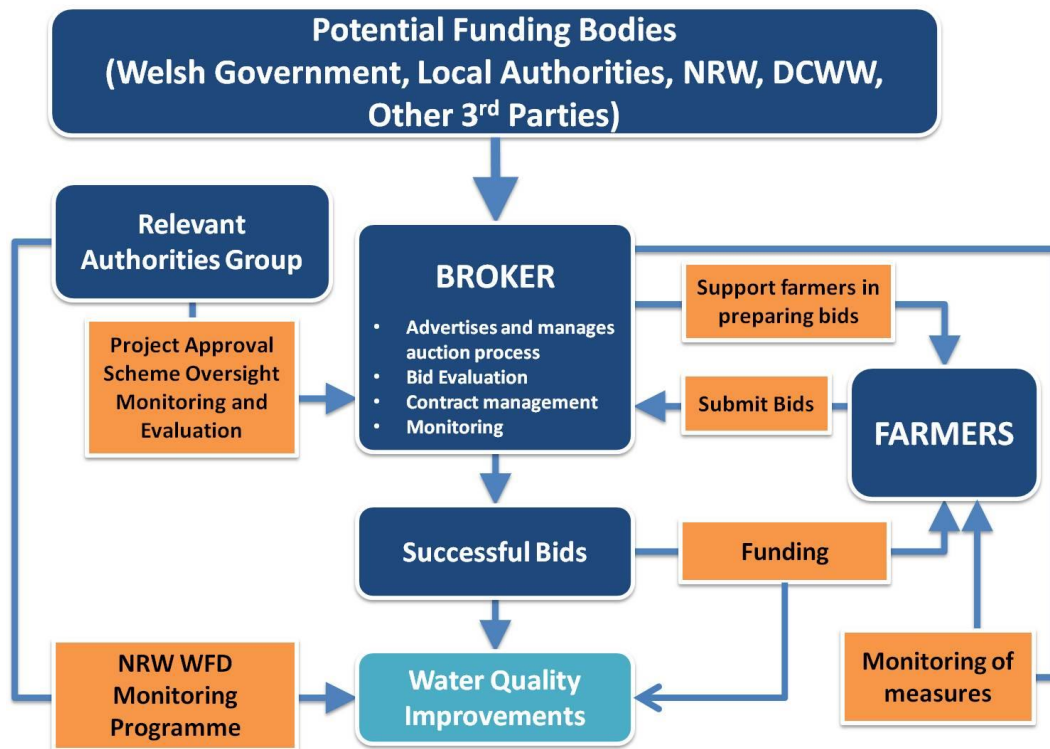
Advantages of online reverse auctions are based on time and price. Where price is a priority, they provide opportunities to obtain better prices, as the auction process quickly lowers prices. Additionally, they are generally quicker than other types of procurement processes, where there are quicker reactions to changing markets. As such, the auction is efficient, both for the buyer and seller; Sellers can focus time on direct proposals, and buyers can quickly find new business and customers.

There are disadvantages for both the buyer and seller. The buyer will often be subjected to the additional associated with setting up a reverse auction – through registration, subscription and commission fees. Moreover, as sellers compete with others, their profit margins may be reduced as they are forced to lower prices<sup>39</sup>.

Auctions can be preferred when benefits of investments can be estimated accurately without specific knowledge of each farm consequently this approach can reduce the cost element of engaging with a large number of farms as is required under a typical trading scheme.

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<sup>39</sup> Kuo, C-C., White, R. E. & Rogers, P. (2003) A critical review of online reverse auctions. Available from: <http://www.sbaer.uca.edu/research/swdsi/2003/Papers/O91.pdf>



**Figure 14: Potential Structure of a Reverse Auction**

### 5.7.1 Participants

Participants would include farmers and land managers with management control over eligible farms and they would be able to apply for grants to deliver land-use change or for capital investments.

### 5.7.2 Funding

A fixed pot of money would be used to fund the auction(s). The funding does not need to originate with one organisation but typically with Reverse Auctions this is what ends up happening. The budget would be allocated to the sellers through a competitive bidding process in which farmers would enter bids for funding the N reduction activities.

### 5.7.3 Advantages

A reverse auction has the advantage of utilising competition between those seeking conservation contracts to reach an economically efficient outcome. Those farmers who find it the cheapest to undertake pollution activities will more likely win the auction.

The key to the reverse auction approach is that it requires landholders to determine their own price for setting aside or improving their native vegetation. By having to decide how much they are willing to accept in a competitive setting (because other landholders are also bidding), the landholders must consider seriously the relative values of the land in both its current and future managed states.

The costs in compiling bids falls on those who are looking to secure the contract. This minimises the amount of on farm visits required for the auction administrator and therefore can bring down the overall administration costs associated with the scheme (it is acknowledged that this could also be a disadvantage and this is explored below). As a result, inverse auctions can deliver large cost-effectiveness gains.

In Australia for example, the inverse auction mechanism applied in the Tasmanian Forest Conservation Fund programme resulted in a 52% cost-effectiveness gain (compared to a first-come-first-served approach to allocating PES contracts). Likewise in the United States, a local PES programme in the Conestoga watershed found that the use of inverse auctions resulted in a seven-fold increase in the reduction of phosphorus runoff per dollar spent compared to a fixed price approach<sup>40</sup>.

The market is driven by those who provide the funds and therefore not dependent on the numbers or scale of buyers. In addition, as it is a voluntary initiative it requires no new legislation.

The other benefit of this approach is the quasi-standalone nature of an auction. Essentially one could be held as frequently or infrequently as required, depending on the available buying fund. Other systems need more or less continuous throughput of buyers and sellers in order to maintain the process.

One other benefit of the auction system is that it reduces the advisor input with regards to farmer liaison and farm visits. This reduces costs and makes the processes more cost effective. However, when considering the significant problem of nutrient loading and the cost of putting a bid together there may be a case for the Broker being more involved than would typically be normal. This would allow the greatest level of benefits to be realised (it is more likely that the upper limit of 20kg/ha reduction rate would be achieved with input from a knowledgeable, independent broker than if the farmer was doing it themselves) for what is likely to be a relatively small cost. The evidence from the First Milk case study clearly shows the value of

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<sup>40</sup> Selman, M., S. Greenhalgh, M. Taylor, and J. Guiling (2008), "Paying for environmental performance: potential cost savings using a reverse auction in program sign-up", World Resources Institute, Policy Note No. 5, Washington DC.

advisor interaction and it is recommended that at least during the first auction there is significant advisor input.

An outcome-based design would make the payment a farmer received conditional on the levels of improvement in water quality resulting from that farmer's actions. Such a design would have the clear advantage of ensuring that the scheme only paid for verified improvements in water quality.

Finally, the Firstmilk case study has shown that NRW is confident that an output based system will deliver the required improvements and as a result it is recommended that an output system is chosen over an outcome one.

### ***Disadvantages***

Considerable effort is required to design and administer a reverse auction. Cockerill and Hutchinson, (2007) detail the extensive prior testing required for this type of auction including theoretical model of bidding behaviour, laboratory experiments, field experiments with real bidders and activities.

There is no guarantee that sellers will agree with the need for land management measures, or they may not want to implement them on their land. This could lead to inflation in the cost of delivery (i.e. if sellers don't see the value in implementing the measure or cannot identify how it will increase profit or offset costs then the bid they submit is unlikely to be good value), or sellers may just not submit bids at all. Both these scenarios would severely limit the value for money of such an approach as well as the ability to reduce nutrient loading.

If it is a publically financed scheme, which has no guaranteed outcomes, i.e. a cap on nutrients is not set. Nevertheless, pilot schemes should help the implementing agency anticipate the scale of nutrient reduction and budget required.

Large transaction costs on the part of the bidders in estimating their bids add to administrative burden experienced by farmers.

Output based auction systems may result in funders paying sellers for actions that have the potential to deliver water quality improvements, without any guarantee that the level of improvement in water quality is sufficient. In addition, an auction allows a seller to bid for actions that they planned to do irrespective of whether the scheme existed or not. Such payments would not yield additional improvements in water quality but would transfer the cost for that activity from the seller to the funder / buyer.

All PES schemes whether output or outcome based tend to lack accurate and robust monitoring that allow the contributions of individual sellers / groups of sellers to be recorded via changes in water quality. In such a situation it becomes very difficult to identify whether measures are working effectively and if not why not. The long term viability of a scheme will depend on its ability to adapt, especially the ability to change emphasis if the original aims and objectives are not being met.

In addition, water pollution outcomes are highly variable depending not only on farmer actions but also on a variety of natural processes that are not always well understood. As a result, farmers would have only limited control over the levels of payments they might receive. A mechanism where payments are unpredictable is likely to discourage farmer participation.

#### **5.7.4 Combining the Schemes**

A third option might be to develop a hybrid scheme, selecting the best elements from nutrient trading and reverse auctions. For example, once a publically financed scheme which auctions nutrient reduction contracts has been proved to be effective, new funding from more traditional 'buyers' could partially, or fully fund (dependent on the scale) this auction.

New developments that result in nutrient pollution could be required to buy (through a S106 agreement, a planning condition or via the permit system) credits to offset the additional discharges into the catchment. The funds resulting from the purchase of credits can go towards funding an auction.

Over time the burden of financing the periodic auctions could move from the public to the private sectors. This would not preclude organisations such as Welsh Government retaining an interest and providing funding it just removes the need for them to do it, as without them the scheme would fail.

### **5.8 WORK PACKAGE 4: CONCLUSIONS**

The success of a PES scheme is predicated on there being four main actors; the buyers, the sellers, the broker and the knowledge providers. Analysis of the Milford Haven and Cleddau catchments shows there is a big enough pool of sellers to sustain a PES scheme whilst the EEP and RAG, as well as other groups can readily perform the role of knowledge provider.

The role of broker is more complicated and changes depending on the type of PES scheme chosen. There are a number of organisations within the area which could perform such a role, however initial discussions with these bodies has shown an initial reticence which is understandable as so many important points have yet to be

decided. It appears likely however, that one or more organisations would be able to perform the role of a successful broker.

The buyer remains the one main element of a PES scheme that has not yet been satisfactorily resolved. Initially there appeared to be sufficient potential buyers, especially within the Port of Milford Haven and surrounding areas. However after analysing the available information further, it is clear that the number of buyers that would move from being a potential buyer to an actual buyer is very small.

Much of this is due to the focus on nitrate which prevents organisations that could join a scheme from doing so because their activities will not result in an increase to the nutrient load in the waterbodies. However, it is also because there simply isn't sufficient activity within the catchments creating increased nutrient loading levels to stimulate and maintain a PES scheme.

As there is not obvious solution to this lack of buyers it is likely to inform the type of PES scheme ultimately proposed.

## **6 WORK PACKAGE 5**

### **6.1 INTRODUCTION**

The research and analysis undertaken for the previous work packages demonstrates the potential benefits of instigating a PES scheme in the Milford Haven and Cleddau Catchments. After suggesting two possible options in WP4 this section outlines the structure of a Reverse Auction scheme that we believe the evidence shows is likely to deliver the best chance of successfully reducing nutrient loading in the waterbodies.

The main benefit of a reverse auction in the Pembrokeshire context is that the market is driven by those who provide the funds and is therefore not dependent on the numbers or scale of buyers. As indicated previously the size and number of buyers has always appeared to represent a potential barrier to successful PES schemes in Pembrokeshire. Though there are disadvantages (namely the source of the funding) the ability to run a scheme without any buyers in the traditional sense outweighs the other concerns.

### **6.2 REVERSE AUCTION PROCESS**

#### **6.2.1 Introduction**

Though Work Package 4 provided some detail about reverse auctions the following section provides a greater level of detail of how such an auction might work in Pembrokeshire. Whilst some very specific suggestions have been detailed below it will be up to any pilot / live scheme to identify which would work most effectively in the context of the Milford Haven and Cleddau catchments.

#### **6.2.2 Reverse Auction Process**

A reverse auction is where the roles of buyer and sellers are reversed – the bidder is the seller and not the buyer. It is a relatively simple process which at its most basic is characterised by organisations interested in a specific outcome contributing funds to an auction process where the winning bid generally provides the greatest value for money not the highest price as is typical in a normal auction. Most bids are different and reflect the variation of sellers that exist, each bid is weighted by the sellers themselves depending on the service the seller is proposing or the measures they are agreeing to put in place. Many reverse auctions occur online, and tend to be either open or sealed bids with one or more bidding rounds.

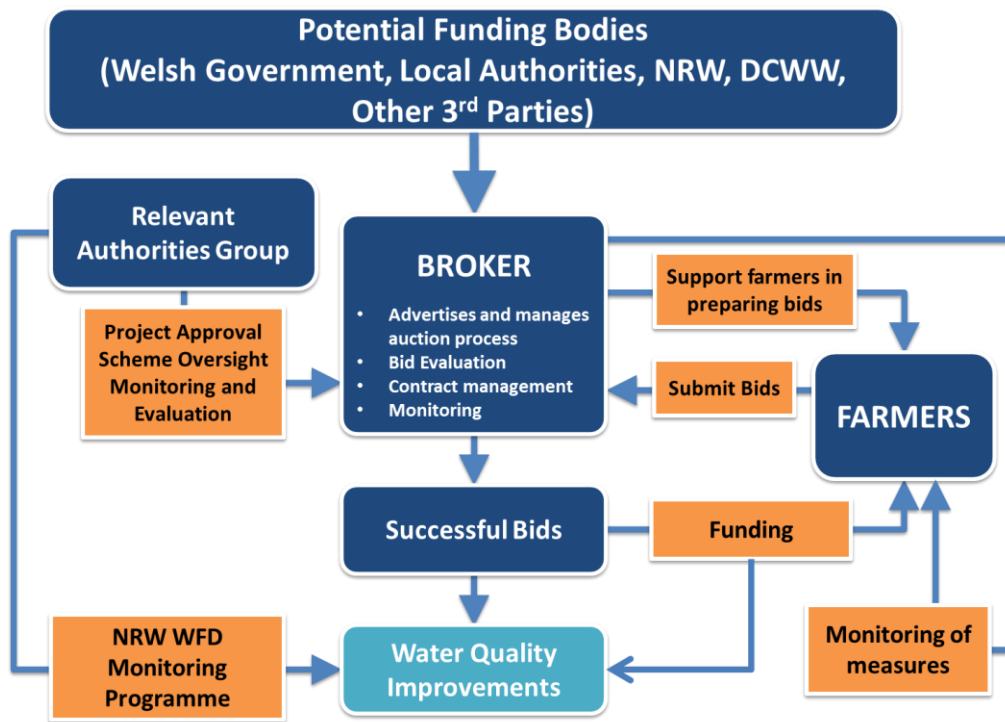
A reverse auction has the advantage of utilising competition between those seeking the contracts in order to reach an economically efficient outcome. Consequently, those farmers who find it the cheapest to undertake pollution activities are more

likely to be successful in the auction process. This however, can dissuade potential participants as profit margins can easily be reduced when sellers are forced to lower prices to compete with other sellers. The reduction in costs and hence increase in value for money is often cited as an advantage of the scheme yet it must also be recognised that it can be seen as a disadvantage to achieving meaningful reductions in nutrient loading if sellers cannot identify how they would reduce costs or increase profitability via such a scheme.

The key to a reverse auction is that it requires Sellers to determine their own price for implementing the land management measures (which may include reducing yields, reducing stock numbers, increasing unproductive land etc.) which will be different for each farmer. By having to decide how much they are willing to accept in a competitive setting (because other landholders are also bidding), the landholders must consider seriously the relative values of the land in both its current and future managed states.

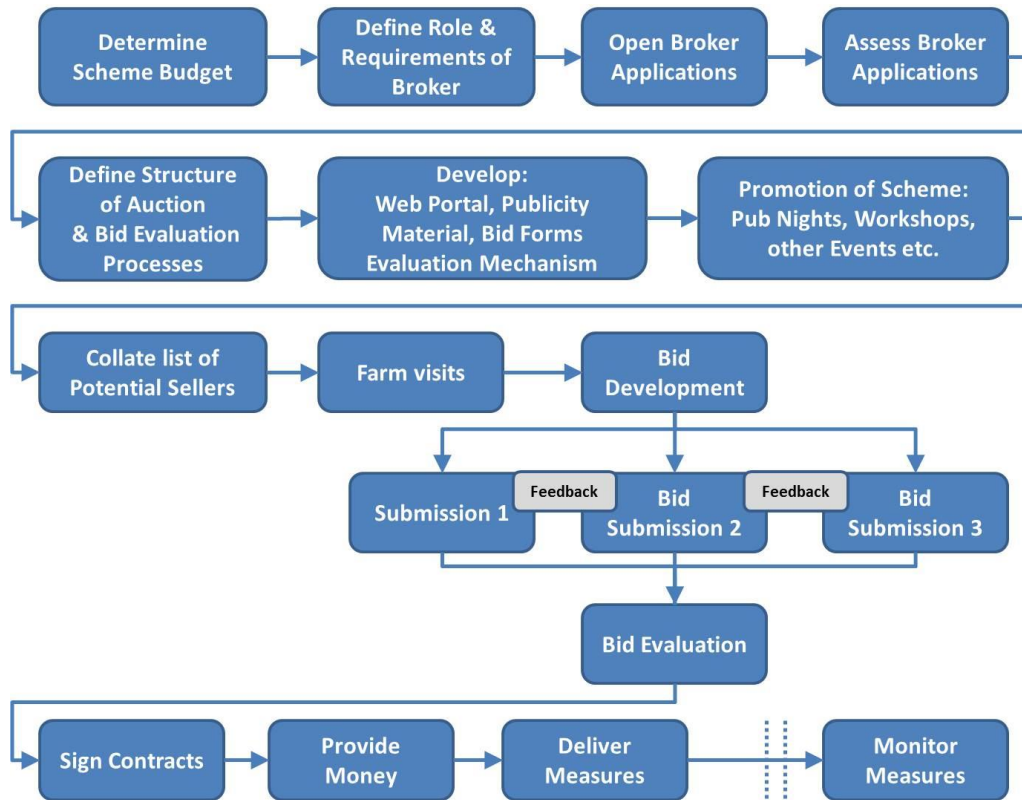
There may also be additional advantages, both in terms of value for money and environmental benefits, if groups of Sellers are encouraged to bid together. Benefits are compounded when delivered at a landscape scale, rather than at an individual farm scale and these joint bids should be encouraged wherever possible, especially if the benefits could be delivered at a sub-catchment scale. Joint bids also allow parties to apportion risks through negotiation, though the process of joint bidding would need to be carefully managed by the Broker and RAG.

Figure 15 below illustrates a potential reverse auction structure whilst Figure 2 shows the process in more detail.



**Figure 15: Potential Structure of a Reverse Auction**

The figure above shows a simplified method for how a reverse auction could operate, however in practice such a scheme would be more complex. Each stage of such a scheme has been outlined in Figure 16 and below.



**Figure 14: Reverse Auction Flow Diagram**

1. Determine scheme budget

All organisations with an interest in reducing nutrient loading should identify the level of funding they can contribute. This should then be combined to provide the overall scheme budget for the first auction.

2. Define role etc. of broker

As has been mentioned elsewhere the need for an independent broker is clear, however, the role of such a body needs to be defined in the context of this scheme. It is recommended that this role is defined by the RAG group with external assistance if needed

3. Open broker applications

As no single organisation, capable of operating as a broker, has been identified during this work it is proposed that all interested parties should submit an application to be considered for the role. This should detail their expertise in undertaking such a role including but not limited to: knowledge of the catchment; knowledge of buyers and sellers, ability to negotiate complex deals, a track record of stakeholder engagement; experience of managing large amounts of capital; experience of managing legal agreements;

and ability to remain impartial.

4. Assess broker applications

It is recommended that the applications for the role of broker are assessed by the RAG with expert financial and legal assistance when required.

5. Define structure of auction and evaluation process

Though this work has recommended the structure and way such a scheme would work it is recommended that the Broker and RAG work through the suggested process and amend wherever necessary. This will then ensure that the final structure is the one most likely to deliver success

6. Develop administrative functions to assist auction process

Once the level of funding and the broker have been identified it will be necessary to develop the administrative tools that will allow the scheme to function. It is recommended that this is undertaken by the Broker, with external assistance where required, with the RAG providing an oversight function. All material should be made available to stakeholders as early as possible to gather feedback and improve if necessary

7. Promote scheme

This should be undertaken by all stakeholders however it is suggested that the majority of this work is undertaken by the Broker. Any and all techniques should be used to increase knowledge and understanding of the scheme amongst stakeholders (including the general public) to provide the greatest number of buyers and sellers possible. A related but distinct element of this work will be for the RAG group (and others where required) to promote the scheme within their own organisations. This will help for a number of reasons not least the fact that it might increase the scheme budget if other business areas can see the potential benefits to their objectives (i.e. multiple benefits over and above reducing nutrient loading).

8. Collate list of potential sellers

During all stages of the process outlined above, it is recommended that the Broker collates a list of sellers. This should help identify the level of interest in the scheme (and allow for changes in approach to be made if there is little appetite) as well as the likely level of load reduction that might be achievable.

9. Farm visits

Whilst one of the benefits of a reverse auction is a reduction in the level of engagement with sellers which reduces scheme costs it is suggested that in the context of the Milford Haven and Cleddau catchments a greater level of engagement would be beneficial. The Frist Milk scheme has demonstrated the value of one to one visits and due to the loading problem it is likely that a skilled broker would be able to deliver greater reductions through using more land management measures than would be likely via the farmer alone. It would not be necessary to visit every single Seller however it is recommended that this option is provided where necessary, at least for the first auction.

#### 10. Bid development

At a pre-determined date the bidding process would be opened and all interested Sellers would be responsible for developing and submitting their bids. It is suggested that once the bidding process is live the Broker is barred from providing any further assistance to Sellers other than general administrative issues. Based on other similar schemes it is recommended that the process includes more than one bidding round whereby the Broker can provide feedback on individual bids and provide an opportunity for the Seller to amend their submission. This ensures the process is as fair as possible but also can help to increase the value for money as bids are re-worked, generally with lower costs or more measures included, in the expectation of receiving the funding.

#### 11. Bid evaluation

The Broker would be responsible for evaluating all bids and recommending successful bidders to the RAG. The RAG would not have a role in confirming the successful bidders but would be required to evaluate the bidding process and confirm that it had been transparent and fair and undertaken along the previously accepted methodology.

#### 12. Sign contracts and provide funding

All successful bidders would be required to sign legally binding contracts before receiving their funds. This would include the conditions of delivery especially the dates by which the management options needed to be in place. Once all contracts are signed the Broker would be responsible for transferring funds probably on a yearly cycle (though this is something that would need to be agreed during the development of the scheme).

#### 13. Deliver measures

Over the period of their agreement the successful bidder would be required to deliver at least all the measures they included in their bid. It would be their responsibility to maintain relevant records and evidence as well as informing the Broker of any problems. If Sellers looked to drop out from the scheme it would be the responsibility of the Broker to fill that capacity with other Sellers in order to deliver the continual decline in loading that is required.

#### 14. Monitor measures

As mentioned previously in this report the success of this scheme will be predicated on robust monitoring programmes being set up (and funded) from the outset. Once monitoring programme will need to be undertaken by the Broker and should involve the auditing of all successful Sellers to ensure that the measures they are being paid to deliver are in place. The scheme should include the ability to sanction any Sellers who are not delivering as agreed

### **6.2.3 Bidding Process**

As mentioned previously the reverse auction is a relatively simple process consisting of a defined budget being allocated to sellers via a competitive bidding process in which sellers would enter bids for funding a range of N reduction activities.

Sellers would construct their bids by identifying, from the 100 or so measures provided by ADAS what activities they would be willing to deliver for N reduction on their farm, before proposing the size of grant that they would require in order to deliver this work. It is suggested that the broker works closely with the sellers at this point to ensure the bids are focussed and likely to provide the benefits being sought.

The list of eligible options would be made available to farmers via a number of sources (website, handouts and events, post). and they would need to complete an order to submit a bid. It is recommended that the application process is on-line and sellers would be supported by the Broker.

In order to assist with the administration and scheme management it is suggested that the application process is undertaken through a secure bidding facility on a custom web portal. Other similar schemes such as the Fowey PES scheme successfully used such a system and noted that in particular bids submitted via the portal could be pre-checked by the software for completeness and errors ensuring only valid bids were entered by participants. In addition, bids submitted

electronically could be processed automatically, reducing the need for administrator time in handling paper bids received through the post<sup>41</sup>.

Whilst online applications have some obvious benefits it would not be fair to make this the only way to apply as this would discriminate against sellers who did not have the internet. The same form would be available to all sellers irrespective of whether they were completing it electronically or by hand and the timing of the auction would prevent discrimination against postal submissions to ensure the auction remained transparent and fair.

#### **6.2.4 Likely Role of Funding Bodies**

As was identified in WP4 one of the main issues with a reverse auction is the need for a fixed pot of money to fund the auction(s). It is difficult to identify how large each 'pot' for an auction would be but in the context of this scheme it is likely that it would need to be well over £100,000 and probably closer to £1,000,000. This level of funding requirement tends to place the burden of providing funding onto larger public sector bodies or significant private sector developments.

However, it is also worth noting that the funding does not need to originate with one organisation, and it is often better when multiple funders are involved. Currently there is no clear idea of what organisations might be willing to provide money though Welsh Government, Dwr Cymru Welsh Water, Pembrokeshire County Council, the National Park and NRW naturally all appear to be the main contenders. The appetite for this has not yet been adequately identified and needs to be checked during any subsequent stages of the scheme's development.

The potential for wider stakeholders to act as funders should not be ignored and money originating in the private sector would help to reduce the reliance on the shrinking pot of public sector funds. The ability to draw in other funders will ultimately rest on whether the additional benefits of the scheme can be adequately communicated. If they can, and the cost would be lower than alternative activities, then it would clearly make financial sense for the wider stakeholder to contribute to this scheme.

#### **6.2.5 Broker Role and Support To Farmers**

As outlined in the previous section the role of the broker is crucial in a PES system. In the context of Pembrokeshire the broker would be expected to manage the auction mechanism; issue a call for bids; provide information about the procedure and rules associated with the auction; assist landholders to develop their individual

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<sup>41</sup> Day, B., Couldrick, L. (2013) *Payment for Ecosystem Services Pilot Project: The Fowey River Improvement Auction* (Defra London)

management plans; provide information on costs to encourage realistic and feasible bids; manage the bid evaluation process; administration; and monitoring and enforcing the delivery of the land based measures.

The specific details of how the broker would function cannot be identified at this stage however one of the main requirements would be the ability to hold funds and manage contractual obligations for a maximum of 10 years. This is would be a major undertaking for an organisation and the EEP / RAG would need to be satisfied that any organisation putting itself forward for this role could satisfy these criteria as a minimum.

### **6.2.6 Outline Contractual Conditions**

To be eligible for inclusion in the scheme it is suggested that sellers must agree to certain conditions, similar to the ones listed below. These have been amended from the current Glastir Rules Booklet.

- The seller must be a registered customer with the Welsh Government and have been issued with a Customer Reference Number (CRN)
- The seller must have registered all of their land with the Welsh Government's Land Parcel Identification System (LPIS)
- The seller must be the sole claimant of European Aid schemes (e.g. Basic Payment Scheme and Glastir) on the land
- The seller must have management control over the land for the duration of the contract (10 years), alternatively a Landlord Indemnity arrangement must be in place
- Only field parcels located in the Cleddau and Milford Haven catchments will be eligible
- Field parcels already under another scheme (e.g. Glastir) may be eligible for inclusion but only if the measures included under this scheme deliver additional benefits or different benefits to that already being achieved through the other scheme
- Land designated as a SSSI, SPA, SAC, Ramsar or NNR can be included within the scheme but the measures put in place must not conflict with the management requirements of the protected area. It is a legal requirement to obtain written consent from NRW, prior to entering the scheme when Management Options are located on statutorily protected land
- If after joining the scheme land is transferred or sold the original signatory may be subject to financial penalties and / or having to repay money (if measures have been paid for but not implemented).
- If land is transferred or sold the new occupier can decide to take over the PES commitments for the remainder of the contract period.

- In order to qualify for the scheme sellers must agree to periodic inspections of the measures to monitor delivery and identify levels of success.
- The seller must maintain all records and information to evidence that all required undertakings have been achieved.
- At all times the seller must continue to meet all Cross Compliance requirements. If Statutory Management Requirements or Good Agricultural and Environment Conditions are not met this may impact ongoing involvement in the scheme

In addition, it is likely to be necessary to provide information on land that is not eligible including:

- Land that is located outside Cleddau and Milford Haven catchments.
- Field parcels / part parcels that are subject to shared grazing.
- Field parcels that are being used to claim for European Common Agricultural Policy payments by another farmer.
- Developed land, e.g. permanent caravan sites, golf courses.
- Field Parcel / part parcel less than 0.1 hectares

#### **6.2.7 Bid Evaluation**

Bids would be evaluated by the broker(s) on the basis of value-for-money, with bids offering higher value-for-money being considered for funding before bids offering lower value-for-money.

A bid's value-for-money would probably be calculated using a formula that takes account of the number of measures proposed (and consequently the likely N reduction), the type and quantity of capital works, and the farm's location in the catchment, although this latter one may not be included in the final proposals.

To be considered eligible for funding, bids must exceed a pre-set minimum value-for-money threshold (which will take into account maintaining profitability). Farmers would be able to improve the value-for-money of their bid by agreeing to deliver certain measures for less than the projected cost (i.e. they do not apply for 100% of the projected funding requirement if they think the measure can be delivered more cheaply).

All bids would be ordered according to their value for-money and bids would be accepted for funding up until the point at which the money runs out or the value-for-money threshold is reached. If the latter is reached before the former, unsuccessful sellers would be given an opportunity to re-evaluate and re-submit their bids to try and secure some of this underspend.

### **6.2.8 Relevant Authorities Group**

The RAG will retain oversight of the whole process and ensure that the broker delivers a transparent and fair scheme. The RAG will not however, be visible in the auction process and will not have any input into the day to day management of the scheme.

If the scheme is successful and expands beyond a traditional reverse auction there will also be a role for the RAG to provide the permitting and planning permission drivers to bring additional buyers into the scheme. This will be an important consideration if the scheme intends to move from a majority publicly funded scheme to a majority privately funded scheme.

## **6.3 HYBRID SCHEME**

As detailed in Work Package 4 one of the main weaknesses of a reverse auction is the need for a funding pot. Typically in similar schemes this is either public or quasi-public (e.g. water company) money, and for a scheme looking to develop a market based solution a reliance on public funding would be a potential weakness. However, this weakness was considered to be less of a threat to implementing a scheme than a lack of buyers is to a more traditional ‘nutrient trading’ approach within Pembrokeshire.

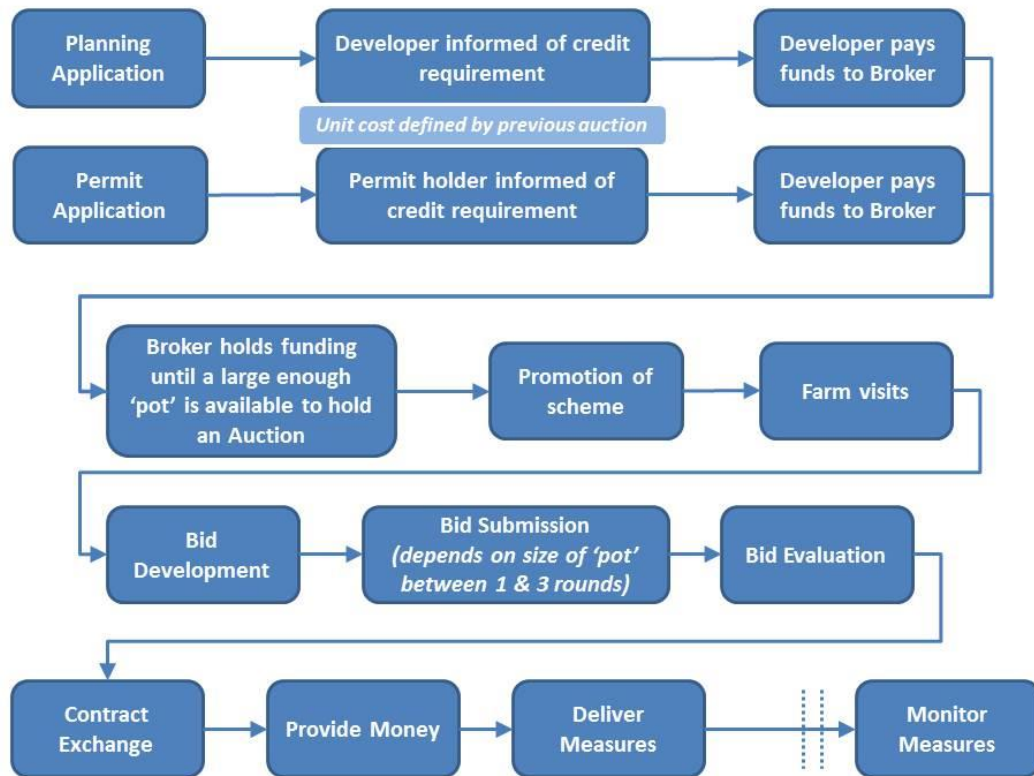
As a result, further research was undertaken on a third option of a hybrid scheme, where the best elements from nutrient trading and reverse auctions are combined. It is envisaged that in Pembrokeshire this would see an element of the funding pot being provided by public funds (as with a reverse auction) but as and when other buyers (most likely to be industry or developers) require permits or planning permission they would be required to provide funds / buy credits which could then be auctioned off.

Over time, if sufficient alternative buyers were available the burden of financing the periodic auctions could move from the public to the private sectors. This would not preclude organisations such as Welsh Government or Dwr Cymru Welsh Water retaining an interest and providing funding to increase the scheme budget if required but it ensures a more equitable split of funding.

A flow diagram for a possible hybrid scheme structure is outlined below. It is similar to the standard reverse auction shown in 24.2 with the exception of the front end. In this scheme whenever a permit or planning application is submitted the submitting body would be informed of the cost of offsetting their impact and they would pay these funds to the Broker. Once the funds have been paid this removes any liability

from the Buyer for reducing nutrient levels. The broker would hold the funds until a sufficiently large budget was available to hold an auction.

As detailed above, any other organisation could supplement the budget provided by the Buyer by providing additional funds. These would be secured by Sellers in the same way, irrespective of source, and it would be the role of the Broker to ensure that the measures being put in place delivered sufficient savings to reduce nutrient loading in the rivers.



**Figure 17: Possible Hybrid Scheme Flow Diagram**

## **7 MONITORING**

### **7.1 INTRODUCTION**

An integral part of a successful PES scheme is a robust and ongoing monitoring programme. This programme should not just focus on monitoring changes in water quality but should also ensure that the measures which were funded via the auction are being put in place by the sellers. Further details of the suggested monitoring regime are outlined below.

### **7.2 MONITORING OF MEASURES**

Due to the predicted length of the contract (10 years, probably with a potential break at year 5) a structured monitoring plan will need to be implemented. It is suggested that the Broker, or an alternative suitably qualified organisation undertakes an inspection of at least 10% of schemes per year. During the initial or pilot phases it is recommended that Depending on the content of individual schemes, the inspections should focus on at least 50% of the measures to be delivered by each seller that received the most funding, and the measures that will deliver the most benefits before other This monitoring would be non-negotiable and any sellers not willing to allow such monitoring would be prevented from continuing with the scheme.

### **7.3 WATER QUALITY MONITORING**

#### **7.3.1 Long Term Monitoring of the Effectiveness of Mitigation Measures**

In order to understand if the applied mitigation measures are effective, particularly with respect to agriculture, a long term monitoring plan is required. Though WFD monitoring is ongoing in the catchments it is suggested that this is augmented with a sufficiently detailed programme to allow changes to be identified over the entire catchment. In addition, marine sampling would be required to understand the ongoing contribution from the marine environment to the estuary. A draft monitoring proposal is presented below.

#### **7.3.2 Water Quality Monitoring – Test Catchment**

One of the most effective ways of demonstrating scheme success is through the selection of a relatively undisturbed sub-catchment which can provide a baseline against which the changes in this river and other waterbodies can be better understood. This is especially important if the effectiveness of the scheme needs to be demonstrated quickly.

To provide the greatest value a test catchment would ideally require all farms to be active in the scheme. This would allow stakeholders to begin to understand what

measures might be the most effective as hopefully changes in leaching rates as a result of the measures put in place would be relatively obvious in the water quality samples. This is also a reason why all farms need to be involved as it becomes more difficult to identify the cause of changes in water quality when you cannot know for certain what is causing the change.

It is suggested that once measures and location of application are known that a farm specific monitoring network is set up.

This would involve establishing routine water quality monitoring points on rivers within the catchment. Points would be established upstream and downstream of farms in order to capture upstream quality and downstream quality (which includes runoff from the surrounding land).

Water quality at these sites would be sampled on a monthly or weekly basis. Additionally wet weather sampling at these sites would also be undertaken in order to characterise the runoff quality from the land and how this varies during a storm. The sampling should be undertaken regularly throughout a storm event and may be undertaken by hand or by using an autosampler.

In order to capture a greater range of qualities this wet weather monitoring should cover all seasons, for example after application of nutrients to land or after a prolonged dry period. Key to this monitoring is the duration. Nutrient sampling should be undertaken for a sufficient period before initiation of the nutrient reduction measures in order to establish a baseline set of conditions to compare the impact of the measures against. The duration of monitoring after the measures have been initiated should be agreed prior to the start of the study.

Based on initial evaluation a catchment in the Western Cleddau has been identified as a potential candidate. It contains a range of mixed habitats and a range of land uses including grassland, arable, upland and woodland. In addition, it contains a small number of farms that could easily be targeted for inclusion in the scheme, and has very little significant discharges, the only ones being a few septic tanks. Finally, there are a number of different waterbodies that can be monitored (the top of the catchment, tributaries and the confluence with the Western Cleddau itself) providing an ideal range of data with which an accurate assessment of the change in nutrient loading can be assessed.

The catchment is situated around the Spittal Brook, near Ambleston, Spittal and Wallis (see Figure 18). There may be alternative catchments that could also perform this function, however the most important consideration is that at least one catchment is chosen and then monitored.

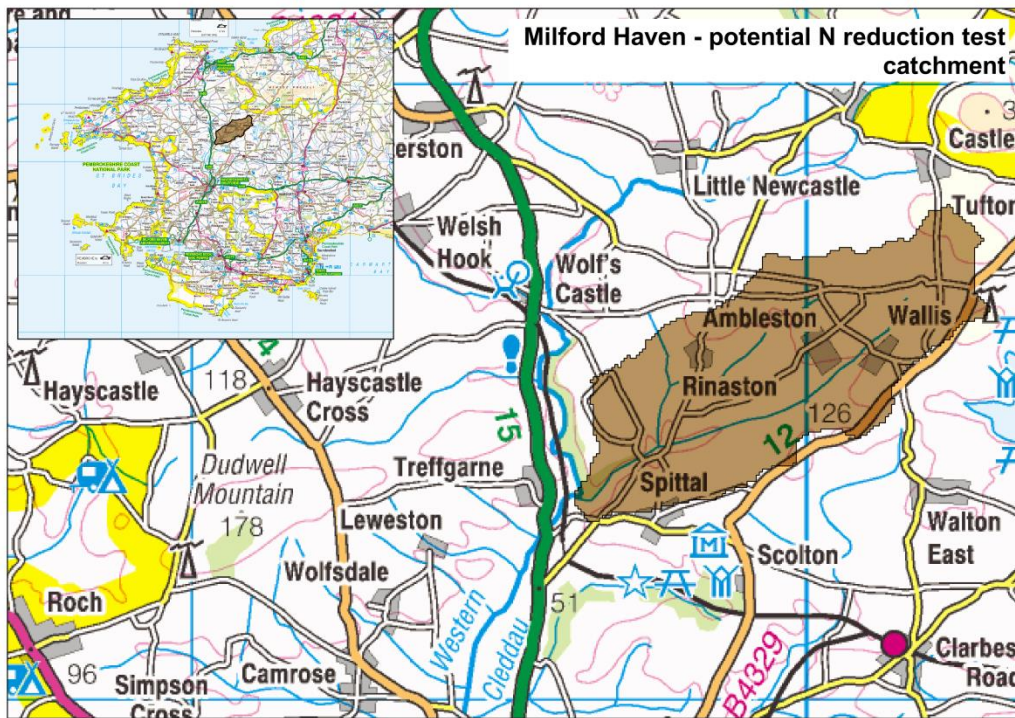
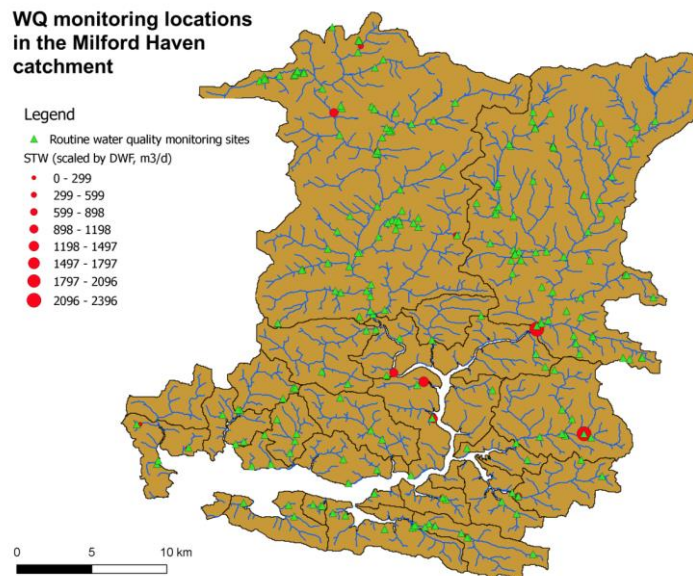


Figure 18: Possible Test Catchment for Long Term Monitoring

### 7.3.3 Water Quality Monitoring - Rivers

In addition to a test catchment routine river water quality monitoring is also required. The current spatial distribution of routine water quality monitoring points in the Milford Haven catchment is shown in Figure 19.



**Figure 19 Natural Resources Wales routine water quality monitoring points in the Milford Haven catchment**

For future long term monitoring of nutrients within the system, in response to the implementation of mitigation measures, regular analysis of all the suitable routine water quality monitoring points should be undertaken. Although they are likely to be only limited temporal resolution they will provide a broad assessment of nutrient changes throughout the catchment. Expansion of the routine monitoring network should also be considered to cover parts of the catchment found not to be covered by the current network of routine monitoring points.

As with the test catchment we would recommend sampling on a monthly or weekly basis with at least some locations also being sampled during storm events. The exact number of sites to be monitored should be established when the programme of measures and their locations for application are known. Furthermore, the number of samples should be based on the types of measures applied and where possible several monitoring sites should be established per type of measure in order to understand the effectiveness of the measure under different land use conditions. If many different types of measures are used then sufficient number of sample sites should be established to cover as many of these measures as possible.

**7.3.4 Water Quality Monitoring – Estuary and Marine**

In order to understand the long term changes in nutrient loading in the estuary marine water quality samples are required. It is not known if any monitoring is currently undertaken within the estuary. If monitoring is undertaken this data should be requested and analysed on a regular basis.

If possible samples should be taken at flood slack and ebb slack, the points where the marine dominance in the estuary are at their greatest and lowest respectively. This will allow the impacts of fluvial and marine nutrients to be elucidated if this is possible. Where possible marine water quality samples should be undertaken on the same day as river water quality sampling at measures farms.

**7.3.5 Sewage Treatment Works Discharges**

Long term monitoring of STW discharges is relatively simple and involves obtaining current data for each STW discharging (Figure 19) into the estuary on a predefined basis from Dwr Cymru Welsh Water and comparing this with long term trends in the data.

### **7.3.6 Other Discharges**

Other discharges within the catchment include industrial and private discharges, particularly those industries along the Haven itself and the urban areas. Ongoing monitoring of these discharges would be undertaken in the same manner as for STW discharges, namely by obtaining the most up to date data, the inclusion or removal of any discharges and analysing these for any changes.

Previous work (Natural Resources Wales, 2014) has identified that aerial deposition of nitrogen from some industrial units along the estuary banks contribute to the nutrient loading, although its impact was negligible. For the purposes of this study aerial deposition of nitrogen will be neglected and the impact assumed to be negligible.

## **8 WORK PACKAGE 6**

### **8.1 INTRODUCTION**

The aim of the final work package was to develop a business development plan for whatever scheme type was chosen. This included evaluating the business case for implementation and identifying the financial opportunities in the study area.

In terms of the business case for implementation there is a clear case to be made for implementing a PES scheme in order to reduce nutrient loading in the Milford Haven and Cleddau Catchment. However, what has not yet been agreed is whether the cost of any scheme is worth the financial input when the problem appears to be constrained to algal mats on a small number of SAC features. The evidence from this work has been provided in this report in order that this decision can be made based on the most appropriate and robust evidence.

In addition, the financial opportunities in the study area have not been specifically identified mainly because an additional pilot study is required in order to move such a scheme forward. Only through a pilot study would this kind of information be adequately identified and without this it is hard to make the case for further work in this area.

The Table below details some ideas for a pilot proposal that could be put forward to funding bodies to identify whether there is any appetite to fund a proposal to identify whether a PES scheme is going to be achievable in Pembrokeshire.

**Table 5: Proposed Business Plan**

Task List	Support / Administration Costs	Capital Costs	Timescales
1. Determine Scheme Budget	<b>£5,000</b> <ul style="list-style-type: none"> <li>Advocating the scheme to colleagues and other stakeholders</li> <li>Presenting the scheme mechanisms to stakeholders</li> <li>Supporting decision makers by providing technical support / information</li> <li>Calculate likely return on investment (in terms of nitrate reductions) and identify most appropriate catchments for targeting</li> </ul>	<b>£1,000,000</b> (this is suggested as the minimum value to achieve meaningful reductions in the catchment  This could be supplemented by third parties through, for example, catchment based approach (e.g. DCWW, local authorities).	0 – 3 months
<b>Total timescale for this phase: 3 months</b>			
<b>“Go / No Go” Decision Point 1</b>			
2. Define Priority Areas	<b>£2,000</b> <ul style="list-style-type: none"> <li>This is a nominal figure included to reflect that whilst this task has mainly been completed under current phase of work there may be a need to further refine the outputs during a pilot</li> </ul>	n/a	Month 1 after Go / No Decision
3. Define Baskets of Potential Measures and Test Appropriateness with Partners	<b>£5,000</b> <ul style="list-style-type: none"> <li>This is a nominal figure included to reflect that whilst this task has mainly been completed under current phase of work there may be a need to further refine the outputs during a pilot</li> </ul>	n/a	Month 1 after Go / No Go Decision
4. Identify Broker(s)	<b>£10,000</b> <ul style="list-style-type: none"> <li>Identify and formalise legal and banking requirements of a broker</li> <li>Develop and support an application process</li> <li>Review broker applications for most suitable candidate(s)</li> </ul>	<b>£5,000 - 25,000</b> <ul style="list-style-type: none"> <li>Set up costs and other costs associated with identifying and securing a broker or brokers.</li> <li>Budget depends on easy of locating broker and work to ensure legal entitlement to distribute monies.</li> </ul>	0 – 6 months after Go / No Go Decision
<b>Total timescale for this phase: 6 months</b>			
<b>“Go / No Go” Decision Point 2</b>			
5. Define Mechanism for Reverse Auction	<b>£10,000</b> <ul style="list-style-type: none"> <li>Whilst a possible structure for a reverse auction has already been developed this would need to be refined</li> <li>Facilitation of events</li> <li>Farm visits to explain and engender enthusiasm</li> <li>Liaison with RAG</li> </ul>	<b>£5,000 – 25,000</b> <ul style="list-style-type: none"> <li>Creation of handbooks and scheme materials</li> <li>Creation of publicity material</li> <li>Development of web portal</li> <li>Project approval mechanism</li> <li>Venues</li> <li>Budget depends on sophistication of brokering methods and procurement (eg. use of websites, communication strategy etc)</li> </ul>	0 – 3 months after Go / No Go Decision
<b>Total timescale for this phase: 3 months</b>			
<b>“Go / No Go” Decision Point</b>			
6. Monitoring and Evaluation of Approach (Magenta Book compliant):	<b>£25,000</b>	n/a	3 months from start of whole process to set up the evaluation framework
<ul style="list-style-type: none"> <li>Process impacts</li> <li>Economic evaluation and Value for Money</li> </ul>			
7. On site Water Quality Monitoring, Audit of Measures	<b>£25,000 – (set-up and first 2 year costs)</b>	<b>£50,000</b>	<ul style="list-style-type: none"> <li>Appropriate monitoring is fundamental to</li> </ul>

<p>Implementation and Impacts of Scheme:</p> <ul style="list-style-type: none"> <li>• Baseline Condition</li> <li>• Environmental Changes</li> <li>• Delivery of Measures</li> </ul>	<ul style="list-style-type: none"> <li>• Staff costs</li> <li>• Reporting</li> <li>• Farm visits</li> </ul>	<ul style="list-style-type: none"> <li>• Monitoring equipment costs</li> </ul>	<p>the success of a PES scheme and it is proposed that this is started with Task 1</p> <ul style="list-style-type: none"> <li>• A benefits assessment as part of the economic evaluation will ensure that the applicability of the approach can be rigorously tested and its long term future assessed, in terms of public expenditures.</li> </ul>
8. Manage Auction and Deploy Capital	<p><b>£25,000</b> (for pilot or per auction)</p> <ul style="list-style-type: none"> <li>• Set up auction process</li> <li>• Support to farmers</li> <li>• Administration costs</li> <li>• Reporting to WG, RAG and others</li> </ul>	n/a	3 – 6 months after final Go / No Go Decision
<b>Total timescale for this phase: 6 months</b>			
<b>Total</b>	<b>£82,000</b> (for pilot stage)	<p><b>Reverse Auction Fund – £1,000,000:</b> subject to WG and other funders (e.g. DCWW, local authorities)</p> <p>Other capital items: <b>£60,000 – 100,000</b></p>	<b>Approximately 15 – 18 months from start to capital being deployed</b>
<b>Likely total per future auction</b> (if scheme progressed beyond the pilot phase)	<b>£25,000 - £30,000 per auction</b>	Other capital items: <b>£5,000 – 20,000</b>	<b>Approximately 3 - 6 months</b> (frequency of future auctions would be determined by rate of success of finding buyers / additional funding)

## 9 OVERALL CONCLUSIONS

Based on the current nutrient loading of the Milford Haven and Cleddau catchments, there is clear evidence of the need for a PES scheme, or at least that some effort is made to reduce the scale of nutrient loading in the catchment. Evidence gathered from the review of global initiatives and the Pembrokeshire case studies highlighted both good and bad practice and these lessons have been incorporated into the recommendations contained within this report.

The main conclusions and recommendations are that:

In the absence of any other desired values, the WFD standard for the **High / Good status boundary of Transitional and Coastal Waterbodies** should be chosen as the threshold to which nutrient loading should be reduced. This is a tough measure to meet and will require a significant land area to be included in the scheme; however it does provide a universally accepted figure that is easily defensible.

Due to the uncertainty over the number of buyers and whether there are sufficient to provide a constant throughput of money, it is suggested that a **reverse auction mechanism** is utilised. Although there are funding requirements and some of the benefits will be offset by increased Broker input (identified as important in the context of these catchments to maximise the selling capacity), it is considered that this type of scheme would be most likely to succeed.

It may also be advantageous to combine a bank and auction in a **hybrid scheme** in order to reduce the burden on public funding and if a significant number of buyers (or one large buyer) need to discharge planning or permitting requirements. In this situation, the buyer(s) could either co-fund the auction or could refund the costs of the funding body that initially paid thereby reducing the need for public money within the scheme.

In order to understand if the applied mitigation measures are effective, particularly with respect to agriculture, a **long term monitoring plan** is required. This should be sufficiently detailed to allow changes to be identified over the entire catchment.

Furthermore, a **monitoring programme will be required of the measures** implemented on farms within the scheme to ensure that the measures for which they have secured funding are delivered within the agreed timescale, and to the specification required. This is a key component of the monitoring of First Milk and it is recommended that it is a key element of this proposed scheme too.

It is vital that all stakeholders engaged in the scheme, irrespective of the form it takes, understand the absolute necessity of monitoring and evaluation. Adequate

funding should be made available (even if the monitoring is carried out as part of standard statutory monitoring) and the results should also be systematically recorded. The success of a PES scheme in Pembrokeshire can only really be judged on the reduction in N loading within the catchments. If this is not apparent after a sufficient monitoring period, the scheme would either have to fundamentally change or would have to be closed. However, choices such as this can only be made on the back of robust data and it is paramount that data are collected and monitored from now onwards to achieve the required robustness.

Finally, it is recommended that **a pilot / trial scheme should be tested** prior to any further investment. This should be funded and involved the complete process from identifying the funding pot to delivering measures on the ground. Most of the successful initiatives analysed had some form of pilot and without this step the prospect of failure is much higher. It is therefore recommended that any scheme is effectively planned and tested before it is launched.

This pilot should also include assessing whether there are alternative mechanisms for achieving the required loading targets. Whilst an innovative approach, utilising the market wherever possible, demonstrates leadership in this area by the EEP more traditional methods of reducing loading may actually be the best approach. This needs to be considered due to the size of the problem and the apparent gap between the value of a buying fund and the N reductions this would 'buy'. The **EEP should not be averse to combining approaches wherever possible** to deliver the headroom required.

Finally, what has not yet been agreed is whether the cost of any scheme is worth the financial input when the problem appears to be constrained to algal mats on a small number of SAC features. This is not a decision that can be resolved through this work or in this report but the problem should be discussed further during Task 1 of the business plan outlined above.



## **APPENDICES**

## **APPENDIX A: REFERENCES**

1. ADAS (2007) Diffuse nitrate pollution from agriculture: Strategies for reducing nitrate leaching. Defra, London.
2. Alison Milward Associates (2014) Defra PES pilot evaluation of the Pumlumon project.
3. Alvarado-Quesada, I., Hein, L. & Weikard, H. (2014) Market-based mechanisms for biodiversity conservation: a review of existing schemes and an outline for a global mechanism. *Biodiversity and Conservation*. 23 (1), 1-21.
4. Austen, E. & Hanson, A. (2008) Identifying wetland compensation principles and mechanisms for Atlantic Canada using a Delphi approach. *Wetlands*. 28 (3), 640-655.
5. Australian Government & Environmental Protection Agency (2007) Development of a water quality metric, for nutrient offsets for Moreton Bay, Queensland.
6. Bavarnick, A., Knight, C. & Stephenson, J. (2010) Habitat banking in Argentina: A feasibility assessment working paper. United Nations Development Programme.
7. Bavarnick, A., Knight, C. & Stephenson, J. (2010) Habitat banking in Latin America and Caribbean: A feasibility assessment working paper. United Nations Development Programme.
8. Bavarnick, A., Knight, C. & Stephenson, J. (2010) Habitat banking in Peru: A feasibility assessment working paper. United Nations Development Programme
9. Bennett, G., Carroll, N. & Hamilton, K. (2013) Charting new waters: State of watershed payments 2012. Washington, DC: Forest Trends
10. Bonn, A., Holden, J., Parnell, M., Worrall, F., Chapman, P.J., Evans, C.D., Termansen, M., Beharry-Borg, N., Acreman, M.C., Rowe, E., Emmett, B. & Tsuchiya, A. (2010) Ecosystem services of peat - phase 1. Report to Defra. Project code SPO572.
11. Brewer, T. R., Mant, J., Harris, J., Gill, A., Shaw, H., Burgess, P. J. & Farewell, T. (2014) Improving the River Lea in Luton for the local economy, society and environment. Final report to Defra. Cranfield University.
12. Briggs, B. D., Hill, D. A. & Gillespie, R. (2009) Habitat banking—how it could work in the UK. *Journal for Nature Conservation*. 17 (2), 112-122.
13. Bryan, G., Jonas, P., Money, R., Kite, D. & Bardon, R. (2012) Draft strategy for managing nitrogen in the Poole Harbour catchment to 2035.
14. Bull, J. W., Suttle, K. B., Gordon, A., Singh, N. J. & Milner-Gulland, E. (2013) Biodiversity offsets in theory and practice. *Oryx*. 47 (03), 369-380.
15. Bullock, C. (2013) ECORISK Chapter 6: Ecosystem services, impacts and synergies. In: *Environmental Liability, Resource Equivalency and the Valuation of Ecosystem Services*. Funded under the EPA Strive Programme.

16. Burgin, S. (2008) BioBanking: an environmental scientist's view of the role of biodiversity banking offsets in conservation. *Biodiversity and Conservation*. 17 (4), 807-816.
17. CCW (2005) Pembrokeshire Marine European Marine Site, Advice provided by the Countryside Council for Wales in fulfilment of Regulation 33 of the Conservation (Natural Habitats, &c.) Regulations 1994, Issue 1.0, Countryside Council for Wales.
18. CCW (2009) Pembrokeshire Marine European Marine Site, Advice provided by the Countryside Council for Wales in fulfilment of Regulation 33 of the Conservation (Natural Habitats, &c.) Regulations 1994, Supersedes Issue April 2005, Countryside Council for Wales.
19. Chandrasekharan Behr, D. Cunningham, E. M., Kajembe, G., Mbeyale, G., Nsita, S. & Rosenbaum, K. L. (2012) Benefit sharing in practice: insights for REDD+ initiatives. Washington, DC: Program on Forests (PROFOR)
20. Chesapeake Bay Foundation (no date) Nutrient trading fact sheet.
21. CIWEM (2013) A blueprint for carbon emissions reduction in the UK water industry. London, UK.
22. Cockerill, C. & Hutchinson, G. (2007) Lough Melvin nutrient reduction programme. Strand 3: Technical Report "To investigate the use of nutrient trading". Queen's University Belfast.
23. Conway, M., Rayment, M., White, A. & Berman, S. (2013) Exploring potential demand for and supply of habitat banking in the EU and appropriate design elements for a habitat banking scheme. European Commission.
24. Cook, D. & Clay, D. (2013) Marine biodiversity offsetting and habitat banking feasibility study. The Crown Estate.
25. Corrales, J., Melodie Naja, G., Rivero, R., Miralles-Wilhelm, F. & Bhat, M. G. (2013) Water quality trading programs towards solving environmental pollution problems. *Irrigation and Drainage*. 62 (S2), 72-92.
26. Davies, S. (2013) Biodiversity offsetting & habitat banking for Scotland: Notes from the workshop. Edinburgh Centre for Carbon Innovation.
27. Day, B. & Couldrick, L. (2013) Payment for Ecosystem Services pilot project: The Fowey River improvement plan. Defra, London
28. DECC New South Wales (2003) Hunter river Salinity Trading Scheme: Working together to protect river quality and sustain economic development.
29. DECC New South Wales (2009) The science behind BioBanking
30. Defra (2004) Mapping the problem: Risks of diffuse water pollution from agriculture. London.
31. Defra (2010) Biodiversity offsetting: Discussion material. London, UK.
32. Defra (2011) Biodiversity offsetting: Guiding principles for biodiversity offsetting. London, UK.

33. Defra (2012) Biodiversity offsetting pilots. Technical paper: the metric for the biodiversity offsetting pilot in England. London, UK.
34. Defra (2013) Biodiversity offsetting in England: Green paper. London, UK.
35. Defra (2013) Developing the potential for Payments for Ecosystem Services: An action plan. London
36. Defra (2013) Payments for Ecosystem Services: A best practice guide. London, UK.
37. Defra (2013) Realising nature's value: The final report of the ecosystem markets task force. Government Response. London, UK.
38. Defra (2014) Defra Payments for Ecosystem Services (PES) pilot projects: Review of key findings of rounds 1 and 2, 2011-2013
39. Doyle, M. W. & Shields, F. D. (2012) Compensatory mitigation for streams under the clean water act: reassessing science and redirecting policy. *Journal of the American Water Resources Association*. 1-16.
40. Drechsler, M. & Hartig, F. (2011) Conserving biodiversity with tradable permits under changing conservation costs and habitat restoration time lags. *Ecological Economics*. 70 (3), 533-541.
41. Drechsler, M. & Wätzold, F. (2009) Applying tradable permits to biodiversity conservation: Effects of space-dependent conservation benefits and cost heterogeneity on habitat allocation. *Ecological Economics*. 68 (4), 1083-1092.
42. Dunn, H. & Smith, C. (2014) Developing the potential for Payments for Ecosystem Services in England: Emerging lessons from practical application. [Presentation]. Defra.
43. Dunn, H. (2011) Payments for Ecosystem Services. Defra evidence and analysis series. London.
44. Dunnett, S. (2012) Can biodiversity offsetting follow in carbon's footprints? MSc thesis. Imperial College London.
45. Ecosystem market place (2013) Innovative markets and market-like instruments for ecosystem services.
46. Ecosystem markets task force (2013) Realising nature's value: The final report of the ecosystem markets task force.
47. EFTEC & IEEP (2010) The use of market-based instruments for biodiversity protection: The case of habitat banking. Technical report.
48. EFTEC (2010) The use of market-based instruments for biodiversity protection – habitat banking case studies.
49. EFTEC (2012) Innovative use of financial instruments and approaches to enhance private sector finance of biodiversity. European Commission.

50. Electric Power Research Institute (2014) Initiation to water stewardship credit auction [Poster].
51. Environment Agency (2009) Science report: Ecosystem services case studies.
52. Environment Systems & Countryside Council for Wales (2012) A practical application of SCCAN in Bridgend.
53. ESAWADI (2013) Work Package 5: Synthesis and policy recommendations.
54. FAO (2011) Payments for ecosystem services and food security.
55. Farley, J. & Costanza, R. (2010) Payments for ecosystem services: from local to global. *Ecological Economics*. 69 (11), 2060-2068.
56. FERN (2014) Briefing note 3: Biodiversity offsetting in practice. Gloucestershire, UK.
57. Ferreira, C. (2014) Biodiversity offset markets: current challenges and prospective developments: PhD thesis – executive summary. Coventry.
58. Flatt, V. B. (2014) C(r)ap and trade: The brave new world of non-point source nutrient trading and using lessons from greenhouse gas markets to make it work. *Houston Law Review*. 52 (1), 301-359
59. Foden, J., Brazier, P., Best, M., Scanlan, C. & Wells, E. (2010) Water Framework Directive development of classification tools for ecological assessment: Intertidal seagrass. UK TAG Report for Marine Plants Task Team, January 2010, Publ. UK TAG.
60. Forest Trends (2008) Payments for Ecosystem Services: Market profiles.
61. Forest Trends (2011) Laying the Foundation: An analytical tool for assessing legal and institutional readiness of PES. UNDP.
62. Fujita, R., Lynham, J., Micheli, F., Feinberg, P. G., Bourillón, L., Sáenz-Arroyo, A. & Markham, A. C. (2013) Ecomarkets for conservation and sustainable development in the coastal zone. *Biological Reviews*. 88 (2), 273-286
63. Gaylard, S. (2005) A tradeable rights instrument to reduce nutrient pollution in the Port waterways: feasibility study. On behalf of Environment Protection Authority, Adelaide.
64. Goldman, R. L. & Tallis, H. (2009) A critical analysis of ecosystem services as a tool in conservation projects. *Annals of the New York Academy of Sciences*. 1162 (1), 63-78.
65. Hannis, M. Sullivan, S (202) Offsetting Nature? Habitat banking and biodiversity offsets in the English land use planning system. Technical report. Green House, Weymouth, UK.
66. House of Commons (2013) Biodiversity offsetting: Sixth report of session 2013-14. Environmental Audit Committee.
67. Houses of Parliament (2011) Biodiversity offsetting. POSTNOTE.

68. Institute for water resources (1995) National wetland mitigation banking study: Technical and procedural support to mitigation banking guidance. Virginia, USA.
69. IUCN (2013) Independent report on biodiversity offsets. Environmental stewardship.
70. JBA Consulting (2013) Payments for Ecosystem Services: Canal & river trust pilot study. Defra, London.
71. Kerr, S., McDonald H. & Rutherford, K. (2012) Nutrient trading in Lake Rotorua: A policy prototype. Motu Note #10, Motu Economic and public policy research, Wellington.
72. MacEachern, K. (2013) Market-based instruments within the green economy. Conservation Ontario.
73. MacGillivray (2013) Payment for Ecosystem Services (PES) pilot on flood regulation in Hull. Final report, Defra, London
74. Madsen, B., Carroll, N. & Moore Brands, K. (2010) State of biodiversity markets report: Offset compensation programs worldwide. Washington DC: Forest Trends
75. Madsen, B., Carroll, N. Kandy, D. & Bennett, G. (2011) Update: State of biodiversity markets. Washington, DC: Forest Trends
76. Manale, A., Morgan, C., Sheriff, G. & Simpson, D. (2011) Offset markets for nutrient and sediment discharges in Chesapeake Bay Watershed: Policy tradeoffs and potential steps forward. US Environmental Protection Agency, Washington, DC.
77. Matzdorf, B. & Meyer, C. (2014) The relevance of the ecosystem services framework for developed countries' environmental policies: A comparative case study of the US and EU. *Land use Policy*. 38, 509-521.
78. McAfee, K. (2012) The contradictory logic of global ecosystem services markets. *Development and Change*. 43 (1), 105-131.
79. Meineri, E., Deville, A., Grémillet, D., Gauthier-Clerc, M. & Béchet, A. (2014) Combining correlative and mechanistic habitat suitability models to improve ecological compensation. *Biological Reviews*.
80. Mercer, D. E., Cooley, D. & Hamilton, K. (2011) Taking stock: Payments for forest ecosystem services in the United States. US Department of Agriculture.
81. MHWESG (2001) Milford Haven Waterway Environmental Surveillance Group Annual Report April 1999- March 2000, CCW Contract Science Report No 439.
82. Moilanen, A., Van Teeffelen, A. J., Ben-Haim, Y. & Ferrier, S. (2009) How much compensation is enough? A framework for incorporating uncertainty and time discounting when calculating offset ratios for impacted habitat. *Restoration Ecology*. 17 (4), 470-478.

83. Monk, K. A. (no date) Living Wales programme: Ecosystem understanding and future management project. Developing and embedding the ecosystem approach for the natural resource body. [Presentation] Environment Agency Wales.
84. Neatt, N. C., Bowron, T. M., Graham, J. M., van Proosdij, D. & Lundholm, J. (2011) Post-restoration monitoring (year 5) of the Walton River salt marsh restoration project. Nova Scotia Department of Transportation and Infrastructure Renewal.
85. Nemes, V., Plott, C. R. & Stoneham, G. (2008) Electronic BushBroker exchange: designing a combinatorial double auction for native vegetation offsets.
86. Newell Price, J.P., Harris, D., Taylor, M., Williams, J.R., Anthony, S.G., Duethmann, D., Gooday, R.D., Lord, E.I. and Chambers, B.J. Chadwick, D.R. & Misselbrook, T.H. (2011) An inventory of mitigation methods and guide to their effects on diffuse water pollution, greenhouse gas emissions and ammonia emissions from agriculture. Defra. Project number WQO106.
87. OEH New South Wales (2012) BioBanking review: Discussion paper.
88. Ohio EPA (2013) Ohio nutrient reduction strategy.
89. Osmond, D. L., Hoag, D. L., Luloff, A. E., Meals, D. W. & Neas, K. (2014) Farmers' Use of Nutrient Management: Lessons from Watershed Case Studies. Journal of Environmental Quality.
90. PCC (2013) Local Development Plan: Planning Pembrokeshire's Future (up to 2021), Pembrokeshire County Council.
91. PCNP (2010) Local Development Plan (end date 2021): Adopted Plan, Pembrokeshire Coast National Park.
92. Porras, I. (2010) Fair and green? Social impacts of payments for environmental services in Costa Rica. International Institute for Environment and Development. London, UK.
93. Porras, I. Grieg-Gran, M. & Neves, N. (2008) All that glitters: A review of payments for watershed services in developing countries. Natural Resource Issues No. 11. Institute for Environment and Development. London, UK.
94. Poulton, D. W. (2014) Conservation offset policy for Alberta: A comparative legal analysis. Graduate program in law thesis. University of Calgary.
95. PPF (2012) Pembrokeshire Local Housing Market Assessment, Local Development Plan, Planning Pembrokeshire's Future.
96. Quétier, F. & Lavorel, S. (2011) Assessing ecological equivalence in biodiversity offset schemes: key issues and solutions. *Biological Conservation*. 144 (12), 2991-2999.
97. Quétier, F., Wunder, S. & Lavorel, S. (2011) Habitat banking in France: Experimenting with a nascent PES framework for biodiversity conservation. [Presentation] Berlin, November 2011.

98. Quick, T., Reed, M., Smyth, M., Birnie, R., Bain, C., Rowcroft, P. & White, A. (2013) Developing place-based approaches for Payments for Ecosystem Services, URS London.
99. Quintero, J. D. & Mathur, A. (2011) Biodiversity offsets and infrastructure. *Conservation Biology*. 25 (6), 1121-1123.
100. Reed, M. S., et al. (2013) Peatland Code research project final report, Defra, London
101. Reed, M. S., Rowcroft, P., Cade, S., Savege, S., Scott, A., Black, J., Brace, A., Evely, A. C. & White, C. (2013) Visitor giving Payment for Ecosystem Service pilot final report, Defra, London.
102. Sattler, C. & Matzdorf, B. (2013) PES in a nutshell: From definitions and origins to PES in practice—Approaches, design process and innovative aspects. *Ecosystem Services*. 6, 2-11.
103. Short, C., Phelps, J., Henehan, D., Staddon, C., Wells, S. & Turvill, J. (2014) Cotswold catchment Payments for Ecosystem Services pilot: Catchment based approach collaborative project demonstrating the integrated local delivery framework, Defra project report NEO144, Defra funded round 2 PES pilot. CCRI: Gloucester.
104. SNES Consultants Ltd. (2012) Fish habitat banking in Canada: Opportunities and challenges.
105. SNES Consultants Ltd. (2013) Best practices for advancing the application of habitat conservation banking in Canada.
106. South Hook CHP (2013) Environmental Statement: Marine environment and ecology.
107. Stavins (2001) Experience with market-based environmental policy instruments. *Resources for the Future*. Washington, DC.
108. Sukhdev, P., Wittmer, H. & Miller, D. (2014) The Economics of Ecosystems and Biodiversity (TEEB): Challenges and Responses, in Helm, D. & Hepburn, C. (eds), *Nature in the Balance: The Economics of Biodiversity*. Oxford: Oxford University Press
109. Teklehaimanot, K. W. (2014) How is biodiversity offsets operation? A study of its governance structure, strengths and weaknesses and the process of institutionalising it in the UK. Master thesis. Norwegian University of Life Sciences.
110. The Tamar Plan (no date) Phase 1: Developing a shared catchment vision.
111. The wetlands initiative (no date) Measuring a test market for nutrient farming: Finding profits in the Illinois River watershed.
112. Treweek, J., ten Kate, K., Butcher, B., Venn, O., Garland, L., Wells, M., Moran, D. & Thompson, S. (2009) Scoping study for the design and use of biodiversity offsets in an English context. Final Report to Defra. Project number NEO801.

113. UK National Ecosystem Assessment (2011) Synthesis of the key findings. Cambridge, UNEP-WCMC.
114. Vaissière, A. & Levrel, H. (2015) Biodiversity offset markets: What are they really? An empirical approach to wetland mitigation banking. *Ecological Economics*. 110, 81-88.
115. van Teeffelen, A. J., Opdam, P., Wätzold, F., Hartig, F., Johst, K., Drechsler, M., Vos, C. C., Wissel, S. & Quétier, F. (2014) Ecological and economic conditions and associated institutional challenges for conservation banking in dynamic landscapes. *Landscape and Urban Planning*. 130, 64-72.
116. Vatn A., Barton, D. N., Lindhjem, H., Movik, S., Ring, I. & Santos, R. (2011) Can markets protect biodiversity? An evaluation of different financial mechanisms. Norwegian University of Life Sciences, UMB.
117. Vatn, A. (2014) Markets in environmental governance. From theory to practice. *Ecological Economics*.
118. Waters, R., Lusardi, J. & Clarke, S. (2012) Delivering the ecosystem approach on the ground – an evaluation of the upland ecosystem service pilots. Report to Natural England. Project code NERRO46
119. WAVES (2014) Designing pilots for ecosystem accounting. Working paper.
120. Waylen, K., Blackstock, K. & Holstead, K. (2013) Exploring experiences of the ecosystem approach. The James Hutton Institute.
121. Wells, E., Wilkinson, M., Wood, P., Scanlan, C. and Best, M. (2010) Water Framework Directive development of classification tools for ecological assessment: Macroalgae Species Richness. UK TAG Report for Marine Plants Task Team, January 2010, Publ. UK TAG.
122. Welsh Government (2012) Sustaining a living Wales: A Green paper on a new approach to natural resource management in Wales. Number WG13943.
123. Welsh Government (2013) Towards the sustainable management of Wales' natural resources. White paper. Consultation on proposals for an environment bill. Number WG19631.
124. WFD UK TAG (2008) UK Environmental Standards and Conditions (Phase2): Final, UK Technical Advisory Group on the Water Framework Directive.
125. Willamette Partnership & The Freshwater Trust (2014) Regional recommendations for the pacific northwest on water quality trading. For US EPA, Seattle.
126. Wynne-Jones, S. (2013) Connecting payments for ecosystem services and agri-environment regulation: an analysis of the Welsh Glastir Scheme. *Journal of Rural Studies*. 31, 77-86.
127. Wynne-Jones, S. (2014) 'Reading for difference' with payments for ecosystem services in Wales, *Critical Policy Studies*, 8:2, 148-164.

## APPENDIX B: EXAMPLE SCHEMES

### FOWEY CATCHMENT

The Fowey Catchment scheme looked to fund capital investments on farms in order to improve water quality in the River Fowey. The PES scheme was part of South West Water's Upstream Thinking Initiative. As part of that initiative, the Westcountry Rivers Trust had been charged with distributing money to farmers for capital investments delivering water quality improvements in certain strategically important catchments.

The Rivers Trust's advisors liaised with farmers in to identify projects eligible for funding through the scheme. Where projects were identified, farmers were offered a *fixed-price* deal in which South West Water would pay 50% of the costs of the capital investments.

The scheme was based around a reverse auction with £360,000 to distribute. The auction was a simple design where all farmers in the Fowey catchment were contacted and provided with a list of capital investments eligible for funding under the scheme. Farmers were asked to enter bids indicating which of those were required by their farm business and the grant they would need from South West Water to proceed with the investment. For each bid, an environmental improvement score was calculated based on how greatly the proposed project would improve water quality. The fund was extremely popular and oversubscribed, receiving bids for £776,000 of investment.

The auction stimulated competition between farmers by only funding bids that offered the best value for money for South West Water. In this case, 'value for money' was determined by dividing a bid's environmental improvement score by the grant request.

Bids were entered onto a secure website or via post. Bidding was open for six weeks with three rounds. Each farmer received feedback on the likely success of their bid during each round.

It has been estimated that the the Fowey River Improvement Auction delivered between 20% and 40% better value for money than the fixed-price alternative.

<http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=18245>

## **DRAFT STRATEGY FOR MANAGING NITROGEN IN THE POOLE HARBOUR CATCHMENT TO 2035**

An expansion of macroalgal mats fuelled by rising levels of nitrate and inorganic nitrogen compounds is causing a problem within Poole Harbour. It has failed to meet 'good ecological status' under WFD due to elevated nitrogen in harbour waters and has also failed to meet the SPA requirements of 'favourable conservation status' because of the extent of the microalgal mats.

76% of the nutrients originate with rivers, 7% direct discharges and c.17% from the English Channel. In total it is estimated that diffuse agricultural pollution contributes 86% of the loading to the harbour. Nitrogen loading is expected to peak at 2500 tonnes/yr in 10-20 years and it is predicted that it takes 30-35 years for diffuse nitrate to move through ground water into the harbour.

The strategy lays out clear target reductions namely - 1721 tonnes-N/yr. This reduction is made up of 700 tonnes-N/yr from agricultural sources and an additional 32-57 tonnes/yr adjusted for population growth in 2025 and 2035. Overall phosphorous reductions are planned to be achieved through adoption of Catchment Sensitive Farming measures such as: changing crops; adoption of winter cover crops in arable rotation; and 10% reduction in stocking density. Point source reductions are planned to be achieved through nitrate stripping at STWs and lowering operation rates, although this has high capital, operational and environmental costs. The scheme is also suggesting that all new development is nitrate neutral.

The success measures for the scheme are: the extent of algal mats with biomass >2kg/m is limited to <5% across Poole Harbour and <10% cover over individual mudflats over 5 year period. In order to achieve this the plan proposes the following mitigation has been proposed: purchasing high nitrate leaching land and replacing it with other land cover types, implementing management changes, and removing nitrate at STWs and requesting that developers purchase managed grassland or arable land and revert it to woodland, heathland or fen. Interestingly this scheme was not supported by two of the Local Authorities because it was seen to put to significant burden on developers without anything appearing to impact on what the main polluters were doing.

Bryan, G., Jonas, P., Money, R., Kite, D. and Bardon, R. (2012) *Draft Strategy for Managing Nitrogen in The Poole Harbour Catchment to 2035*.

<http://ecosystemsknowledge.net/resources/programmes/pes-pilots/poole>

## **NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM**

The Ecosystem Enhancement Program's mission is to provide cost-effective mitigation alternatives that improve the state's water resources.

The program offers four voluntary In-Lieu Fee (ILF) mitigation programs to the public and private sectors to satisfy compensatory-mitigation requirements in state and federal laws and regulations. The initiatives offset unavoidable environmental damage from transportation-infrastructure improvements and other economic development, and help to prevent harmful pollutants from endangering water quality in sensitive river basins.

The Program is designed to assist in meeting loading requirements for nitrogen and phosphorus in the Neuse and Tar-Pamlico River basins, and in the Jordan and Falls Lake watersheds, as part of the nutrient-management strategies in these areas.

Developers may choose to use a "buy-down option" and request to pay a fee to EEP to meet their nutrient loading requirements. Once payment has been accepted and received by EEP, a receipt is issued which allows the developer to receive final approval from the local government. Upon receiving the payment, EEP assumes the responsibility for the mitigation requirement, including mitigation site construction and monitoring of buffer-restoration sites or other types of nutrient-offset.

Once the offset calculation has been completed, a developer needs to complete a nutrient reporting form for their project which provides the information needed to determine the developer's need and eligibility to purchase offsite nutrient credits.

The applications are reviewed to identify whether the developer has met the requirements necessary to seek off-site offsets. If so the developer is then authorised to purchase the credits.

Developers can offset the required nutrient loads themselves (either onsite or offsite) or seek a third-party offset provider such as the NC Ecosystem Enhancement Program. Though the use of 3rd party providers is allowed they must be able to abide by a number of specific offset rules and statutes.

Once payment is made to the approved nutrient offset provider, a receipt is issued which is provided to the local government to demonstrate the developer's compliance. Only at this stage can the developer start work.

If the developer cannot find a third party to deliver the offsets for them they remain obligated to meet the loading requirements for the project either through increased on site measures or through their own approved off-site nutrient reduction measures.

## **Costs**

This program is interesting because the costs are based on “The Actual Cost Method.” The Actual Cost Method (ACM) is a procedure that ensures the EEP Nutrient Offset Payment Program sets rates based on the actual costs of providing nutrient load reduction credits.

The ACM accounts for all costs associated with achieving nutrient reductions inclusive of contracts, restoration projects, expenditures for land acquisition and program administrative costs.

The ACM is based on a simple equation:

$$\text{Actual Costs} / \text{Total Pounds} = \text{Actual Cost per pound}$$

Actual Costs include: completed projects, terminated projects, existing projects in process, and administrative costs (staff, supplies, rent) and all costs are adjusted to present day values.

Total Pounds is also determined using present day values to represent the true cost of implementing a new project, factor in changes in regulations and ensure the rates will never be below actual cost.

In addition, if EEP’s Nutrient Program’s total costs are greater than the Program’s receipts, an Adjustment Factor is applied to the fee calculation. This ensures that fees are commensurate with the actual costs of the program.

The rules require that rates be set using the ACM at least annually. Quarterly adjustments are made if income and expenses for the program show significant discrepancies. In new rate areas the highest Program rate is used until two nutrient reduction projects are available for use in determining the rate for that area

Onkaparinga catchment based auction trial aims to increase the cost effectiveness and environmental benefits of public funded schemes for private land management actions. In particular, it aims to improve biodiversity and water quality under threat from productive agricultural land use. The auction is managed by the Onkaparinga Catchment Management Board.

The auction process is similar to that adopted in the BushTender Trial, where officers visit interested landholders to assess sites and develop detailed site action plans. These plans are submitted with a bid to the Board along with the required level of cost sharing for implementation of actions. Bid assessment is very detailed in this case and incorporates risk analysis as outlined below:

$$\text{Risk} = \text{Value of Land} \times \text{Threat Value}$$

$$\text{Impact} = \text{Threat Reduction from proposed Actions} \times \text{Risk}$$

Environmental Benefits = Impact x Area

Environmental Benefits/\$ = Environmental benefits/Cost

Bids are then ranked according to this benefits index with contracts awarded to those which offer most benefit per dollar spent for their bid price. (Bryan et al, 2005)

Computer-based simulation was used to test the bid ranking and selection techniques prior to implementation. The trial contacted 224 landholders, 42 of which participated in site visits resulting in 29 bids from 27 landholders. Seventeen bids were accepted within the trial budget of \$150,000

## **BUSHTENDER TRIAL, AUSTRALIA**

Australian conditions which present problems concerning nutrient and salinity control and vegetation conservation requiring some form of land-use change (eg. Stoneham et al, 2003) afford many opportunities for the application of auction based land management techniques. The need for additional cost effective management of native vegetation on private land in Victoria prompted the

Department of Sustainability and the Environment to consider the viability of auctions as a potentially efficient technique to increase biodiversity in the area. Two trials occurred during 2001-2 and 2002-3 in North Central/North East Victoria and Gippsland respectively. The first trial accepted 97 bids submitted by 73 landholders who collectively received \$400,000 (Aust \$). The Gippsland trial awarded predominantly 6-year contracts (with an option to extend to 10 years) to 33 successful bidders for \$800,000.

The auction was initiated by requests for expressions of interest from landholders who were visited by government officers. During these visits, ecological information was collected to devise a Biodiversity Significance Index used to indicate a benefit:cost ratio of bids. The benefit component of this index comprised a conservation or biodiversity value to reflect scarcity of vegetation type multiplied by a habitat service score to reflect the quality change resulting from proposed management actions. The cost component equalled the bid value. Contracts were drawn up individually between government and landholders. A discriminatory sealed bid auction was conducted with bids ranked and allocated until the budget was spent. (Stoneham et al, 2003)

Compliance is reported at around 95% with an estimated saving of 700% compared to alternative fixed price schemes (Stoneham et al). However, this estimation is criticised as an overestimation because they do not consider that bids contain value of information rents i.e. the difference between how much has been bid and the actual cost or opportunity cost to the landholder (Latacz-Lohmann & Schilizzi, 2005)<sup>13</sup>.

### **Conservation Reserve Program**

The Conservation Reserve Program has been operational since 1986 and is the first known application of an auction for conservation purposes. The auction aims to reduce soil erosion and improve water quality. Farmers enter into a 10-15 year contract with the US Department of Agriculture (USDA). Land that is heavily eroded or environmentally sensitive is retired from crop production. Land cover is converted to natural vegetation through planting. In return, farmers receive annual rent from the Commodity Credit Corporation with initial costs shared. The program is

administered by the Farm Service Agency with decisions regarding land, producer or practice eligibility made by the Natural Resources Conservation Service.

Initially simple, the bid design has been developed to employ an environmental benefits index (EBI) to compare bids for land retirement for conservation use. Bids are scored according to land characteristics, such as erodability, and land management practices, such as land cover, before being weighted according to environmental priorities, such as improved water quality. Bid value enters the index as a negative score. Bids that exceed a threshold score will be accepted. (Latacz-Lohmann & Schilizzi (2005).

The program is largely successful with an estimated 34 million acres of retired land achieving average rents of \$45.95/acre (Latacz-Lohmann & Schilizzi, 2005; Sullivan et al, 2004). The benefits of the program, in addition to reduced soil erosion and improved water quality include reduced agricultural diffuse run-off, development of wildlife habitat, reduced sedimentation in water bodies, maintained soil productivity and provision of a source of income for farmers (Riechelderfer & Boggess, 1988; Huang et al, 1990; Young & Osborn, 1990; Kinsinger, 1991). In addition, Dunn et al (1993) reported that ecological benefits are likely to be hidden and are likely to also include reduction of landscape fragmentation and a positive impact on carbon balance.

A report conducted by Sullivan et al (2004) investigates the economic impacts of the CRP on communities within the local region and reports that initial impacts, such as low level unemployment from rural areas, are short lived. No evidence of migration from the region was found and expenditure on outdoor recreation increased. Adaptation to the CRP in the long run appears to balance any short term effects, with a small overall impact dependent on local economic conditions.

## **SAN JOAQUIN VALLEY (CALIFORNIA)**

The Grassland Area Farmers is a regional drainage entity which works together to improve water quality in the channels used to deliver water to wetland areas. There are many programs schemes which they adopt, one of which is a tradable loads program. The total allowable selenium load is allocated among member irrigation and drainage districts. The districts can either buy or trade their load allocation

The scheme is based on a bilateral market between point and non-point sources. Trades are for either monthly or annual allowances, with no banking permitted. The units of trade are pounds of selenium per year.

Costs of the scheme are seen by those involved as reasonable. Administration costs are low, as the program piggy backs onto existing organisations of farmers and systems of monitoring and record keeping. Most districts report negligible costs for implementing a trading, with only one district reporting \$500-\$1000 for having a lawyer. A total of \$14,320.00 changed hands during the first 5 years of the agreement.

[http://water.epa.gov/polwaste/nps/success319/Section319III\\_CA.cfm](http://water.epa.gov/polwaste/nps/success319/Section319III_CA.cfm)

## **CHATFIELD RESERVOIR (COLORADO)**

The Chatfield Reservoir scheme is a phosphorus trading scheme based around a clearinghouse market, but which also accepts bilateral agreements. The units of trade are pounds of phosphorous per year. The Chatfield watershed authority accepts credits from nonpoint sources and pools them as credits to be purchased by point sources. Point sources can alternatively contact point sources directly to pursue a trade, subject to approval.

A \$100 application fee to cover administrative costs is required for point sources to apply for increased discharge through trading (Chatfield Watershed Authority 2000). Credits that enter the pool are sold at a price that reflects the cost of nonpoint source reduction projects, costs associated with the pooling program, and costs incurred by the Authority to administer the trading program (Chatfield Watershed Authority 2000). Exact costs are unknown, but the monitoring program has been estimated to cost \$58,500/year.

<https://www.cbd.int/financial/pes/usa-peswatersurvey.pdf>

## **CHERRY CREEK BASIN (COLORADO)**

This scheme involves phosphorus trading between point and non point sources via a clearinghouse market. Two types of point to non point trades are possible. The authority can grant credits from the reserve pool to point sources that have completed a new trade project, or have extended wastewater service to semi urban areas.

It can also sell or lease credits from the Phosphorus Bank to point sources that can demonstrate compliance with past effluent limitations and the adequate designs/operations to meet future effluent limitations. The program also allows for one kind of point to point trade. The authority may transfer phosphorus allocations from one wastewater facility to another for a single year or for multiple years, as long as the receiving discharger is committed to “take all reasonable interim steps to decrease, to the extent practicable, the total phosphorus loading”(CDPHE 2001, p9.)

The authority charges each project owner submitting an application to create reserve pool credits \$2500 to cover the costs of consultants. Dischargers seeking credits from the Phosphorus bank must deposit \$500 for the consideration of their request.

<https://www.cbd.int/financial/pes/usa-peswatersurvey.pdf>

## **BEAR CREEK (COLORADO)**

This scheme involves phosphorus trading between point sources. One urban point source (Forest Hills) is allowed to discharge more than its permit, with Evergreen Metropolitan District, a large point source polluter offsetting the difference. It is estimated that Forest Hills saves over \$1.2 million, equivalent to the cost of an expensive system replacement that would be necessary to meet their allocation without a trade. Each year Evergreen Metro reduces phosphorus releases in a trade of 40-80 pounds per year and in exchange for this Forest Hills pays an undisclosed amount of money.

<https://www.cbd.int/financial/pes/usa-peswatersurvey.pdf>

## **DILLON RESERVOIR (COLORADO)**

This scheme relates to non-point source trades of phosphorus involving connection of septic systems to sanitary sewer, however it has recently expanded to include point source to non point source and non point source to non point source trades.

The scheme is based around bilateral negotiations in which each transaction must be carefully negotiated between individual buyers and sellers of credits. Buyers and sellers are responsible for agreeing upon the terms of trade.

<https://www.cbd.int/financial/pes/usa-peswatersurvey.pdf>

## **LONG ISLAND SOUND (CONNECTICUT)**

This is a scheme based around point source to point source trading of nitrogen with trades taking place via a clearinghouse market. It is estimated that reaching the 15 year nitrogen reduction goal without trading would cost approximately \$1 billion, and that trading will save 20% of that cost over those 15 years.

[http://www.ct.gov/deep/cwp/view.asp?a=2719&q=325572&deepNav\\_GID=1635%20](http://www.ct.gov/deep/cwp/view.asp?a=2719&q=325572&deepNav_GID=1635%20)

## **WATSON PARTNERS AND THE SOUTHERN MINNESOTA SUGAR BEET COOPERATIVE (SMSBC) (MINNESOTA)**

This is a scheme based around a 2:6:1 trade ratio for nonpoint source of phosphorus. Remedies centred on best management practices including; cattle exclusions, buffer strips, constructed wetlands, setasides, and cover cropping. This was to allow construction of a new wastewater treatment plant.

SMSBC implemented best management practices on approximately 18,000 acres/year, generating an average of 5,765 lbs of phosphorus reduction credits. Since SMSBC paid farmers \$2/acre to implement spring cover crop, the cost to SMSBC of nonpoint source offsets was \$6.22/lb. However, this does not reflect that farmers themselves incurred a cost of \$6/acre, which would bring the actual cost of phosphorus credits to \$18.65/lb, while including transaction costs could drive the cost higher than \$24/lb. Fang and Easter (2003) conclude from this analysis that SMSBC's trading was not more cost-effective than the phosphorus controls for a small-to-medium sized waste water treatment plant. SMSBC, however, disputes Fang and Easter's conclusions. Fang and Easter (2003) compared the nonpoint source controls to the cost of reducing point source discharge from 1.5 mg/L to 1.0 mg/L, but SMSBC was actually looking at bringing the limit down to 0 mg/L, a scenario in which trading did indeed lower compliance costs.

## **RAHR MALTING (MINNESOTA)**

The Rahr Malting scheme is an agreement to offset five day carbonaceous biochemical oxygen demand (CBOD<sub>5</sub>) discharge from Rahr Malting's new WwTP by funding upstream nonpoint source phosphorus reductions. It is a sole source offset scheme. Rahr is responsible for identifying and contracting for nonpoint source credits to satisfy its NPDES permit.

The unit of trade is a cap of 2mg/L of phosphorus and 12 mg/L CBOD<sub>5</sub>. To secure nonpoint source offsets, Rahr established a program with a \$275,000.00 fund. In the 5 years of the project, Rahr achieved the nonpoint source credit requirement through 4 trades.

Overall, the nonpoint source phosphorus control did appear to be cost-effective. The four nonpoint source projects controlled phosphorus at costs ranging from \$2.22 to 2.64/lb during the five years permit phase, which sets the cost of credits (calculated with a 2:1 trading ratio) from \$4.44-5.28/lb P. Including the transaction costs raises the average cost of nonpoint source phosphorus control to \$8.56 over five years, but if the structural improvements last twenty years, which is likely, then the annualized cost is reduced to about \$2.10/lb P. To compare this to pollution control costs outside of a trade, we have to use the cost of controlling CBOD<sub>5</sub> to 1 mg/L through the municipal WWTP. Senjem (1997) estimated this point source control at \$4-18/lb P for capita and operating costs, based on a 20 year investment and an 8% annual interest rate.

<https://www.cbd.int/financial/pes/usa-peswatersurvey.pdf>

## **CHESAPEAKE BAY PROGRAM:**

### **Maryland Nutrient Trading Program**

This scheme provides a public marketplace for buying and selling of nitrogen and phosphorous credits. Credits traded within 3 defined areas: Potomac basin, Patuxent basin, and everywhere else. Phase I of the scheme concerns point source trading and industry generating credits. Phase II covers agriculture non point sources, certain land uses, agronomic practices and BMPs. All are eligible to create credits for the scheme.

The value of the unit is 1 credit = 1lb of nitrogen or phosphorus delivered to the main stem of the bay per year. The trade is set up and administered on line via the Chesapeake Bay Nutrient trading program

<http://www.mdnutrienttrading.com/>

### **Pennsylvania Nutrient Trading Program**

This scheme is an online trading between point sources, non-point sources and third party aggregators within a defined watershed. To be eligible to generate and trade credits, certain baseline and threshold requirements need to be met, and each organisations needs to have an appropriate permit for point source pollution. Online trades are set up concerning pounds of nutrient per year.



## **APPENDIX C: WORK PACKAGE 2 REPORTS**

## APPENDIX D: PEMBROKESHIRE MARINE SAC INFORMATION

The Pembrokeshire Marine SAC covers an area of 138,069 ha. The site extends from near Aberystwyth to Manorbier and includes the coast of the islands of Ramsey, Skomer, Grassholm, Skokholm, the Bishops and Clerks, and The Smalls (21 miles offshore). It also encompasses almost the entire Milford Haven Waterway. The landward boundary of the SAC mostly follows the extreme high water mark.



**Figure 1: Pembrokeshire Marine SAC**

Pembrokeshire Marine SAC is a multiple interest site that has been selected for the presence of eight marine habitat types and associated wildlife (Habitats Directive Annex I habitat types) and seven Annex II species (Habitats Directive Annex II species).

Annex I habitats that are a primary reason for selection of this site comprise:

- Estuaries
- Large shallow inlets and bays
- Reefs

Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site comprise:

- Coastal lagoons and sandbanks which are slightly covered by sea water all the time
  - Mudflats and sandflats not covered by seawater at low tide
  - Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)
  - Submerged or partially submerged sea caves

Annex II species that are a primary reason for selection of this site comprise:

- Grey seal, *Halichoerus grypus*
- Shore dock, *Rumex rupestris*

Annex II species present as a qualifying feature, but not a primary reason for site selection comprise:

- Sea Lamprey, *Petromyzon marinus*
- River Lamprey, *Lampetra fluviatilis*
- Allis Shad, *Alosa alosa*
- Twaite Shad, *Alosa fallax*
- Otter, *Lutra lutra*

It is considered that the potential impacts arising from nutrient enrichment could affect all but two of the designated habitat features. The features likely to be impacted include:

- Estuaries
- Large shallow inlets and bays
- Coastal lagoons
- Mudflats and sandflats not covered by seawater at low tide
- Atlantic salt meadows (*Glauco-puccinellietalia maritimae*)

## RELEVANT INTEREST FEATURES

### ***Estuaries***

Pembrokeshire Marine SAC includes the Daugleddau estuary (the estuary which forms from the following four rivers; the Western and Eastern Cledday, Carew and Cresswell rivers). The estuary supports a wider range of environmental conditions, particularly a variety of seabed substrata, tidal streams and salinity gradients, creating a diverse array of communities and species. The species-richness of sediment communities throughout Milford Haven and the Daugleddau is high. The site also includes smaller estuaries entering the Daugleddau and Milford Haven and wide intertidal mudflats with rich and productive invertebrate annelid and mollusc communities, occurring in rivers or streams known as ‘pills’.

### ***Large shallow inlets and bays***

The Milford Haven waterway, within the Pembrokeshire Marine SAC, is a ria with wide, shallow, predominantly sandy embayments. As with the estuary feature detailed above the wide range of environmental conditions supports high community and species diversity. The species richness of sediment communities is particularly high, with intertidal sandy/muddy areas supporting extensive beds of narrow-leaved eelgrass *Zostera noltei*, *Zostera marina* and muddy gravels.

### ***Mudflats and sandflats not covered by seawater at low tide***

Intertidal mud and sand-flats are habitat types that vary considerably throughout the site.

Sediment flats within Milford Haven waterway are accreting slowly in places but expansion is curtailed by channel structure throughout much of the waterway. Extent has also been reduced through intertidal land claim, shoreline development and possibly indirectly modified as a consequence of channel dredging.

### ***Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)***

Atlantic salt meadows develop when salt-tolerant vegetation colonises intertidal sediments of mud and sand in areas protected from strong wave action. This vegetation forms the middle and upper reaches of saltmarshes, where tidal inundation occurs with decreasing frequency and duration. The salt meadow is distributed intermittently throughout the Milford Haven waterway, with the largest areas within the tributary estuaries.

## **APPENDIX E: LAND MANAGEMENT MEASURES**

Please note that this Appendix is over 280 pages long and as a result is only available electronically.

The Appendix details the likely reductions in N loading that are likely to be possible from implementing different land management measures on different farm types with different environmental factors (e.g. soil type, rainfall etc). The suggested figures will need to be agreed with the RAG (primarily NRW) but should form the basis of the scheme.