

THE OPINIONS OF THOSE COMMUNITIES WHO RELY UPON RIVERS FOR LIVELIHOODS
AND HOBBIES, TOWARDS NITRATE VULNERABLE ZONES IN THE UK, AND THEIR
VIEWS REGARDING THE ALL-WALES NVZ

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ABSTRACT

The introduction of new nitrate vulnerable zone laws, that encompass all of Wales, has been received with great controversy within the farming communities. However, the opinion of those affected by nitrate pollution are often overlooked in literature. This study is designed for people who rely on the river for either their livelihood or recreation, specifically towards anglers and fishermen, for their opinions and views on the All-Wales NVZ. A questionnaire was developed with several categories: their awareness of NVZ's and nitrate pollution, the human and environmental impact, their views regarding the effectiveness of NVZ's and their opinions on the All-Wales NVZ. The questionnaire was distributed via link, which was sent to many angling clubs stationed throughout Wales, the link was distributed on social media and by email. The links were also distributed to various trusts and river and environmental organisation. Other data collected was in the form of interviews, which followed a semi structured questioning, both participants in the interview had extensive knowledge on the environmental, legal, and social situation surrounding nitrate pollution and NVZ's. The results of this study show that there is a poor awareness of NVZ's within the angling community, apart from those that work within the industry. There was a great deal of uncertainty whether their hobbies had affected, apart from those whose livelihoods depend on the river. The majority expressed that they had been negatively affected. There was also a large concern given to human health. The majority, 77%, stated that the environment was a greater priority than agriculture. There was a significant positive response to the All-Wales NVZ, 71% stating that Wales was not protected before the All-Wales NVZ and 83 % in favour of the All Wales NVZ, although there was uncertainty towards the effectiveness, with 45% stating maybe and 41% stating yes, this uncertainty has shared with the interviewees who pinned the effectiveness of enforcing regulation on budget and manpower of NRW. There was also a positive response towards an All-UK NVZ. The majority pinning responsibility on farmers, who have been criticised for poor attitude and lack of effort, an opinion supported by surrounding literature. Overall, the study has revealed that the two communities (both anglers and farmers) show a lack of engagement with the public, and that there may be underlying issues with regards to the culture of these two stakeholders and could be a future area of study.

TABLE OF CONTENTS

Acknowledgments.....	i
Abstract	ii
Table of Contents	iii
1. Introduction	1
2. Literature Review	3
3. Aims and Objectives	25
4. Method	27
4.1 Participants.....	27
4.2 Data Collection.....	28
4.3 Data Processing	30
5. Results.....	31
5.1 Demographics.....	32
5.2 Awareness of NVZ's and Nitrate Pollution	33
5.3 Human Impact	35
5.4 Environmental Impact.....	37
5.5 Responsibility.....	39
5.6 Views and Opinions on NVZ's	48
5.7 All-Wales NVZ	52
6. Conclusion.....	57
6.1 Demographics.....	57
6.2 Awareness of NVZ's and Nitrate Pollution	57
6.3 Human Impact	58
6.4 Environmental Impact.....	58
6.5 Responsibility.....	59
6.6 Views and Opinions on NVZ's	61
6.7 All-Wales NVZ	61
7. Discussion	62
6.1 Demographics.....	62
6.2 Awareness of NVZ's and Nitrate Pollution	63
6.3 Human and Environmental Impact.....	64
6.4 Responsibility.....	66
6.5 Views and Opinions on NVZ's and an All-Wales NVZ.....	69
6.6 Limitations	72
6.7 Strengths	73
8. References	74
9. Appendices	84

1. INTRODUCTION

Nitrate vulnerable zones were first introduced by the United Kingdom when the European union introduced laws for all countries that are part of the European Union must reduce their nitrate levels in their drinking waters to a maximum of $50 \text{ NO}_3^- \text{ mgL}^{-1}$ due to the associated effects nitrates have on health and the environment. With directive EC Directive 80/778/EEC and 91/676/EEC (GOV, 1991), as a result many countries introduced Nitrate vulnerable zones to combat the effects of excessive nitrate pollution. The effects nitrates have on the environment with regards to water pollution is a process called eutrophication in which the overall oxygen concentration has decreased, due to the process of nitrification, as will be discussed in the literature review, this chemical process also leads to the acidification of water bodies, these two effects cause an overall deterioration of the natural water habitats and results in much wildlife dying. There are also many associated human health impacts such as baby blue syndrome, in which water with high nitrate levels used to prepare baby formula milk. This has been shown to be an extremely negative effect on infants and has even led to deaths, in two cases babies exposed to water with nitrate levels of nitrate-nitrogen concentrations of 22.9 and 27.4 mgL^{-1} (Knobeloch et al., 2000), which is alarmingly around half of the current maximum nitrate level permitted (50 mgL^{-1}). Within the United Kingdom, the distribution of nitrate vulnerable zones is not homogenous throughout the United Kingdom and varies from country to country, England having the highest percentage nitrate vulnerable zone coverage being around 55%, Scotland with 14%, and Wales with only 2.3% (Welsh government, 2014). Over the years since the introduction of nitrate vulnerable zone England has seen the most positive growth in terms of areas protected by nitrate laws, starting with only 8% coverage in 1996, after the NVZ action plan increased the nitrate vulnerable zone area coverage to around 47% in 2002 and now is up to 55% (University of Hertfordshire, 2011). This progression from a small area coverage to almost half of England

has not been seen in Wales until recently, with the decision to turn all of Wales into a nitrate vulnerable zone, a percentage coverage increase from 2.3% to over the whole country. This sudden but very progressive change, decided in 2021, has left many farming communities in shock and anger (Wales Farmer, 2021) due to the additional costs and change in rules, however turning Wales from the least protected country in the United Kingdom to having all of it being classified as a nitrate vulnerable zone sets an example towards the rest of the UK. The backlash and anger from farmers are considerable, as the majority of Welsh farmers were not subjected to nitrate protection laws before the recent decision to turn all of Wales into a nitrate vulnerable zone, or even before the introduction of the previous nitrate vulnerable zones, which covered only 2.3 % of the land area and as a result a very small number of farmers are affected. However, on a much larger scale, the majority of much larger countries from the north of Europe have classified their entire areas as nitrate vulnerable zones, these countries include Denmark, Netherlands, Belgium and Germany (Osborn, 1997), the decision to make countries nationwide to protect their ground waters from nitrate pollution, and the potential health related consequences and also the protection a marine based habitats that may be subjected to eutrophication and acidification. The opportunity for Wales to set out an example to the other countries in the United Kingdom is an important one that could influence the attitudes of nitrate usage nationwide, that could one day lead to all of the UK becoming a nationwide nitrate vulnerable zone. However, progress on a more local scale needs to be made, and understanding the resentment and attitudes of Welsh farmers, alongside the effectiveness of the current nitrate vulnerable zones are essential in taking that first progressive step, if other countries have managed to live with nitrate protection laws, there is no reason the UK couldn't. As the livelihoods of anglers and the ecosystems of the UK's rivers are in danger.

2. LITERATURE REVIEW

The historical usage of such fertilisers stems from after the second world war where the government introduced serious investment into the future of the United Kingdom's agriculture sector with the introduction of the post war agricultural act 1947 (Agriculture Act, 1947) which focused mainly on food security and was designed to promote a greater agricultural output as part of the nation's food supply at the lowest price whilst returning an adequate income for farmers. However, the introduction of nitrate and phosphorous based fertilisers have caused a great impact in the United Kingdom's freshwater environment.

The purpose of this study is to examine the opinion and attitudes of those who have been affected by nitrate pollution, specifically focusing on anglers and fishermen. And their attitudes and relationships to NVZ's and farmers.

Pollution of natural bodies of water due to the intensification of agriculture, has led to a deterioration of some of the natural water habitats, especially from nitrates and phosphates. Nitrate pollution is mainly associated with intensified cattle farms due to the use of ammonium-based fertiliser and the spreading of slurry. The slurry and other nitrate based, or ammonium-based compounds end up in adjacent rivers due to local runoff, these compounds have led to an overall acidification of water bodies and soil (environment agency, 2019; Gov, 2018; Welsh Government, 2015). 78% of slurry incidents were caused by dairy farms. It is important to note that these figures only refer to incidents reported to NRW (Welsh Government, 2016). The excessive abundance of nitrates in river bodies overall increase the nutrient richness causing excessive growth of algae and aquatic plant life, this excessive growth results in an increased uptake in oxygen percentage in the water which then leads to an overall decrease in biodiversity (Chislock, M. F et al, 2013), this process of excessive nutrient enrichment is known as eutrophication. This alteration in oxygen concentration overall shifts the water environment into one that is unliveable for many aquatic lives, such as fish and crustations However, nitrification is not only caused by liquid-based nitrate compounds, but also from nitrogen oxide gasses that dissolve into the water. Normally there is

a natural nitrogen cycle (Xia et al., 2018) that occurs, a very fragile system that is susceptible, if the balance or concentration of nitrogen-based compounds are increased or decreased.



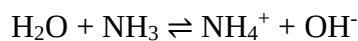
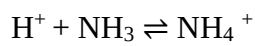
Figure 2.1- diagram displaying the nitrogen cycle (Xia et al., 2018)

Nitrogen based compounds are important in ecosystems and represent the fundamental basic chain link in protein synthesis, by the creation of the amide bond (Ouellette and Rawn, 2018), but naturally the majority of the natural nitrogen that is used for within the water environment comes from both plant life, from the atmosphere via nitrate oxides and other nitrogen based gasses dissolving in the water, nitrogen is too inert to dissolve by itself. The process of dealing with waste proteins in fish differs to that of humans, which usually metabolise excess waste proteins into urea, however, fish simply metabolise waste proteins and excrete the nitrogen-based compounds as ammonia NH_3 , directly into the water supply (Nerici, Silva and Merino, 2012). The cycle then continues with both the nitrification and denitrification of either ammonia NH_3 or the ammonium NH_4^+ , which both have a reversible equilibrium relationship by the laws of the Bronsted-lowry acid base theory (Nicolaus Brønsted and Martin Lowry, 1923), which represents an equilibrium reaction whose rates of reaction changes depending on the various concentration, by the Le Chatelier principle (LibreTexts, 2020).

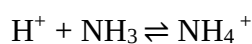
Of the nitrogen cycle there are four main reactions that need to be discussed to further the understanding of the effect nitrogen-based compounds have on the water environment, and the two main effects it has are acidification and eutrophication.

Acidification

the first is the ammonification reaction (Romillac, 2019), of which ammonia NH_3 is changed into ammonium NH_4^+ , much of which is present in many fertilisers today. Taking the Arrhenius concept of an acid, that it is a single positive proton H^+ , and Bronstat-Lowry acid base theory, the reversible equilibrium reaction and Le chatelier principle which states in one side of the reaction increases in concentration the equilibrium will shift in favour to the other side. As seen in the below reactions.



Therefore, increasing the ammonium (NH_4^+) concentration from the addition of agricultural runoff such as fertiliser and slurry, would shift the equilibrium reaction in favour of the left-hand side, creating an increase in NH_3 . This is however a very balanced environment and the shift of equilibrium, with focus on the left-hand side of the equation, will force the NH_4^+ to dissociate, see below reaction.

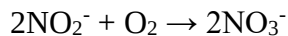


This reaction in turn causes an increase on acid proton H^+ concentration, and therefore leads to an overall decrease in Ph value and the acidification of the water environment, an acidification which will cause the waters to become unliveable for many animals. The

nitrification reaction as displayed in the eutrophication section also leads to acidification with the creation of many protons.

Eutrophication

In addition to the already destructive effects of acidification, the nitrification of ammonia, normally done by plants and bacteria, see reaction below, uses oxygen to form, NO_2 , and later NO_3 , this removal of oxygen causes a further deterioration of the environment, this process is called eutrophication (Subba Rao et al., 2017).



As can be seen from the nitrification reactions the conversion of ammonium into nitrates requires the consumption of a considerable amount of oxygen in addition to the creation of multiple protons, further contributing to the acidification of the water environment by lowering the Ph.

This consumption of oxygen used for the synthesis of nitrates, usefully completed by bacteria or plant life. But the end results in the reduction in oxygen concentration causes an inhospitable environment for the majority of wildlife present, along with the lethal algae blooms.

The only process removing nitrogen from the water is the denitrification process in which nitrogen gas or nitrogen oxides are released, however this is less chemically favourable than the nitrification and ammonification. Please see equations below for the various reactions and their relationship. There are several methods designed for removing nitrates from water.

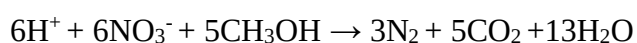
Denitrification

So far, a vast amount of literature surrounding nitrate vulnerable zones and general ammonium pollution in freshwater bodies only mostly focuses on the origins of nitrates into water and the preventative measures used to prevent contamination, by studying the origins of nitrate pollution. Although not all literature focuses on denitrification there are methods of removing it from bodies of water, there are many methods of nitrate clean up, but are generally divided into two separate categories, the first are non-treatment methods and the second are treatment-based processes.

Treatment based processes: Bacteria bio-chemical denitrification

There are a variety of treatment processes for the removal of nitrogen-based compounds from water bodies. Methods include bacteria base chemical denitrification, ion exchange using specialist resins, and the reverse osmosis.

Denitrification by the use of specific bacteria also known as bio-chemical denitrification, requires the presence of ethanol in order for the specialised denitrifying bacteria. A slight draw back to this method is that sometimes specialist bacteria known as nitrosomas, are required to convert all free ammonium ions into nitrite, as it is necessary to remove all nitrogen from the solution (Shuval, 1977). The denitrifying bacteria are able the oxidation of nitrites to nitrates, which can be removed with the presence of alcohol (see reaction below). The nitrate is converted to nitrogen in a gaseous form which is released from solution, which is a huge benefit.



This method does however, contain drawbacks, the specialised bacteria, although quite effective at removing nitrogen from solution, are influenced by other compounds/toxins in solution, which as we are dealing with freshwater, contamination of various impacting chemicals or toxins is a risk. Another drawback to the using denitrifying bacteria is

that it may not be suitable for the use of freshwater bodies, but the water purification aspect, for reducing the adverse health risks of high nitrogen levels in water.

Resin Ion exchange

Ion exchange works by transferring ions, totalling to the same charge (normally negative). In the case of denitrification. This requires the solution that is to be purified has to be neutral with regards to its electric charge, introducing an ionic compound such as a resin, the fixed anions (negatively charged ions) in the resin can be exchanged with anions within the solution, the transfer of electric charge must be the same (Guter, 1981) . Within the context of denitrification resin, commonly made up of either magnesium, sodium or calcium for the positive cation component of the ionic compound, while using chloride ions as the negative anion, for example CaCl_2 , two negatively charged chloride ions Cl^{-1} bonded via ionic bond to a single positive calcium ion Ca^{+2} . This is an example of an ionic compound; the anion and cation components may differ accordingly.

The process of ionic exchange works by chloride ions Cl^{-1} in the resin being displaced for the NO_3^{-1} anions in solution, effectively removing the nitrate from the solution and fixing it to the solid resin, releasing chloride ions in the process. With regards to this process, it is essential to select a resin that will focus on capturing and removing the nitrate anions. One enormous drawback to this method is that the resins are not selective with regards to only removing nitrogen-based anions but will remove most anions in general.

The resin itself generally comes in the form of small spherical beads that together make up a resin bed, there are several further stages to the denitrification process. The ion exchange method according to an older study has been able to reduce the nitrate concentration from 16mgL^{-1} to 2.6mgL^{-1} . This is the most efficient and effective of the treatment-based processes (Moore,1991)

Non treatment processes

Non treatment processes when compared to the treatment processes are considerably simpler. The methods mainly revolve around blending and mixing water with lower nitrate levels to decrease the levels as a whole, alternatively connecting two water systems to introduce new less contaminated water is also possible. The disadvantages of non-preventative measures are that they do not in essence physically or chemically remove nitrate from the system, treatment processes such as ion exchange and bacterial chemical denitrification is required. Another major disadvantage, when water systems are connected is that contamination can spread from one system to another, potentially causing a larger region of impact than before. However, joining systems does allow cheaper and easier ability with regards monitoring contaminants (Subhash Chand, 2011).

Currently preventative measures are some of the most effective ways to counteract or reduce agricultural nitrate pollution, and generally revolves around storage of silage/ fertiliser and management of flood plains. As treatment-based processes are very expensive and only suitable in certain situations, the importance of reducing nitrate pollution should be not only for environmental purposes but also for financial, due to the cost of clean-up, paid for by the taxpayers.

In efforts to reduce this devastating effect the introduction of nitrate vulnerable zones, NVZ were introduced, to limited success. In a timescale from 12 and 15 years has shown that 69 % of all protected NVZ's showed no significant improvement in surface water nitrate concentrations, and 31% of NVZ's actually showed signs of further worsening in their condition (Farmers Weekly, 2021). Many farmer organisations have heavily criticised the

implementation of the NVZ's however the reality may not necessarily be due to the ineffective counter measures of the NVZ's but actually due to the continued destructive practices undertaken by farmers who are not following the agricultural policies and continue to use excessive ammonium based compounds and slurry, as stipulated in the previous government guidance for farmers policy (GOVa,2021).

In order to effectively reduce the nitrate level that is present, the Welsh government initially released several consultation forms in 2016 (Welsh Government, 2016), with regards to the future of protecting Welsh water environments from the nitrate impact that was happening. The consultation document outlined two options with regards to the future. The first option was a targeted approach to the designation of specific nitrate vulnerable zones, which would work on the polluter pays. The second option was to make all of Wales into a nitrate vulnerable zone. This would make NVZ homogenous throughout Wales and would essentially put all farmers on equal ground with regards to commitment and impact. On the 3rd of March 2021 the Senedd voted in favour of turning all of Wales into a nitrate vulnerable zone. This decision has left many farmers and their respective communities in outrage (N.F.U. Cymru, 2021), with many signatures being signed to overturn the decision. The national farmers union appeal remarked several statistics regarding the lack of success and the failure of previous NVZ's, they argue that the NVZ's are not an effective measure and that the economic impact on farmers is unwanted, the national farmers union regards the NVZ policy as stifling and stopping the ambitions of local farmers. However more information and research needs to be made with regards to the effectiveness of NVZ's and the reasons for their effectiveness, which could possibly backfire on farmers criticising the NVZ if they have been using excessive slurry and fertiliser and not following the prescribed policy. Despite outrage from the farming communities the consultation document actually showed (Welsh government, 2018) a majority support for making all of Wales a nitrate

vulnerable zone. These regulations (Senedd, 2021) have been set to start at the 1st of April 2021 and lists the various criteria and rules concerning the use and storage of nitrates (Welsh Government, 2021).

This new nitrate vulnerable zone laws have now been passed and the appeal has been rejected by the Senedd despite the pleas from the national farmers union and other outraged communities (Case, 2021), the national farmers union has decided to seek any legal challenges and lawfulness or opportunities to fight against the decision (NFU Cymru, 2021b).

To add to the critical reception the proposal for turning all of Wales into a nitrate vulnerable zone, members outside of the farming community have protested and argued the radical change. Fay Jones Mp for Brecon and Radnorshire argued that the new changes to the laws revolving storage and use of nitrate-based fertilisers and slurry are unfair to farmers (Jones, 2021). Her calls for the Welsh government to reconsider the new nitrate vulnerable zone laws, after controversial information concerning Welsh Water, whose Aberbaiden plant had been dumping untreated raw sewage into the river Usk (Cross, 2021). A river that recently has been failing water quality standards, according to Natural Resources Wales. The drop of water quality of the river Usk is most alarming due to the fact that it is a designated Site of Special Scientific Interest. It has been shown that Welsh water Aberbaiden site had been dumping untreated sewage into the Usk in December 2020 and have also been using an overflow pipe without a permit.

The highly controversial illegal dumping into the river Usk does ask important questions, especially with regards to the accountability of the various stakeholders who are involved in contributing to pollution within the rivers. Fay Jones Mp for Brecon and Radnorshire has argued against the nitrate vulnerable zone laws, on the bias that farmers are not solely responsible, as evidence by the scandal, and that the cost and responsibility should be shared amongst the pollution contributors, the proposal has been

further criticised with regards to harshness of farmers and the indiscriminate nature, as all areas will be subjected to the nitrate vulnerable laws, regardless of local river qualities.

There has been a considerable amount of controversy surrounding the illegal dumping of sewage into rivers, a lot associated to storm overflow tanks still releasing even at low water levels (GOV, 2020). This has been a source of argument by those against the NVZ proposal. However, despite being an environmental problem, mostly in more urban areas where the older sewage system is unable to cope with greater populations, rural agriculture especially in rural area, particularly Wales, which is more oriented around livestock agriculture, and one of the highest areas in the UK in terms of major polluting incidents. The government amended the environmental bill to help combat this problem (GOVb, 2021), although water companies have drawn considerable criticism from the public.

Currently in Wales the majority of major agricultural incidents occurs in west Wales, a region of Wales which has the most concentrated dairy production in the country, below are the NVZ areas present in Wales prior to making all of Wales a designated nitrate vulnerable zone (UKSO, 2019).

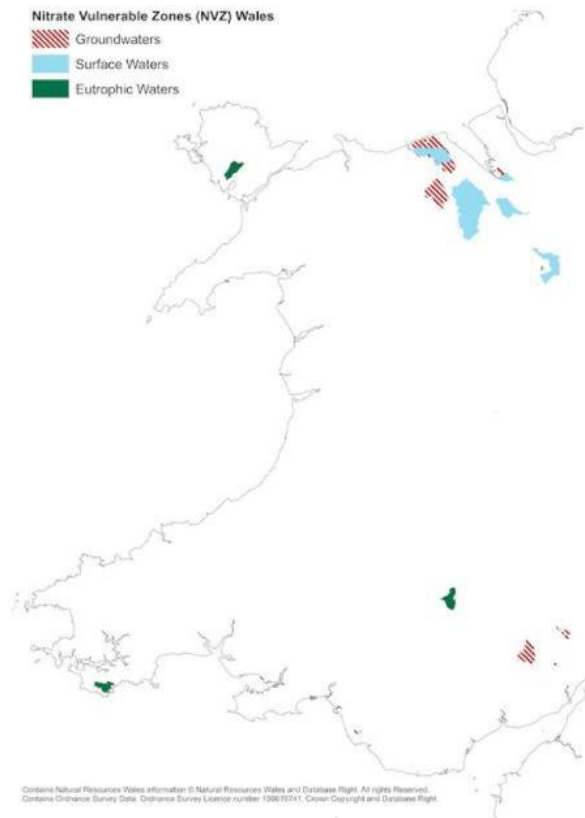


Figure 2.2- map of Wales showing the different NVZs across the country (UKSO, 2019)

Overall, the total percentage of land designated as Nitrate Vulnerable Zones is less than 2.3%, a considerably smaller amount when compared to England, which covers over 55% of the land area. The comparisons between England and Wales shows a clear and steep difference between the initiative for nitrate pollution protection, with Wales having a far lower area protected, despite its agriculture being more oriented around livestock and therefore at greater risk of nitrate pollution. Wales does have several bodies of water protected, such as Llangorse lake (May, Spears, Dudley and Hatton-Ellis, 2010). Despite the vast majority of major agricultural contaminations occurring in the west of Wales, there is only an extremely small NVZ designated for such a large area with an extremely high concentration of dairy produce.

Despite the huge number of major contamination events occurring in west Wales, only the very small area of designated land in the Buckspool and Bosherten area despite the majority of major agricultural incidents occurring in central and western of Pembroke, west Wales. As can be seen on the map below (Welsh Government, 2016), displaying major agricultural pollution incidents. Clearly according to this map, the nitrate vulnerable zone is not in an area most severely affected by agriculture, so the benefits of the nitrate vulnerable zone in the south of west Wales may not see large improvement due to it being placed in an area with relatively low pollution incidents, when compared to the rest of west Wales.

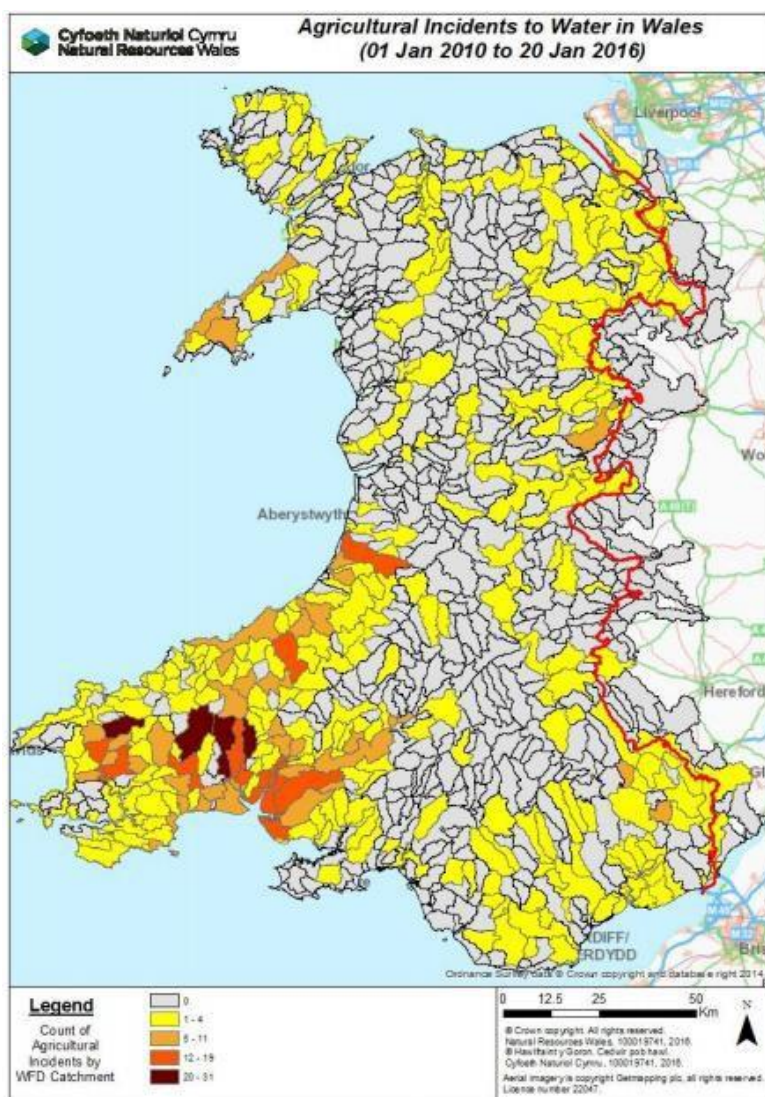


Figure 2. 3- a map displaying major agricultural incidents with regards to water (Welsh Government, 2016)

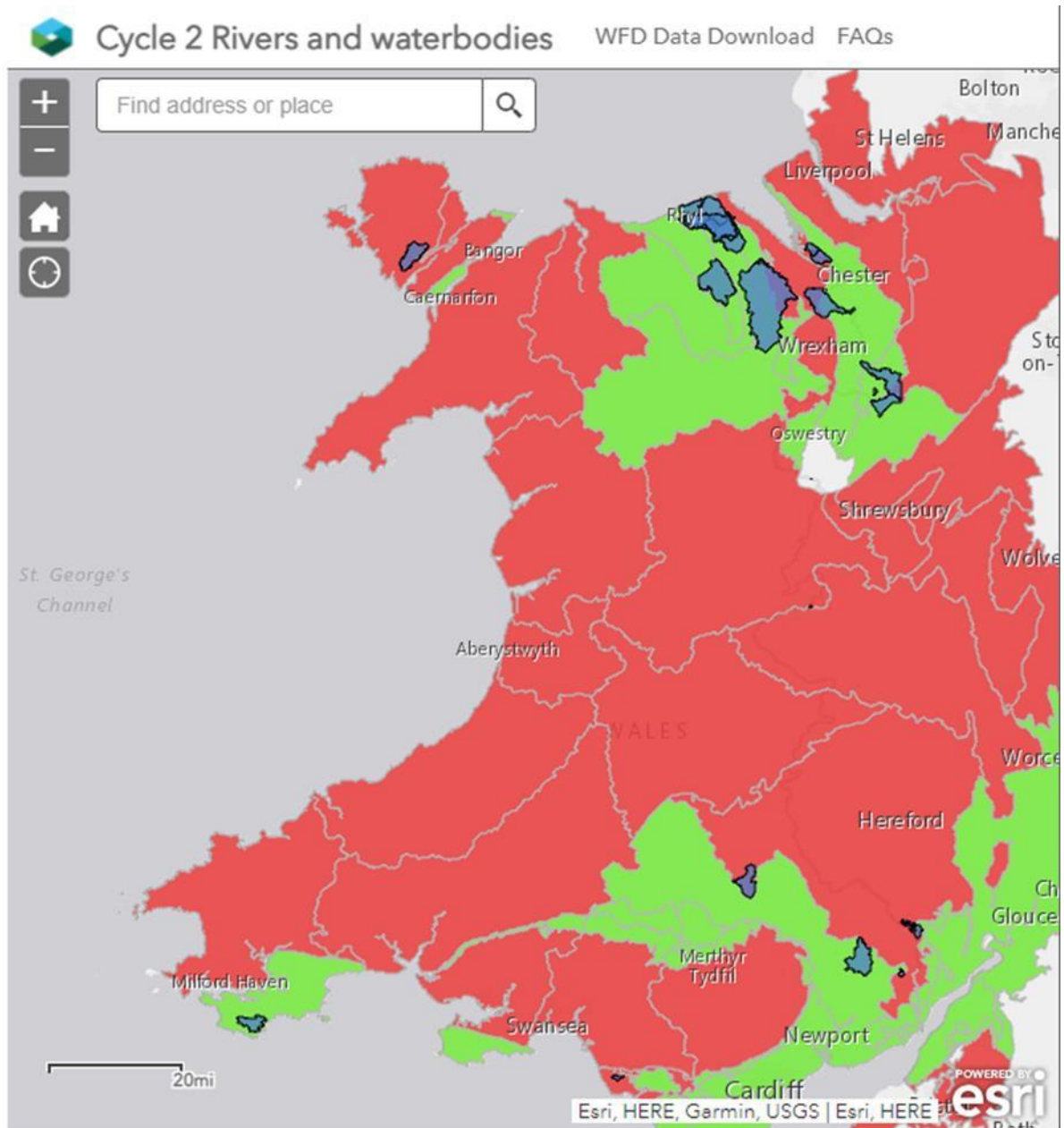


Figure 2.4- map displaying NVZ's with ground water quality status (NRW, 2018)

the figure displays the previous nitrate zones prior to the Senedd's decision to turn all of Wales into a nitrate vulnerable zone. The data presented shows that the status for the vast majority of groundwater catchment in Wales with their respective quality, has poor status within the category of chemical pollution. The figure is extremely clear that the groundwater catchments in and close to the previous nitrate vulnerable zones are higher in quality than groundwater catchments further away from the nitrate vulnerable, this does show the clear

effectiveness of Nitrate vulnerable zones, despite protest from national farmers union Cymru, who in protest and opposition to the proposal and the introduction of an all-Wales nitrate vulnerable zone (Case, 2021b).

The national farmers union Cymru repeatedly criticised nitrate vulnerable zones on their ineffectiveness and have even taken legal action against the Welsh government concerning the all-Wales NVZ (Case, 2021a).

Within Wales the situation of nitrate pollution and its subsequent effects of eutrophication on freshwater according to reports conducted by natural resources Wales to identify the severity and scale of nitrate pollution by identifying the various symptoms of eutrophication, as previously discussed, such as low dissolved oxygen concentration, loss of sensitive species, and the algae blooms, the symptoms that manifest in bodies of water experiencing eutrophication are not always the same nor are they consistent and can vary from site to site, making testing for nitrate pollution a much more complicated issue. Currently the environmental agency follows a method that scans for the various described symptoms (environmental agency, 2012) that uses extensive and consistent monitoring-based method for identifying lakes within NVZ's in an evidence-based manner, that was agreed by the various stakeholders. This evidence-based method seeks to identify nitrate pollution by assessing evidence based on the symptoms of eutrophication by analysing three distinct categories. The first category analyses the chemical components of the water body, in this case nutrient concentrations. The second looks at the various plant communities to see whether there is any substantial growth due to increased nutrient concentration. And thirdly, is the observance of secondary effects such as detecting low oxygen concentrations, and loss or decreasing numbers of sensitive flora and fauna.

Currently according to the environmental agency and Natural Resources Wales, collecting data and information in the method described, throughout Wales, from December 2009 to 2014. From the data gathered it has been concluded that information compiled from 101 lakes of these 80 were considered to have either no eutrophication problem or a problem that was uncertain (Hatton-Ellis, 2016)

It is important to note as previously discussed is that eutrophication of water bodies cannot solely be based upon nitrate concentrations. The data collected from 2014 to 2016 released by natural resources Wales has classified as unreliable following anomalous results for orthophosphate, that were observed to be 78% higher than previous years (NRW, 2018; Hatton-Ellis, 2016)

Phosphorous although not the same as nitrate, is also a by-product from fertilisers and swage, whether human waste or animal slurry. And still contributes to an over-rich environment and promoting a eutrophic environment.

More recently due to the problem regarding the data with regards to phosphorous measurements it was necessary for natural resources Wales to review the objectives for the rivers in areas of special areas of conservation (SAC) and clamped down on phosphorous targets.

Data was collected from January 2017 to December 2019. Samples were taken from 125 water bodies. According to the study carried out by Natural resources Wales 18 of the 125 bodies of water could not be tested leaving only 107. Overall, out of the 107 bodies of water only 42 passed their SAC phosphorus compliance levels, with 65 water bodies failing. This means that out of the total bodies of water tested only 39% had passed with a 61% failure (NRW, 2019).

SAC Name	Passing	Failing (Episodic)	Failing (Consistent)	Not Assessed
River Dee & Llyn Tegid	5	2	1	1
Afon Gwyrfa i a Llyn Cwellyn	2	0	0	0
Meirionnydd Oakwoods	3	0	0	0
Afon Eden – Cors Goch Trawsfynydd	3	0	0	1
Afon Teifi	8	8	0	2
Afonydd Cledau	5	5	5	4
Afon Tywi	2	0	0	1
River Usk	2	7	8	6
River Wye	14	11	17	3
Total	42	33	31	18

Table 16. Summary of the overall status of Welsh SACs in relation to phosphorus targets, as number of water bodies.

Figure 2.5-Summary of the overall status of Welsh SACs in relation to phosphorus targets, as number of water bodies (NRW, 2019)

There is considerable outcry from environmentalist groups and angling communities (Angling Trust, 2021) with regarding the impact on freshwater wildlife. According to Natural Resources Wales all salmon stocks are at risk or probably at risk, even stocks within SAC are classified as unfavourable (NRW salmon, 2018). As a result of the tremendous scale of pollution there has been serious protest at the declining populations of wildlife.

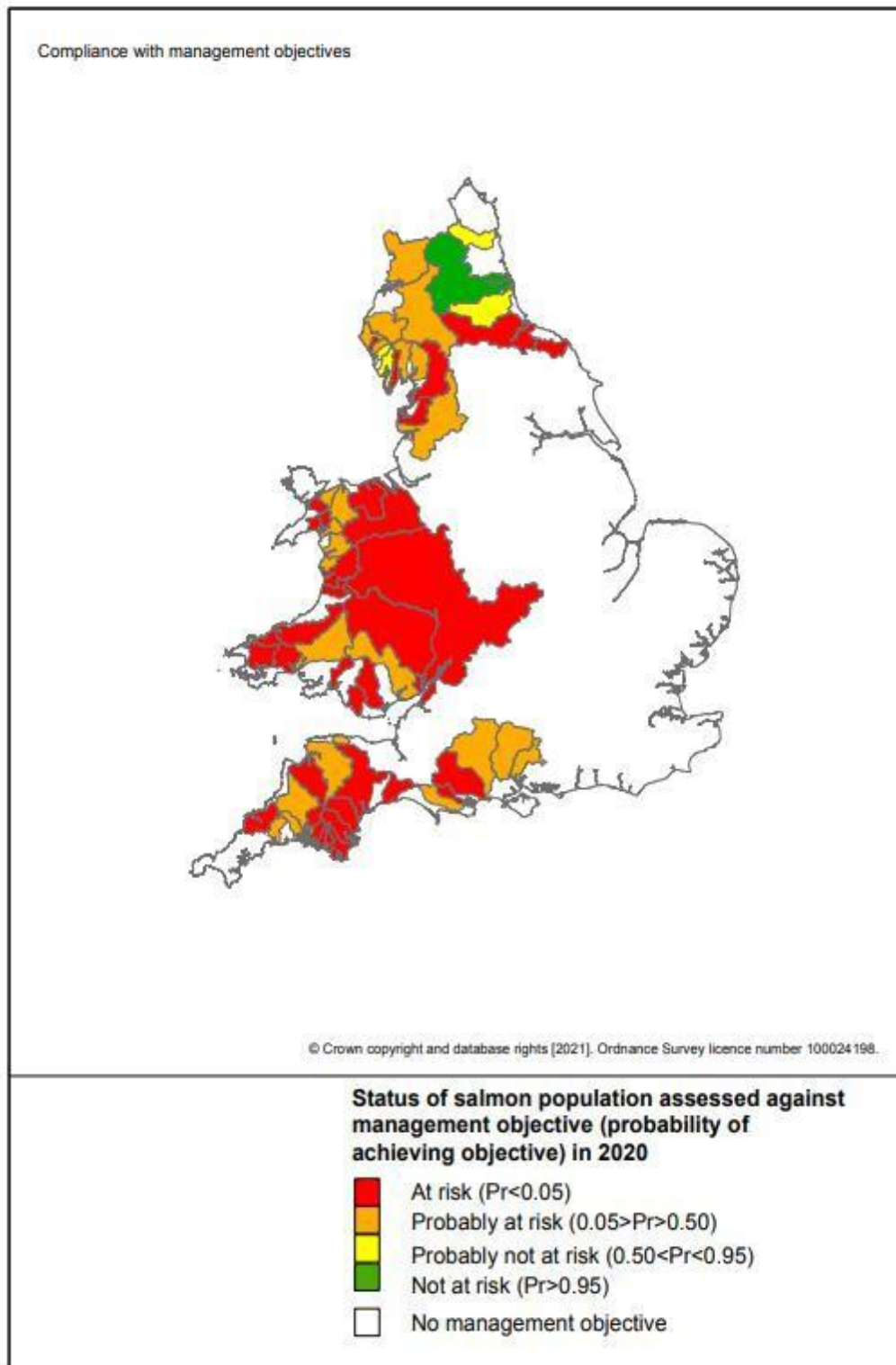


Figure 2.6- Status of river catchments in 2020 (Environment Agency, 2020)

from figure 2.6, it is clear that especially in Wales, the vast majority of salmon populations are at risk. Over half of all freshwater species are in decline and 13% are facing

extinction due to the increasing levels of agricultural pollution (Wild Trout Trust, 2017), which is detrimental to the angling communities.

To further add to the evidence with regards to the destruction of the river ecosystem publications by the government revealed that there has been a decline in salmon population within the UK and showed an almost catastrophic loss in population over a 5 year period, a -92% decrease in the number of salmon caught (GOVc,2021), in Wales populations of both trout and salmon have dropped dramatically in a 5 year period

Focusing mainly in Wales the majority of rivers classified as not at risk has steadily declined to all 22 principle salmon rivers being classified as 'at risk' where as in England 37 out of the 42 principle salmon rivers (GOVc,2021). The as can be seen from figure 2.6 from the same source, the majority of rivers at risk are predominantly in the west, this is mostly due to the increased level of livestock farming in comparison more cereal and crop based farming in the west. please see figure 2.7 for the percentage of salmon rivers being categorised (GOVc,2021).

Focusing mainly on Wales whose situation of the risk of rivers is considerably worse than England, possibly due to a lower coverage of NVZ's and as shown by the publication there has been a steady decline in both categorised river quality and fish catches.

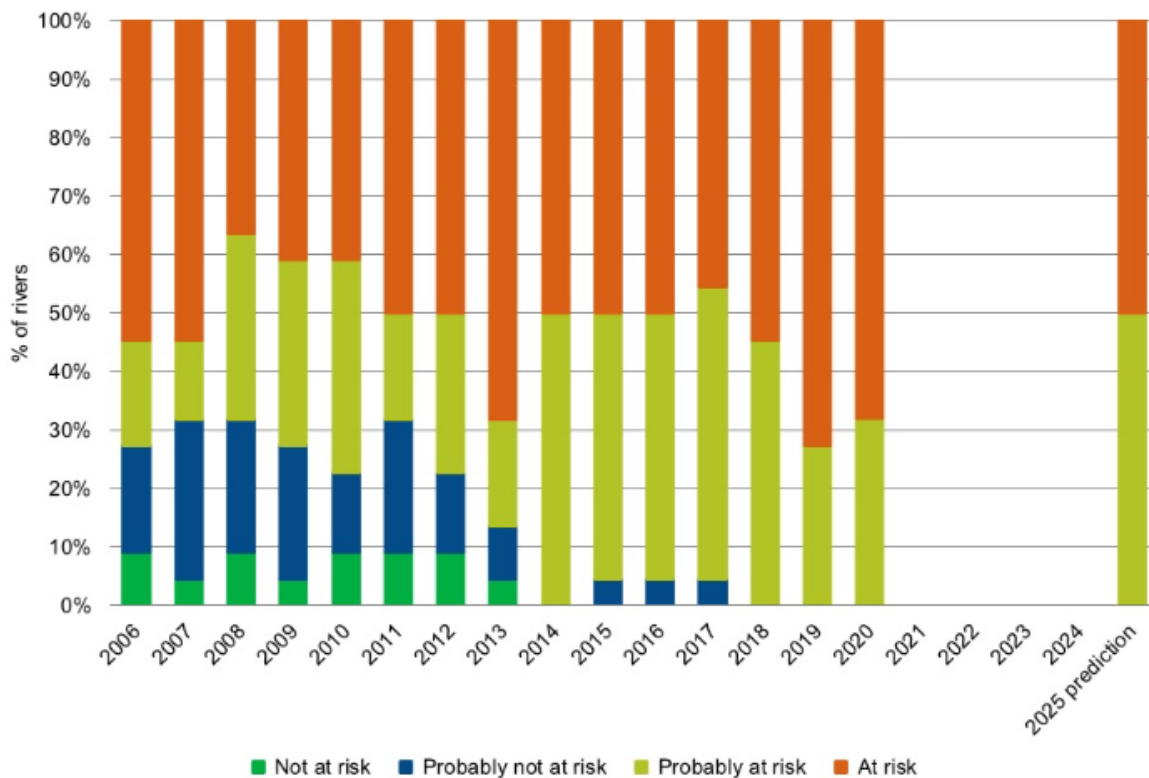


Figure 2.7 Percentage of principal salmon rivers in each risk category assessed against the management objective, for 2006 to 2020 and as predicted for 2025 for rivers in Wales (GOV c, 2021)

However, it is important to note that the impact of water quality is not solely caused by ammonia pollution, but also by a variety of other ammonium contributing sources, both from man (anthropogenic) and from natural sources. One of the main sources as indicated in figure 2.7 is the morphology of the local areas. Other secondary natural sources of pollution such as sediment and pH, the pH levels normally effected by forestry's (Forest Research, 2021), whose pine needles causes considerable acidification. Ammonia, being the focus of this particular studies represents 43% of the reasons for not achieving good quality, a substantial percentage (Hatton-Ellis, 2016). Again, ammonium pollution can be caused by both natural sources or disturbances and from anthropogenic origins such as industry and agriculture. Manmade industry contributes to nitrate pollution due to the release of nitrous oxide, which is absorbed into water bodies, as previously discussed. Technical case supporting a public consultation on proposals for new fishing controls to protect salmon and sea trout stocks in Wales by NRW (2017) reported in a technical case how the variety of reasons why water catchments are not classified as good quality. And although farmers are

not the only ones responsible for the release of ammonium-based substance, they do represent some of the largest contributors, with the excess of slurry and fertiliser. A testament to this is shown in the previous map figure 2.4 displaying the NVZ's of Wales and groundwater quality, in a chemical perspective, shows both the impact on water quality from agriculture not adhering to laws not controlling ammonium-based products (outside nitrate vulnerable zones) and to water quality in and surrounding nitrate vulnerable zones. According to the MAFF (2000) it is estimated that agricultural land in the United Kingdom receives in excess of 125kg of Nitrates per hectare each year. Although as discussed farmers are not the only source of nitrate pollution, they are responsible for 70-80% of all nitrates in British rivers comes from agricultural source's (Ferrier et al., 2001; Defra, 2004; Neal et al., 2006). So, despite not being the only contributors to nitrate pollution, due to huge volumes of excess nitrate-based fertiliser has led to the eutrophication of surrounding water bodies and a degradation in quality of surrounding groundwater catchments as seen in figure 2.8

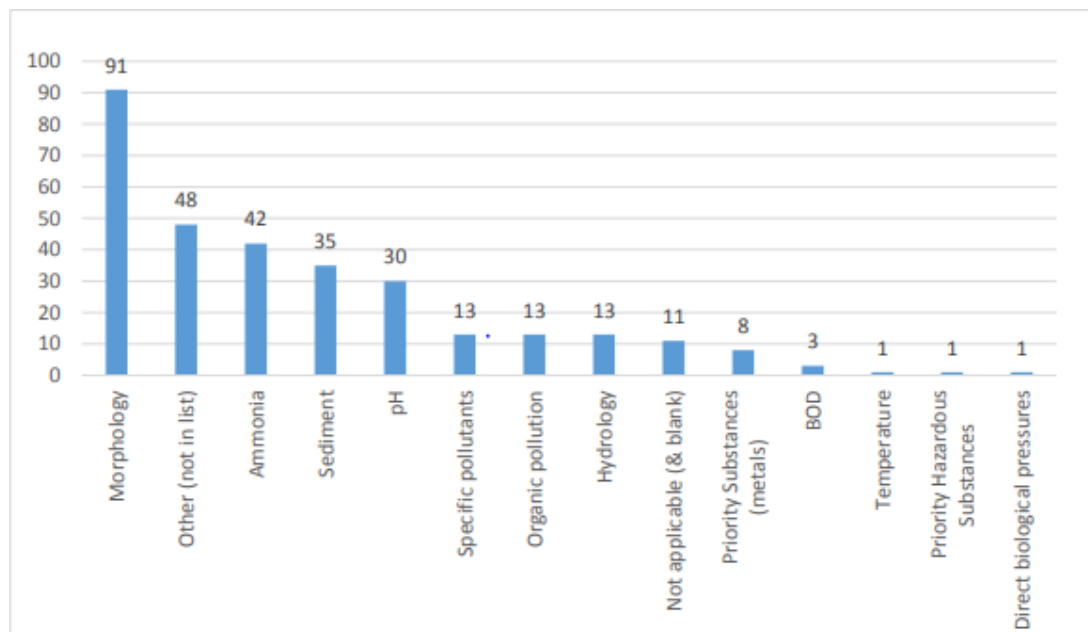


Figure 2.8 reasons for water not achieving passes in quality (NRW, 2017)

The choice for making all of Wales an NVZ, making all of the country 'protected' has been argued to reduce unfairness between competing farmers, as all are subjected to the new rules, rather than a few unlucky farmers whose land may be designated as an NVZ. It would also stop potential land disputes between farmers whose land borders NVZ's. the original suggestion by natural resources Wales was to increase the coverage of nitrate vulnerable zones to around 8%, but instead the government decided to go for the considerably more ambitious objective into turning all of Wales into a nitrate vulnerable zone, whose rivers and water bodies will be protected and monitored by law. But in order for the transition of becoming a nation-wide nitrate vulnerable zone cannot be done by sheer law and enforcement but must be done alongside farmers, taking into account their perspectives and attitudes towards the curtain decisions that are greatly impactful on their lives and the lives of other groups who are reliant upon the river.

3. AIMS AND OBJECTIVES

The main aim of this project is to understand the opinions of view of people who are impacted by nitrate pollution, people who are reliant on rivers for either livelihoods or recreational activities, such as anglers, fishermen, or anyone who works within aquaculture. This study aims to explore the opinions of this demographic on how nitrate pollution has impacted them, the scale nitrate pollution has impacted the environment, the responsibilities concerning nitrate pollution of various stakeholders, their attitudes towards farmers and nitrate vulnerable zones, and the views towards an all-Wales NVZ and the potential for an all-UK NVZ. It is designed to understand their opinions on NVZ's, the efforts made by government and farmers, and their concern for the environment.

The reason and relevancy of this study are due to the recent and very drastic changes undertaken by the Welsh government in turning all of Wales into a nitrate vulnerable zone, from 2.3% of land coverage to for all over the country, introducing a large number of very strict laws that talk about the storage and quantity of nitrates. This sudden and rather unexpected change has left many farming communities in shock and angry at the new changes, there have been appeals made by the Farmers union and now threatening legal action, due to the economic disadvantage this gives to farmers, however, it would be interesting to know the attitudes and practices of farmers on other groups, such as anglers, outside of the farming community, and what has the impact of pollution has been for them.

There have been relatively recent studies into the attitudes of farmers with regards to their opinions and objections to nitrate protection laws, with the introduction of NVZ's particularly about Scotland, however Scotland (Barnes, 2009). The nitrate vulnerable zones in Scotland only account for around 14% coverage, but there has been little information regarding Welsh farmers and their attitudes, opinions, and practices. But there has been even less literature concerning secondary affected parties and communities. This study hopes to

bring insight into the impacts and views of nitrate pollution, outside of the farming community.

4. METHOD

4.1 PARTICIPANTS

The eligibility criteria for participants of this study are that they had to be older than 18, residing in the United Kingdoms, and be employed within the aquaculture industry, and/or be involved with recreational activities involving the freshwater environment. This is essential as it is the impacts, opinions, and views of people who are reliant on the freshwater environment, that is the objective of this study. In total 60 participants responded to the questionnaire, however, 29 participants had to be excluded due to not being eligible for the study. This leaves a total of 31 participants who fall within the wanted criteria. Out of the 31 participants, 23 were male and 8 were female, with an average age of 34 with an age range of 20 to 56 (standard deviation= 9.06). although all 31 participants resided in the UK, their nationalities did differ, with the vast majority coming from England.

Several measures were required to ensure that participants matched the necessary criteria for this study. The socio-demographic questions screened for age, country of residence, whether they are employed in the aquaculture industry (such as fishing), or whether they are involved with recreational hobbies that are reliant upon the water environment.

4.2 DATA COLLECTION

A questionnaire was developed to understand the responses to the target participant group, people who are reliant upon rivers and freshwater bodies for their recreational activities or livelihoods, such as anglers and fishermen. The questionnaire was made of 25 questions, each question belonging to a different category, designed to understand the impacts, views, and attitudes towards the participant group. The questionnaire is based off of questions from several studies involving nitrate pollution but also agriculture-based studies that explore attitudes (Barnes 2008), and also based upon the government's All-Wales NZV consultation document regarding the opinions of farmers (Welsh Government, 2016). Although the nature of these studies is dedicated to the opinions of farmers, the main focus of this study is the opinions of fishermen and anglers and therefore the questions are oriented towards the wanted participant group over the farmers of the previous studies.

The questionnaire was distributed on an open link Microsoft form as an attachment. The link was distributed through social media and email to several angling and fishing societies and groups, as they are part of the target demographic. The questionnaire link was further distributed by emailing personnel and contacting various wildlife and river trusts, other groups that may have participants that have a vested interest on river nitrate pollution. Single messages containing the link were also sent to angling members within the groups.

A short introductory paragraph is shown before the first question, explaining the context of the research, the purpose of the questionnaire, and who the questionnaire is oriented to. The questionnaire consists of several types of questions: multiple-choice, Likert scale in order to gain a magnitude to the opinions of participants, and open-ended questions.

Several interviews are also to be conducted to collect opinions from those who either have an interest or are involved or affected by river nitrate pollution, interviews are to be conducted over the phone, in order to gain opinions related to the questions from the questionnaire. Interviews are to be recorded for, for replay ability and record keeping, being stored on a secure drive. The interviews will be conducted after the questionnaire has been

completed, in order to gain opinions and perspectives of any trends or anomalies that appear within the survey's results. The preferred participants for the interviews are people who have a good awareness of nitrate pollution and with an attachment to the fishing community or the environmental sector. The opinions, views and perspectives of the participants will be presented alongside the survey results alongside the various categories and will be further examined for the discussion.

4.3 DATA PROCESSING

The questionnaire as stated above are designed to provide data for several categories.

The following categories the questionnaire is designed for include:

- Demographics
- Awareness of NVZ's and nitrate pollution
- Human impact
- Environmental impact
- Views and opinions on NVZ's
- All Wales NVZ

The results of the relevant questions belonging to each category will be compiled and presented within the results section clearly under each category, along with the opinions and comments of the interviewees in order to see whether there is a verification or difference of the survey results with the opinions of the participants who have been interviewed

The data was processed using a combination of Microsoft forms and Microsoft excel. From the responses, frequencies were taken and presented alongside participant percentages. Certain questions used a Likert scale, in order to gain a scale of impact and a magnitude to certain opinions, these results were also processed by Microsoft excel and Microsoft forms. For the open-end questions, answers from participants are categorised into several groups depending on their nature, frequencies of each category will be processed using Microsoft excel. The interviews were audio recorded then relevant questions and responses are manually transcribed for presentation within the results section.

5. RESULTS

This chapter is designated for the results of the survey as described previously. This chapter will be separated into several sections accordingly to each segment of the questionnaire. This study was designed to understand the impact and opinions of nitrate pollution of people who are reliant upon freshwater environment either for work or recreational, it is also designed to collect opinions of these participants regarding their views towards nitrate vulnerable zones, their opinions on an all-Wales nitrate vulnerable zone, and their opinion on the potential for the United Kingdom to become a nationwide nitrate vulnerable zone, as discussed in the method section.

Interviews were conducted on two individuals:

the first interview was conducted with 'Interviewee X an employee of Natural Resources Wales as part of the Land management forum, with 2 years of experienced, and has been advising the Senedd with regards to nitrate pollution. X has been heavily involved with the Carmarthenshire Fishermen's Federation and within the angling clubs, with a lot of experience and knowledge in both the environmental sector and with the angling and fishing community.

The second interview was conducted with 'Interviewee Y, a man also involved with the Carmarthenshire Fishermen's Federation, with a strong history of fishing and angling. After a career in law, Y was an important figure in pushing the new all-Wales nitrate vulnerable zone laws through the Senedd and legally fighting against the NFU, who were strongly opposed to the laws.

Both interviewees have a large amount of knowledge and are extremely up to date with regards to the current legal situations regarding nitrate vulnerable laws, attitudes of the farming, attitudes of the angling community, environmental knowledge concerning the effects of nitrate river pollution, farming practices, and of the government and actions of the environmental agency.

5.1 DEMOGRAPHICS

In total 59 participants completed the survey as described previously. However, out of the 59 participants, only 31 people belonged to the target participant groups, either working within the aquaculture industry or being involved in recreational activities involving the freshwater environment. In total, the participants that met the criteria were a total of 31 people, 23 males, and 8 females, with an age range of 20 to 56 (mean= 34, standard deviation=9.06). the majority of the participants identified their nationalities as British (65%), participants identified as Welsh, (16%), and 19% of participants within other categories, consisting of polish, German, Spanish, Nigerian, and American. It is important to note that although 16% of participants identified as Welsh nationality, there may also be Welsh and English identifying as 'British'.

All participants are residents of the United Kingdom. The majority of the participant residencies are from England= 71%, Wales= 23% and Scotland= 6%

Out of the 31 participants that meet the wanted criteria, 39% work within the aquaculture industry and are reliant upon the aquaculture industry, and 98% of those who work in the aquaculture industry are also involved in recreational activities.

During the interviews when questioned for what the possible reasons as to why there was a lower response rate from Wales, both participants expressed that there is a difference in culture between English Anglers and Welsh Anglers. This comment was furthered this by the comparison between the more rural Wales compared to the more urbanised England, with the rural community being more disconnected to information.

5.2 AWARENESS OF NVZ'S AND NITRATE POLLUTION

This section investigates the participants awareness of nitrate vulnerable zones.

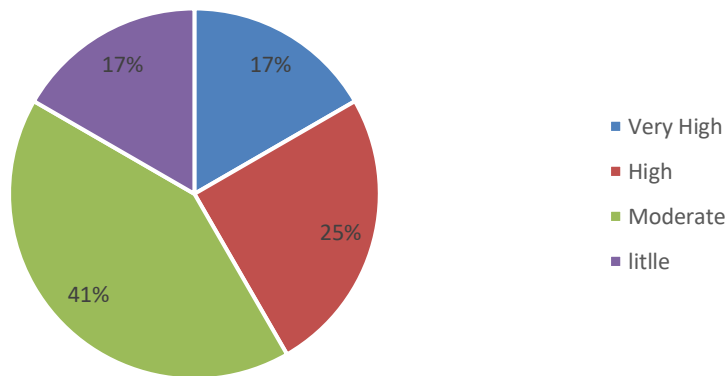
Table 5.1- Frequencies of awareness of NVZ's Within the Overall Sample

How aware are you about NVZ's	Total Sample (N = 31)	
	n	%
Very High	2	6.5
High	6	19.4
Moderate	10	32.3
Little	10	32.3
None	3	9.7

From the table above it is clear that the awareness of nitrate vulnerable zones within the participant sample veers towards moderate awareness, 32.3%, and little awareness, 32.3%. out of all the samples, only 6.5% had high knowledge of nitrate vulnerable zones, and 9.7% had no awareness of nitrate vulnerable zones. It is important to note that although participants may not be aware of nitrate vulnerable zones, their awareness of nitrate pollution may differ, as will be discussed later.

As to be expected participants that work within aquaculture showed a greater awareness when compared to participants who were only involved in recreational activities, see figure 5.2. out of the participants who worked in the aquaculture industry, 83% chose moderate to very high awareness, which represents the majority those who are aware within the 31 participant group.

Figure 5.2- pie chart showing the proportions of awareness of participants who work within aquaculture towards NVZ's



The interviews also revealed concerns with regards to the lack of awareness and disconnection from information. Concerns were raised with regards to the rural urban divide as mentioned previously, but also due to the micro culture within the Welsh angling community. Misinformation and ignorance farming practices and legislation of the angling community has also been expressed.

5.3 HUMAN IMPACT

With regards to health concerns surrounding nitrate pollution in question 9, 77% of all participants have stated that they are concerned about the potential health impacts of nitrate pollution. Interestingly 84% of participants who work within the aquaculture industry chose ‘yes’ for their concerns over the potential health impacts. 6% of participants chose ‘No’ being concerned about health with 16% of participants choosing maybe. Please refer to the table below for the frequencies of choice.

Table 5.3- Frequencies of concern for health impacts from nitrate pollution Within the Overall Sample

Are you concerned about health impacts of nitrate pollution	Total Sample (N = 31)	
	n	%
yes	25	77
No	2	6
maybe	5	16

Overall, with a total of 77% of participants stating that they are concerned about the potential health impacts with an additional 16% of participants choosing maybe shows an overall significant concern within the participation sample towards the health impacts.

With regards to the impact of people’s livelihoods or recreational hobbies, the frequencies were far different from the concerns of health impact, as shown on table 5.4.

Table 5.4 Frequencies of concern for livelihood or hobbies impact from nitrate pollution Within the Overall Sample

Has your livelihood or hobbies been affected by nitrate pollution	Total Sample (N = 31)	
	n	%
yes	11	35
No	6	19
maybe	13	42
N/a	1	3

From the results above, there is far greater uncertainty surrounding whether participants' livelihoods or recreational hobbies have been affected by nitrate pollution, with only 35% of participants stating 'Yes'. Every participant who chose 'yes' and 'maybe' in this question, also chose 'yes' to whether they are concerned about the potential health impacts of nitrate pollution. 19% of participants in this sample chose 'no' and 3% chose N/a.

67% of participants who work within aquaculture and are reliant upon the river for their livelihoods also stated 'yes'

Both interviewees also expressed views referring to the deterioration of the river ecosystem, due to eutrophication and the damaging impact it has had on the angling community, despite there being a low awareness among the angling community members. Interviewee X stated that anglers as a community are more solitary, preferring to be by themselves. He also stated that within the community there was a want for call to cull predators such as kingfishers and otters, due to consuming too many fish, interviewee X further elaborated that this is due to the river ecosystem collapsing resulting in a decrease in fish population, meaning that fishermen are taking more notice of natural predators, and see them responsible for fish population decline.

5.4 ENVIRONMENTAL IMPACT

This section of the results explores the participants' views regarding the impact of nitrate pollution on the environment, rather than their livelihoods or hobbies. The first question in these questions asks the participants the scale of the impact of nitrate pollution on freshwater wildlife.

Table 5.5 impact of pollution on wildlife

Impact of Freshwater wildlife	Total Sample (N = 31)	
	n	%
Very Great	2	6.5
Great	17	54.8
Moderate	7	22.6
Small	3	9.7
Very small	2	6.5
None	0	0

As can be seen from the table above, the participant from the sample, every participant has stated that there is an overwhelming bias that nitrate pollution has had an impact. Not one participant chose 'not at all' option, meaning the whole sample believe that there is some impact. A total of 54.8% chose great, 6.5% chose very great. With an additional 22.6% of participants choosing moderate. Meaning out of the sample 83.9% of the sample chose options greater than small, showing the magnitude of nitrate pollution on wildlife. This could be compared to the previous question 'has your livelihood or recreational hobbies been affected by freshwater nitrate pollution in which 77% of participants chose 'yes; and 'maybe'. The views on whether protecting the environment is a greater priority than the welfare of the agricultural industry are explored in question 23. See table below

Table 5.6 opinions on whether the environment or farming industry has greater priority

Is protecting the environment a greater priority than the welfare of the agricultural industry?	Total Sample (N = 31)	
	n	%
yes	24	77
No	6	2
maybe	5	16

From the table above, the results show a vast majority of participants from the sample (77%) view the protection of the environment as being a greater priority than the welfare of agriculture.

The interviewees shed a lot of light concerning the impact agriculture has had on the environmental quality of the rivers. In a comment made in interview X, 90% loss in river invertebrates has been seen over a period of 5 years, a relatively rapid degradation. Interview X also stated that the rivers in Wales are some of the most damaged and lifeless rivers in Europe. During the interview participant X emphasised the catastrophic loss of ecosystem in Welsh rivers particularly the population in invertebrate, a food source for many creatures in the river. The reduction in this food source population has drastically lowered fish populations, resulting in fishermen noticing predator action within the river, and mistaking the predators being the main reason of fish population decline.

5.5 RESPONSIBILITY

This part of the results will focus on the participants' views and opinions to understand the opinions of people who use the freshwater environment either for their jobs or for their hobbies. This section looks into the participants' views regarding the responsibilities of various parties. Topics that will be searched; what is most responsible for causing water pollution, who is most responsible for causing the pollution, and who is most responsible for protecting the environment.

Several questions in the survey were directed at gathering the views of participants on what causes nitrate pollution. The first question (10) 'what is the greatest source of nitrate pollution' was asked, with the vast majority of participants. Although for this question many participants gave more than one answer, as such all answers will be used within this section.

Many responses included the use of both farming/ agriculture with the use of fertilisers. In total 30 participants completed the question, and there are 37 answers, due to the participants writing multiple answers. The answers of these participants were then categorised depending on their topic, for example, agriculture and farming, fertiliser, industry, and waste. The frequencies for each response were taken for each category. Please see the table below showing the frequency of answers by category.

Table 5.7 categories and frequencies of opinion in what the greatest source of nitrate pollution

What, in your opinion, is the greatest source of nitrate pollution in Wales?	Total Answers (N = 37)	
	n	%
Farming	15	40.5
Fertiliser	14	37.8
Industry	2	5.4
waste	6	16.2

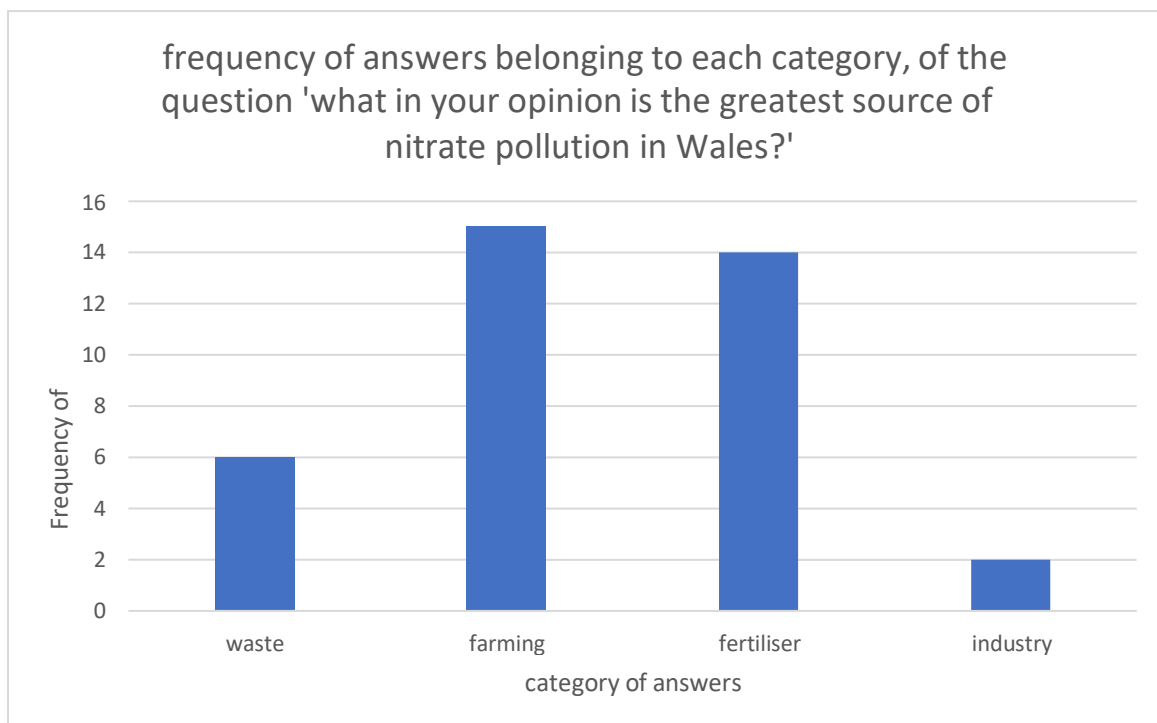
As can be seen from the table 78.3% of all responses are related to farming and fertiliser. 6 out of the 30 respondents, 20% mentioned both farmers and fertiliser in the same response. In terms of waste words such as agricultural runoff and livestock, waste was used for 3 of the 6 responses, adding to the bias that agriculture is the greatest source of nitrate pollution.

Figure 5.8. word cloud displaying the various open responses to the question 10 'what is the greatest source of nitrate pollution'



The number of the opinions of the participants that farmers and the use of fertilisers is the greatest source of nitrate pollution. Please see the graph below for visual representation.

figure 5.9 a graph to display frequencies of categories of the greatest source of nitrate pollution



Question 11 'Who in your opinion is most responsible for nitrate pollution in Wales?', although similar to the previous question, further explores the accountability from the perspective of people who are reliant upon freshwater for their hobbies or livelihood over which stakeholder is responsible for causing the pollution. Although from the previous question farming and fertiliser represented the vast majority of sources of pollution, the question of who is responsible, whether government, farmers, or the public needs to be answered. Again, participants in the sample gave multiple answers which were then categorised accordingly, as seen previously. In total 30 participants answered the question and gave a total of 32 usable answers.

Table 5.10 categories and frequencies of whom is most responsible for nitrate pollution

Who, in your opinion, is most responsible for freshwater nitrate pollution in Wales?	Total Answers (N = 32)	
	n	%
Farmers	17	53.1
government	7	21.9
Industry	2	6.3
human	3	9.4
forestry	1	3.1

From the table above it is extremely clear that from the participation group the vast majority of the participant group chose farmers, 53.1%, and the government, 21.9%. there is also a small significant percentage, 9.4%, who answered human beings in general, or everyone, keywords taken from the responses.

To further add to this, question 21 ‘How much have farmers contributed to freshwater nitrate pollution? Would give a scale and magnitude to their impact, especially proceeding from question 10 and question 11, whose majority answers for both have been farmers/ agricultural community. Question 21 intends to give magnitude to those who are responsible for polluting. Please see the table below for the results. Question 22 ‘how much effort have farmers made to reduce nitrate pollution?’ is also important as the effort which farmers have made to reduce pollution can be compared to how much they contribute, in the participants' view.

Table 5.11 comparison between the views of how much farmers contribute to pollution compared to how much effort they do to reduce pollution

	Total Sample (N = 31)					
	Not at all	very small	small	moderate	great	very great
how much have farmers contributed to freshwater nitrate pollution?	0.0%	6.5%	9.7%	12.9%	54.8%	16.1%
How much effort have farmers made to reduce nitrate pollution?	0.0%	22.6%	38.7%	22.6%	16.1%	0.0%

From the results above for question 24 of the survey there is an overall majority towards a great contribution to nitrate pollution, 54.8%, followed by very great, 16.1%. the relevancy of this question is to understand the magnitude of impact, and from the results combined with the previous two questions it is very clear that the target demographic perceives that farmers and the agriculture industry are the majority contributors due to the use of fertilisers and according to the answers of the participants have contributed, significantly to nitrate pollution, great= 54.8%, very great= 16.1%, and moderate= 12.9%. this shows that the bias trends to the greater contribution to pollution.

It is also important to note that none of the participants selected 'none', showing that all of the demographics view farmers contributing to pollution.

However, with regards to how much effort farmers are making towards reducing their pollutions shows a very different spread of data, with the majority (38.7%) choosing a small amount of effort was being made. Like previously it is important to note that no participant chose 'not at all' or 'very great'.

Finally for this section the perception of who is most responsible for protecting the freshwater environment, question 12. Again, due to the open-ended nature of the question, many answers are then categorized to display the frequencies. Arguably one of the more significant questions, as it details who in the eyes of the target demographic, is accountable for rectifying the situation. Please see the table below for the frequencies of categories for who the

participants answered for being most responsible. In total 30 participants completed the question giving 33 usable answers, again due to multiple answers provided.

Table 5.12 showing categories and frequencies of whom is most responsible for protecting the environment

Who is most responsible for protecting the freshwater environment?	Total Answers (N = 33)	
	n	%
Farming	2	6.1
government	20	60.6
companies	3	9.1
everyone	8	24.2

From the results above it is evident that despite the vast majority of the participants had answered farmers and the agricultural industry as the greatest source of nitrate pollution and the overall majority in being responsible for its cause, the government, in the participants' answers, is most responsible for the protection of the environment, with 60.6% of the demographic answers. The second majority, 24.2%, was 'everyone', which many participants answered, some generally stating people or everyone. One participant answered, 'the people that cause it'.

With regards to companies' participants were general mentioning industry and companies, with the exception of one participant, who answered a company by name 'Dwr Cymru'.

This section overall shows the demographics' awareness over the cause of nitrate pollution and those who are responsible for the pollution, farmers being the majority. However, with regards to who is most responsible for protecting the environment, it is very clear, according to the participants that the government is the overall responsible party.

During interviews with participants X and Y, both participants were questioned with regards to the biggest contributor when compared to other contributors to nitrate pollution such as sewage and water treatments. Both participants expressed those farmers in Wales were the largest source, interviewee X stating that 65% of phosphates in the water are from agriculture, whilst 30% are from sewage. Both interviewees acknowledge that farmers are not the sole contributors, but due to the agricultural environment in Wales is mainly livestock based, when compared to England, which more oriented to cereal crops, Wales is under greater risk.

When asked with regards to the sources both participants expressed concern towards the number of major agricultural pollution incidents and also concern that not all major pollution incidents are being recorded. However, interviewee X furthered that majority of farmers adhere to the rules in place, the problem lies with a minority of farmers, whose poor practices lead to major polluting events, however these events are catastrophic for the environment. Furthering on the topic of causes interview X highlighted issues of the use of satellite farms, and the contribution to pollution by 'playing the system', by essentially increasing the suitable number of livestock for a coverage of land. Both interviewees expressed concern to the culture and attitudes of Welsh farmers, their competitive nature, slow adoption rates of information and rules, language barrier, and ignorance of environmental impact and consequences.

When questioned on the contribution and responsibility of water companies who have been criticized for sewage dumping and discharging of storm overflow tanks even at low water level. Interviewee X answered in detail that although the illegal dumping is still unacceptable and should be confronted, they are for Wales, a much smaller contributor when compared to agriculture. Both interviewees provided further insight as to why water companies, though still at fault, contribute far less to the overall pollution to rivers when compared to farmers, due to the lower level of urbanisation in Wales. Interviewee Y expressed concern for the future, where the increased level of urbanisation overwhelms the capability of the sewage and water treatment infrastructure of Britain. Interviewee X expressed that both farmers are guilty of the crime of pollution, however for the region of Wales it is important to resolve the bigger contributor, being farmers.

5.6 VIEWS AND OPINIONS ON NVZ'S

This part of the results will explore the views and opinions on the effectiveness of nitrogen vulnerable zones, this will also relate to the previous section regarding both human and environmental impact of nitrogen vulnerable zones.

Question 17 ‘Has the agricultural industry made sufficient measures to reduce nitrate pollution?’ and question 18 ‘Has the government made sufficient measures to reduce nitrate pollution?’ are designed to understand the current views and opinions surrounding the current situation, whether or not government or farming communities are adhering to guidelines or making sufficient effort to reduce pollution. Please see the table below displaying the percentage responses for both the agriculture sector (question 17) and the government (question 18)

Table 5.13 comparing the opinions of whether the agricultural industry has made sufficient measures to reduces nitrate pollution compared to the government's effort

	Total Sample (N = 31)		
	Yes	No	Maybe
Has the agricultural industry made sufficient measures to reduce nitrate pollution?	19%	58%	23%
Has the government made sufficient measures to reduce nitrate pollution?	26%	29%	45%

Table 5.13 is used as a comparison and can be used to gauge which party, the agriculture industry, or the government, the demographic participant group view as lacking in the commitment to reduce nitrate pollution. The results show for the majority of ‘Has the agricultural industry made sufficient measures to reduce nitrate pollution?’ 58% have chosen no, whereas for whether the government has made sufficient measures there is greater uncertainty, with 45% of participants choosing ‘maybe’.

Concerning question 17, ‘has the agriculture industry made sufficient measures to reduce nitrate pollution, 86% of the participants who selected ‘no’ also chose ‘no’ for question 16 ‘Are the new laws introduced by the Senedd too harsh or severe on farmers?’

Question 13 ‘Before the decision of the Senedd to turn all of Wales into NVZ, was Wales sufficiently protected from nitrate pollution?’ is there to discover whether or not participants viewed their livelihoods as protected by previous nitrate vulnerable zone laws.

Table 5.14 opinions on whether Welsh water were protected before the all-Wales NVZ

Prior to the decision of the Senedd to turn all of Wales into NVZ, was Wales sufficiently protected from nitrate pollution?	Total Sample (N = 31)	
	n	%
yes	5	16
No	22	71
maybe	4	13

From the table above the results show a significant majority of participants choosing ‘No’ (71%), this reflects heavily on the concern of the potential health impacts of nitrate pollution, in which a similar proportion of the participants (77%) selected ‘Yes’.

Both interviewees expressed the serious concern for nitrate pollution from all sources. However, they emphasised the point that agriculture being the overwhelming contributor to pollution, nitrate vulnerable laws are needed in Wales, both interviewees expressed that due to Welsh agriculture being more oriented towards livestock, the threat of nitrate contamination from runoff, excessive spreading, need monitoring and control. On the topic of effort and

attitudes of the farming community, both interviewees expressed that there may be issues imbedded into the culture of Welsh farmer. Interviewee X provided further insight describing that majority of Welsh farmers had adopted a post-war ideology which stresses efficiency and output over environmental conscious. Both interviewees stated that there may be a reluctance to adoption of new farming techniques, preferring traditional or older techniques. Interviewee X also stated that communication could also be an issue and emphasised the importance of having more Welsh speakers engaging with farmers.

5.7 ALL-WALES NVZ

This section explores the results-orientated around the views and attitudes of the participants towards the new laws introduced by the Welsh government. These results can be compared to the results of the previous section which showed the overall attitudes and perceptions of the previous nitrate vulnerable zones.

The view on the restrictions of nitrate-based fertilisers, as part of the new NVZ laws, alongside the participants view on whether the new laws are too harsh or severe on farmers relates to questions 20 ‘On a scale of 0 to 5 how important is the control and restrictions of nitrate-based products used in agriculture for the preservation of freshwater wildlife?’ and question 16 ‘Are the new laws introduced by the Senedd too harsh or severe on farmers?’.

With regards to the participants' view of the importance of the control and restrictions of nitrate based products for agricultural use, please see the table below.

Table 5.14 the scale showing opinions regarding the importance of controlling nitrate based products

On a scale of 0 to 5 how important is the control and restrictions of nitrate-based products used in agriculture for the preservation of freshwater wildlife?		
Total Sample (N = 31)		
	n	%
Very Great	8	25.8
Great	13	41.9
Moderate	8	25.8
Small	2	6.5
Very small	0	0
Not at all	0	0

From the results above there is an overwhelming majority in favour of the importance of controlling and restricting nitrate-based agricultural products. No participants chose ‘not at all’ or ‘small’. 25.8% chose very great, 41.9% chose great, and 25.8% chose moderate. Overall, the participants view the necessity and restrictions of nitrate-based products as important.

With regards to the sympathies towards farmers and the new laws revolving around the storage and use of nitrate-based fertilisers and products, question 16 asks whether the new laws being introduced by the Senedd are too harsh or severe on the farmers, please see the table below.

Table 5.15 opinions on whether new all-Wales NVZ laws are too harsh or severe on farmers

Are the new laws introduced by the Senedd too harsh or severe on farmers?	Total Sample (N = 31)	
	n	%
yes	3	10
No	19	61
maybe	9	29

As can be seen from the result the overall sympathies towards farmers with regards to the newer more restrictive laws is that the majority of the participants do not view the new laws as too severe, with 61% of the participants choosing ‘no’. only a small minority(10%) chose ‘yes’.

Table 5.16 comparison of opinion regarding All-Wales NVZ, whether it will be sufficient, and opinions of an aal UK NVZ

	Total Sample (N = 31)		
	Yes	No	Maybe
Do you agree in turning all of Wales into NVZ?	83%	10%	7%
Will turning all of Wales into a NVZ be sufficient to protect freshwaters from nitrate pollution?	41%	14%	45%
Should the rest of the UK also adopt a nationwide Nitrate Vulnerable Zone plan?	74%	10%	16%

Questions 14 ‘Do you agree in turning all of Wales into NVZ?’, question 15 ‘Will turning all of Wales into an NVZ be sufficient to protect freshwaters from nitrate pollution?’ and question 24 ‘Should the rest of the UK also adopt a nationwide Nitrate Vulnerable Zone plan?’ shows the results of the participant's view of the newly introduced laws, whether or not they see the new laws as effective, and the opinion in the rest of the United Kingdom adopting a nationwide nitrate vulnerable zone. Please see table 5.16.

The results show large enthusiasm for an all-Wales nitrate vulnerable zone, with 83% of participants choosing ‘yes’ to whether they agree with an all-Wales NVZ. To add to the results the opinion regarding a potential nation-wide nitrate vulnerable zone is also a ‘Yes’ majority, leading with 74% of the participants' answers.

However, the results also show a great deal of uncertainty with regards to the effectiveness of the new laws, with 45% of participants choosing ‘maybe’, the second majority is also ‘yes’ making 41% of the participants' choice. Overall, there is a want for new nitrate laws, however, there is some uncertainty among the participants with regards to its effectiveness.

Suggestions for alternative ideas to protect the environment from nitrate pollution was the final question (25), which also had the fewest responses. However, some key answers were given, mentioning, greater restrictions and fines, using organic and environmentally friendly fertilisers, and movement towards sustainable farming.

During interviews with participant X and Participant Y, both were highly supportive for greater regulation to nitrate pollution, however did bring potential problems that the new regulations may face. Participant X who works within the Natural Resources Wales expressed that the environmental agency’s ability to regulate and monitor nitrate pollution and to enforce the

nitrate vulnerable zones is entirely dependent on government funding, but also depending on available man-power. Participant X suggested that natural resource Wales could adopt a volunteer based system in which passionate individuals are given basic training, and using equipment calibrated to NRW's standards could provide essential data that would help monitor the pollution levels in the areas. This does show uncertainty with regards to the ability of the authorities to regulate the NVZ. Both participants also showed great concern for unrecorded agricultural pollution incidents.

Both Participants also expressed that the introduction of the all Wales NVZ would create an economic equality across the country so that the minority of farmers previously situated in the old NZV's would not be disadvantaged. Interviewee Y when asked about an NVZ across the whole of the UK, he was in favour due to the economic equality, but emphasised the importance of the establishment of the all Wales NVZ, due to the livestock based agriculture when compared to England's more cereal crop based agriculture.

6. CONCLUSION

6.1 DEMOGRAPHICS

Out of the 59 participants only 31 met the criteria applicable for this study, the residencies of the sample reside predominantly in England 71%, Wales=23%, and Scotland =6%. Out of the 31 participants 31% work within the aquaculture industry, 98% of which are also involved recreationally.

During the interviews with participant X and participant Y, on whether there is a cultural difference with regards to Welsh anglers and English anglers, due to the higher response rate from England, the interviewees stated that there may be a cultural divide, possibly due to Wales being more rural when compared to the more urbanised England, expressing that there may be a disconnection to information in rural areas.

6.2 AWARENESS OF NVZ'S AND NITRATE POLLUTION

Participants' awareness of nitrate vulnerable zones was overall poor, with the vast majority choosing little to moderate awareness, (Very High= 6.2%, High= 19.4, moderate= 32.3%, little= 32.3%, none=9.7%). However, awareness of NVZ's does not necessarily correlate to awareness of nitrate pollution. But the interviews both expressed a disconnection of information among the angling community with regards to laws and regulations concerning agricultural pollution. Participants that worked within the aquaculture industry and are reliant upon the water environment showed far greater awareness (83% chose moderate to very high awareness) than those who only involved recreationally. This shows that besides the participants that work within the industry, there is a very poor awareness among participants who are only recreationally involved. The interview opinions regarding the awareness of anglers expressed that the anglers are more solitary and less social/ communal, in both interviews it was stated that anglers had a poor awareness of farming regulations, laws and practices, but also the impact on the river ecosystem, with some anglers associating the loss of fish populations with increased

predatory activity, interviewee X expressed the desire to cull various predatory species. This overall shows a very poor awareness not just of NVZ's but also the situation as a whole. Both interviews told that there is a lack of information and also misinformation being spread by those who resist the all-Wales NVZ, such as NFU.

6.3 HUMAN IMPACT

The impact on livelihoods and recreational hobbies shows 35% stating 'yes', 19% stating 'no' and 42% stating 'maybe', this again shows a participant's uncertainty with regards to how nitrate pollution has impacted the sample participants, although every participant who selected 'yes' also selected 'yes' for their concern about health impact. Out of the participants that worked in the aquaculture industry, 67% chose yes to their livelihoods being impacted, and therefore make up the majority of the participants selecting 'yes' out of the total participant pool. This relates back to awareness in which participants only involved recreationally have lower awareness of the nitrate pollution impact on their hobby.

There was an overwhelming concern for the potential health impacts related to nitrate pollution with 77% stating 'yes' and 16% stating 'maybe' showing an overall majority who are either concerned or uncertain about the health-related problem. Again those who work within the aquaculture industry make up the majority of the total participant's choosing 'yes', with 84% of participants who work within the industry choosing 'yes'.

6.4 ENVIRONMENTAL IMPACT

Opinions regarding environmental impact were significantly more decisive with 54.8% of all participants stating that nitrate pollution has had a great impact on the environment, and 22.6% stating moderately. This shows an overall majority in favour of nitrate pollution having a large impact on the freshwater environment. When asked whether protection of the environment or agricultural welfare was more important the vast majority

(77%) chose the environment over agriculture in terms of importance.

In both interviews expressed the overwhelming impact nitrate pollution has had on river ecosystems, the effects of eutrophication and the loss of ecosystem, interviewee X commented that there was a 90% loss of invertebrates within ecosystem, during the interviews both could not stress the disastrous impact that bad agricultural practices and pollution incidents have impacted the river ecosystem. Both interviewees also expressed a concern to the lack of monitoring and undocumented pollution incidents.

6.5 RESPONSIBILITY

Participants when asked what the greatest source of nitrate pollution was from, the responses showed four main categories. The most frequently mentioned was farming (40.5%), fertiliser (37.8%), waste (16.2%), and a minority stating answers relating to industry (16.2%). In total 78.3% of responses relate to farming and fertiliser. Showing an overall view that the agricultural community is responsible for the majority of nitrate pollution, from the perspective of the participants.

The interviewees gave considerable detail into the level of pollution caused by agriculture, when compared to sewage (the other major contributor) Interviewee X stating that 65% of phosphates come from agriculture, whilst 30% comes from sewage. This opinion aligns with literature statistics and also the opinions of the majority of the survey participants. Interviewee Y commented that the situation in Wales was different to that in England due to the Wales being a more rural country than England, Sewage being a larger problem in more urbanised areas. Likewise, the agriculture in Wales is considerably more harmful to the river ecosystem due to agriculture being more orientated around livestock in Wales. Interviewee expressed that although sewage dumping is still a crime that needs to be rectified, the agriculture as a sector needed more attention first due to it being on a much larger scale.

When asked who is most responsible for protecting rivers against nitrate pollution, the majority response was farmers (53.1%) and the Government (21.9%).

The participants when asked how much farmers have contributed to nitrate and responded with the majority of answers being great (54.8%) and very great (16.1%). In terms of how much effort farmers have made to reduce nitrate pollution participants gave a varied response; however, the majority of the answers display very small, small, and moderate efforts for reducing nitrate pollution, showing from the participants perspective a lack of effort and responsibility in reducing pollution, which forms the majority of the participants view, the farmers are creating. However, the participants' view of whom is most responsible for protecting the environment from pollution, the government is the majority answer, followed by 'everybody'.

Participants were asked for their views of both the government and the agriculture industry, on their efforts/ measures on tackling nitrate pollution. The results show a slightly more positive view towards the government with regards to making effort in reducing nitrate pollution in comparison to the agriculture industry. According to the results of the survey only 19% of participants selected 'yes' to whether farmers are taking sufficient measures to counter pollution, which shows the overall lack of faith towards efforts being made by the farmer.

The interviewees gave concerns with regards to the culture of Welsh farmers who priorities of efficiency, profit and output over sustainability or environmentally friendly practices, and slow adoption rates from the government. Slurry lagoons were mentioned by both participants as major concern, in terms of being disastrous to rivers if ill maintained.

Overall this section reveals the angler's opinion of the efforts and attitudes of farmers from the participant's perspective, in total the responses veer towards a more negative perception of farmers and may explain the lack of sympathy towards the severity of the NVZ laws.

6.6 VIEWS AND OPINIONS ON NVZ'S

The results show that Participants answered that Wales was not protected under the previous nitrate laws, with 71% of participants choosing 'no'. Overall, this section shows that there is an overall lack of faith for previous nitrate vulnerable zones in Wales, ability to protect the water from nitrate pollution, especially when considering the participants' view with regards to how little effort farmers are doing to reduce pollution. In both interviews there was strong concern for the health of rivers and stressed the importance of the all-Wales NVZ

6.7 ALL-WALES NVZ

With regards to an all-Wales NVZ, there was an overwhelming majority for support of controlling and restricting nitrate-based products for the preservation of the freshwater habitat. (Great=41.9%, Very Great= 25.8%), this can be related to the view that farmers are not taking enough responsibility or making enough effort in reducing pollution. The participation was shown a vast majority (83%) are in favour of an all-Wales nitrate vulnerable zone. Additionally, there is also significant support from the participants for a potential nationwide NVZ encompassing all of the UK, with 75% of participants choosing 'Yes'. However, participants have shown great uncertainty towards the effectiveness of the NVZ's. this uncertainty was also expressed in the interviews, particularly participant X gave concern that the environmental agency's ability to effectively monitor and enforce the NVZ, is dependent on funding from the government and restricted by the availability of man-power within NRW, the interviewee suggested a volunteer based system that would help support NRW. Final comments left by the survey participants, for any potential solutions to nitrate pollution,heavily emphasized the need for sustainable farming, friendlier fertilisers, more fines, economic incentives, and government restrictions regarding nitrate fertilisers.

7. DISCUSSION

7.1 DEMOGRAPHICS

The overall response rate to the questionnaire was relatively high, possibly due to the fact that the topic is current and very prevalent on the news. However only 31 of the 59 participants were of the wanted criteria group. A possible reason for such a high number of participants did not qualify is due to the method of sampling, as several river trusts were contacted for completing the survey in hopes that there were participants in the criteria. Another important observation is the low response rate from Welsh participants, who in total only accounted for 23% of the participants (not including participants who did not meet the criteria), a possibility for this may again also be due to contacting fishing organisations and trusts that encompass the UK as a whole, and not solely Wales, also the possible reason why the majority of the participants for this study are not from Wales. Opinions gathered from the interviews of interviewee X and interviewee Y, two individuals who have a lot of experience within the angling. In both interviews participants expressed, when asked if there was a difference in attitudes between Welsh and English anglers (due to the higher response rate from England), that the culture not just between English and Welsh Anglers but also farmers. future research into the cultural divide between the Welsh and English anglers. The contrast between urban and rural communities is a topic that could be studied in the future in terms of access to information and the closeness and communication of members in clubs, comparing more urban environments to rural.

In hindsight improvement with regards to this study that could be made would be greater accuracy in terms of location within the country, so participants could be grouped into relevant catchments and mapped out alongside previous/ current NVZ's. other information concerning the demographics would be the level of experience of participants in angling and the frequency.

7.2 AWARENESS OF NVZ'S AND NITRATE POLLUTION

From the results of the survey, but also from the opinions of the participants involved in the interviews, there is a very low level of awareness with regards to NVZ's, with the exception of those who work in the aquaculture industry or are reliant upon rivers for their livelihoods, the reasons for this could range from experience and observation of river ecosystems and receiving information due to their jobs, or potentially being more knowledgeable from experience or qualification. Possible change to the demographic questions could be 'level of qualification?'

Opinions given from the interviewees that anglers are generally prefer solitude and are less sociable, means that they are disconnected from relevant information and even misinformation spread by those who are against NVZ's. If possible, for future studies, interviews conducted with senior fishermen would have been beneficial in comparing their opinions on the state of the rivers in their youth compared to the current state of the river ecosystems.

Because Wales is considerably more rural than England, the comparison of awareness in rural communities compared to urban communities could be a potential a future study for not just Wales but also across the UK.

During the interview, participant X gave concern that members within the angling community were calling for the culling of predatory species, such as otters and kingfishers, due to perceiving predatory action as a cause for fish population decline. This opinion expressed by the angling community, as fish population is due to the collapse of the aquatic ecosystem rather than an abundance of natural predators. This shows a possible lack of awareness in terms of environmental knowledge. Participants Y also mentioned that fishermen frequently reported farmers for spreading slurry, despite farmers working within the guidelines of the law. Again, highlighting a lack of knowledge also in agricultural practices and law.

It is clear from both the results of the survey and from the interviews that there is an

underlying lack of knowledge among the angling community in general, but also within the farming community. There is a disconnection of important information concerning laws and knowledge of the ecosystem, this combined with a competitive profit-based attitudes adopted by farmers shows that there is disconnection of information on both stakeholders and would be in the interest of those seeking environmental improvement to engage communication between the two groups, however more research needs to be made in terms of the cultural values and attitudes of both anglers and farmers.

Overall, despite the poor awareness of NVZ's the vast majority of the participants were aware that nitrate pollution was predominantly caused by agriculture and from fertilisers.

7.3 HUMAN AND ENVIRONMENTAL IMPACT

From literature the evidence of eutrophication and the endangerment of rivers is undeniable in terms of the impact it has had on the aquatic ecosystem and the damage it has caused with all rivers in Wales being classified as 'at risk' (GOVc,2021), this also compared to the rapid decline and endangerment of many fish species. yet despite the enormity of the problem the awareness concerning the issues at hand are considerable from both sides of the argument within the farming community and the angling community there is a great deal of ignorance, as reflected by the attitudes of farmers, although more research needs to be done concerning the environmental attitudes of anglers.

Angling in the UK is not a small industry, contributing £1.4 billion to the UK economy each year, and providing jobs for more than 27,000 people (GOV, 2018b). The industry and has as much right as being protected like any other stakeholder or industry. The wildlife trust after many years of campaigning has also shown great relief towards the introduction of laws, protecting Wales's ecosystem and natural environment which according to Welsh wildlife trust contributes £8.8 billion a year to the economy, they have

stated that its great news for Wales, and that the new regulations will not just support the ecosystems but reduce the cost of water treatment by millions of pounds ((Wildlife Trusts Wales, 2020). Mark Lloyd, Chief Executive of the Angling Trust & Fish legal showed criticism to both government and the agricultural, stating that billions of pounds are invested into the farming industry in the form of subsidies, who inturn pollute waters causing an increase in water bills and the destruction of the environment, at the cost of the taxpayer (Wild Trout Trust, 2017). in essence the angling trust is trying to convey is that taxpayers are essentially paying farmers, who pollute rivers, the cost of which is then paid for again by the taxpayers. From this standpoint, it is easy to see why there is so much outrage towards farmers, from people who are reliant upon rivers but also from normal taxpayers, as shown by the results of this study, in which the majority.

The decreasing salmon and trout populations as seen in publication of the government, show a considerable decrease in the number of issued rod licences by 85% (GOVc,2021) in a period of 5 years, as well as an enormous decrease in fish population, this combined with all the principal salmon rivers in Wales being classified as ‘at risk’ shows the necessity of improved environment protection laws and enforcement of NVZ’s

In comparison to England the rate in decline of fishing populations and issued rod licences is slightly less than in Wales, although predictions do not show an improving quality of the ecosystem. Research could be conducted as to why England’s rivers have fared better than in Wales, a number of reasons, from both this studies survey and interviews are possibly due to the rural urban divide, a difference in attitudes and culture between English farmers and Welsh farmers, but also a comparison of the effectiveness of NVZ’s in England (which covered a larger area, than in pre all Wales NVZ) and finally the type of agriculture being practiced, for example livestock or crops.

The overall impact on the angling community within Wales, the dramatic decrease in issued rod licenses (GOVc,2021) as seen in government publications can only lead to a decrease in size of fishing communities, something which could be further studied, especially noting the perceptions of senior fishermen who will have a much wider view and opinion of the overall

change in river quality and fish population, which has been dramatically decreasing.

The results of this study did show a considerably higher awareness from participants working within the aquaculture industry, a greater concern into the potential health impacts nitrate pollution can cause, as discussed in the literature review, nitrate pollution can be a cause of baby blue syndrome and also bowel cancer.

Additionally, the vast majority, 77% of the participant pool prioritise the environment over the welfare of agriculture, which again supports the notion of anglers losing sympathy towards farmers. Future studies based on what the general public perceive as a higher priority may also be beneficial.

7.4 RESPONSIBILITY

From both literature and the results of this study the predominant opinion on the greatest source of nitrate pollution is from agriculture, particularly answers revolved around the use of nitrate based fertiliser and slurry. However, there has been considerable scandal with regards to the dumping of sewage by water companies. Both politicians and farming communities have expressed anger towards the dumping of sewage. From the interviews from this study and the comparison of nitrate pollution contributed by both water companies and by farmers, both interviewees expressed that politicians that sympathise with the farming community and farming unions are using the scandal as a scapegoat. However, especially in Wales, which is more rural, and therefore less vulnerable to sewage pollution in comparison with England, which is more urbanised, but even across Britain, 70%-80% of all nitrates come from agriculture. Both interviewees expressed concern for the scapegoat behaviour and misinformation of both pollutions and the farmers union. The government has released a bill addressing the sewage pollution, with regard to storm overflow tanks, both participants expressed the importance of rectifying both pollution from sewage and farms but insisted that farming was vastly more responsible for nitrate pollution, which aligns with literature.

When comparing to articles that concern fishermen and anglers (which this study's participants are a part of) there is considerable outcry towards farmers, who from the article and this study's result are seen in a negative light, being most responsible for causing pollution. The salmon and trout conservation have shown relief towards the new laws (Salmon & Trout Conservation, 2021).

There is an overall lack of sympathy towards farmers from the participants, the results showing that farmers are not making enough effort to combat nitrate pollution, which they are largely responsible for. This opinion of the participants is not without reason as studies conducted on Scottish farmers (Barnes et al, 2009) about their attitudes and efforts regarding water pollution and nitrate vulnerable zones in Scotland shows that farmers made little capital investment towards storage or transportation facilities for slurry. The attitudes of the farmers surrounding the NVZ's indicated a negative view towards NVZ's and water protection. This does reflect on the results of this study and shows that the participants' view towards farmers' poor efforts in reducing nitrate pollution can be justified from previous literature (Barnes, 2008), but is also seen within the results of this study, with the majority of the participants choosing, very small (22.6%), small (28.7%) and moderate (22.6%). The opinion of there participants view of the effort farmers are committing to nitrate pollution is again reflective of the negative attitudes seen within literature (HSE GOV, 2009).

Other works of literature show a slow rate of adoption and reluctance for new laws concerning water pollution (Macgregor and Warren, 2006), and a negative view towards environmental protection due to the cost of adoption of new technologies and the effort involved in adhering to the new rules, and that farmers knowledge towards the rules and regulations of nitrate vulnerable zones are lacking. According to studies conducted economic incentives and support do affect the overall attitude of farmers to become more conforming towards new rules (Barnes, 2008; Willock et al, 1999). From the interviews of this study, both participants expressed that there are issues surrounding the culture and attitudes of

farmers in Wales, that there is a disconnection from the public and information. Both participants expressed that farmers prioritise income and efficiency over environmental concerns, this is also supported by literature (Macgregor,2015; HSE GOV, 2009; Barnes, 2009; Barnes,2008; Willock et al,1999)

The attitude of profit and gain also contributes to the spread of excess slurry, due to the perceived benefits (Smith, 2006) but there is currently a lack of environmental concern in the farming community, and a failure to adopt environmental conscious practices (Smith, 2006). In the interviews, a cultural divide between England and Wales may contribute to adopt practices coming from Westminster. It has been suggested that more Welsh speakers are needed to help bridge the farming community in Wales and the government/ public to engage more effectively.

From the combination of previous literature, the results of this survey, and recent news articles concerning farmers and their impacts on the environment, concerning many environmental groups and angling communities. There is a clear problem with regards to the attitudes and efforts of farmers concerning the environment. Although not the sole contributor to water pollution, agriculture accounts for the vast majority of human-induced contamination, around 70 to 80% (Neal et al,2006), followed by sewage. The farming community has shown great protest towards an all-Wales NVZ, claiming the ineffectiveness of NVZ's and that new restrictions will financially burden them. However, the agriculture community, such as the national farmers union or the farmers union of Wales fails to provide alternatives to combat water pollution. Few studies have looked into the effectiveness of nitrate vulnerable zones but Paul Kay et al (2012) study the effectiveness of agricultural stewardship and highlights issues with NVZ's. the study concludes that NVZ's have had little improvement towards water quality, however, the reasons for failure in reduction of water quality has been suggested according to Kay et al (2012) that the reason for failure is not due to insufficient research but due to the implementation and regulation of rules and laws. Which again can be tied back to the poor negative attitudes of farmers, studies have

suggested that without economic or financial incentives, the water pollution schemes are unlikely to succeed.

7.5 VIEWS AND OPINIONS ON NVZ'S AND AN ALL-WALES NVZ

Participants felt that Wales was not sufficiently protected before the all-Wales NVZ and that farmers were not working hard enough to reduce pollution, and their effort was severely lacking for environmental protection. The majority of the participants view the government as responsible for protecting the environment. The government when compared to farmers is seen in a slightly more positive light, with regards to making effort to reduce pollution. It is clear from the literature by the environment agency and the government that river nitrate pollution has been disastrous for river ecosystem, with consequences in the angling community, with a decrease in issued fishing licences and a tremendous decrease in salmon and trout populations. However as discussed previously in the literature the effectiveness of NVZ's is in question. The interviews gave considerable concern that a factor contributing to the ineffectiveness of NVZ's is the attitudes and actions of farmers 'playing the system' with the use of satellite farms and poorly maintained slurry lagoons and unreported agricultural pollution incidents. In both interviews great emphasis was placed on unreported pollution events could contribute to the ineffectiveness of NVZ's, not the laws of the NVZ's themselves. As describe in Barnes (2008), the new NVZ rules introduces in Scotland had very little effect on farmers' compromising activity levels. The study also shows the opposition towards NVZ's and the lack of engagement with the public and government. Farmers feel victimised from the rules and laws that the government is introducing, although pay little attention to the victims of nitrate pollution. like wise farmers have an extremely negative view in terms of water management and environment. This itself couples with the farming culture and attitudes surrounding profit and efficiency over environmental protection as seen in other literature. In essence there is a problem within the farming culture itself and its reluctance even in simply engaging with the public

and other non-farming groups. More research needs to be conducted on the culture of Welsh farmers to help understand their opinions, attitudes and increase the level of engagement.

With regards to an all-Wales NVZ participants showed great support, participants also heavily emphasized the importance of controlling nitrate-based products. The prospect of a nationwide NVZ also received positive support from the participants.

The introduction of the all-Wales NVZ has been controversial splitting opinions between environmentalists and farmers. With regards to anglers and fishermen (the participants of this study), there is very little literature surrounding the impact, opinions, or attitudes towards pollutions. Articles and websites from various angling organizations do give some insight into the impact of pollution. According to ITV news senior fishermen has quoted that the number of salmon and sea trout has dropped by 70 – 80% (Cross, 2021)

There is overwhelming support from the participants for not just an all-Wales NVZ but also a nationwide NVZ to encompass all of the United Kingdoms, there is little sympathy among the participants who view the new regulations as not being too harsh on farmers. However, arguments made during the interviews and the legislation surrounding the all-Wales NVZ, is that it promoted an economic equality, with all farmers being subjected to the same limitations, studies in Scotland show this as a benefit overall, in terms of economic fairness (Macgregor, 2015; Barnes, 2008; Barnes, 2009)

When asked what problem the all-Wales NVZ may encounter in restricting its effectiveness, interviewee stated that the environmental agency was highly restricted by government funding, but also from the availability or lack of man-power able to police or monitor rivers. But the uncertainty in whether the new NVZ laws will be effective is shared also by the participants of this survey, with 45% selecting 'maybe'. However, despite the uncertainty it is clear from the results of this study and also surrounding literature and articles from non-farming bodies there is a very clear call for new protective laws, regardless of the farmer's protest.

It is apparent that standards in water sampling conducted by the environmental agency have dropped in recent years by nearly 50% 2013 (Boren, 2019) one of the main criticisms with regards to the effectiveness of nitrate vulnerable zones is the lack of sufficient monitoring combined with the implementation of the rules. It is apparent from this study with regards to suggestions, that there is a significant push towards sustainable farming and the use of organic and environmentally friendly fertilizer. The lack of adequate sampling is a major problem, especially when concerning the diffuse nature of nitrate pollution when looking at the effectiveness of NVZ's (Blackstock et al. 2009). And research into the adoption of more sustainable farming management as conducted in Scotland (Macgregor and Warren, 2006) would be beneficial for the Welsh farmers who will all be subjected to the new legislation and rules.

A possible solution proposed by interviewee X was the creation of a volunteer team to help in water sampling. The participant stated that a volunteer teams of individuals, using equipment calibrated to NRW's standards and given simple training, can take water sample. This could help alleviate any man-power or financial restrictions the environmental agency is facing. Future research into the effectiveness of a volunteer or reserve force may be beneficial for the environment agency, especially with more uncertainty surrounding the future. Although a slightly more recent study conducted in Scotland (Macgregor, 2015) show demonstrate that the NVZ regulations combined with the economic pressures have affected farmer's attitudes and behaviours resulting in an increase in surface water quality. However, this is only when economic pressure and regulations can be enforced, which leads back to the funding of the environmental agency. But the study does show that NVZ's are effective, so long as enforced are enforced.

There was a positive response also in creating a nationwide nitrate vulnerable zone, both interviewees and also the participants of this survey, the majority were in favour. Interviewee Y expressed a positive attitude to it with economic fairness between English farmers and Welsh farmers, however it was important to protect Wales as the majority of

documented agricultural incidents occur in the west, particularly in Wales, where farming is more livestock based, and was at large more in danger than other parts of the UK. Another idea interviewee Y proposed was the transportation of slurry to the east of England, more crop-based agriculture, although he did talk about the financial costs make this idea unlikely. This could however be a future topic of research.

Overall, the most interesting find from this study is the relationships between the angling community and the farming community, as which from the results of this study is seen in a negative light. The culture of the farming community was a frequent topic in both interviews as a potential issue with the adoption of new methods, their attitudes and knowledge of environmental issues, which is also supported by literature, but also highlights attitudes, knowledge and potential issues with the angling community as well, both of which have shown a considerable lack of engagement with one another, as well as the public.

7.6 LIMITATIONS

There are several limitations to this study, the foremost is that the majority of the demographic of the study's survey resided in England, as the study mainly revolves around the opinions of the new laws introduced into Wales by the Senedd. However, a benefit for having mainly participants that reside in England is their opinions on a nationwide NVZ, as England is not introducing a country wide NVZ, but it does show that there is a want or desire for more regulations and restrictions of nitrate products and laws outside of Wales. There is very little literature surrounding this area of study, about opinions of stakeholders outside of the farming community such as fishermen, meaning that it is difficult to compare the findings of this study to others of a similar field. Another major limitation was connecting to fishermen, particularly older or elderly anglers who may not be able to access the questionnaire, due to it being online. There was difficulty in getting responses from Welsh anglers, which acts as a limitation to a study orientated around the all-Wales NVZ, but does

open a door into future study as why Welsh anglers are less responsive. More extensive testing of the questionnaire and piloting would also of been beneficial in terms of producing better data. Other demographic data, as discussed in the demographics part of this section are also changes that would be made if this study was repeated.

7.8 STRENGTHS

This research is important due to the overall lack of studies conducted on this area, there is little research conducted on NVZ's in the united kingdom's especially Wales, considering the implications of nitrate pollution and the controversy surrounding the topic. This study has given insight into the opinions of those who have been affected by agricultural pollution and gives smaller stakeholders a chance to participate in research, research that can potentially be used in future studies to help both farmers and fishermen alike. Benefits of that this study is that it has opened and highlighted the opinions of anglers on the effort made by both farmers and the government in combating nitrate pollution, particularly with insight into the culture of the farmers but also of the anglers.

there is much research to be done with regards to water pollution, a solution if fixed will help everyone involved, including regular people whose health could be affected and whose taxes will be spent on pollution control. It is important to regain a healthy water environment whilst maintaining sufficient food production. The relationship between farmers and the environment is an important relationship, one which has been neglected, and not just by farmers. Although more effort needs to be made in terms of engaging with farmers, and perhaps improving the environmental attitudes of the farmers.

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9. APPENDIX

QUESTIONNAIRE

Freshwater Nitrate Pollution

In 2021 the Welsh Assembly voted in favour of turning all of Wales into a Nitrate Vulnerable Zone (NVZ), a designated area of land with laws designed to reduce water pollution. This sudden decision was made to counteract the environmental impact caused by nitrate-based fertilisers, such as slurry and protect rivers and lakes from agricultural pollution. Prior to the decision only 2.3% of Wales was protected from nitrate pollution, the decision was very controversial and caused much uproar in the farming community, due to new restrictions and limitations on the amount and storage of fertiliser. The purpose of this study is to understand the opinions of people who use or are reliant on rivers and other freshwater bodies for work or hobbies, to analyse their opinions with regards to the impact on agricultural pollution.

1.age in years

Enter your answer

2.What is your gender?

Male

Female

Other

3.What is your nationality?

Enter your answer

4.What is your residency?

Wales

England

Scotland

Northern Ireland

Outside of the UK

5.Do you work within the aquaculture industry (i.e fishing industry)?

Yes

No

6.Are you involved in any recreational activities involving the freshwater environment?

Yes

No

7.How aware are you about NVZ's (Nitrate Vulnerable Zones)?

None Little moderate High Very High

8.Has your livelihood or recreational hobbies been affected by freshwater nitrate pollution?

Yes

No

Maybe

N/a

9.Are you concerned about the potential health impacts of nitrate pollution?

Yes

No

Maybe

10. What, in your opinion, is the greatest source of nitrate pollution in Wales?

Enter your answer

11. Who, in your opinion, is most responsible for freshwater nitrate pollution in Wales?

Enter your answer

12. Who is most responsible for protecting the freshwater environment?

Enter your answer

13. Prior to the decision of the Senedd to turn all of Wales into NVZ, was Wales sufficiently protected from nitrate pollution?

Yes

No

Maybe

14. Do you agree in turning all of Wales into NVZ?

Yes

No

Maybe

15. Will turning all of Wales into a NVZ be sufficient to protect freshwaters from nitrate pollution?

Yes

No

Maybe

16. Are the new laws introduced by the Senedd too harsh or severe on farmers?

Yes

No

Maybe

17. Has the agricultural industry made sufficient measures to reduce nitrate pollution?

Yes

No

Maybe

18. Has the government made sufficient measures to reduce nitrate pollution?

Yes

No

Maybe

19. On a scale of 0 to 5 what has been the impact of nitrate pollution on freshwater wildlife?

0 (Not at all) 1 (very small degree) 2 (small degree) 3 (moderate degree) 4
(great degree) 5 (very great degree)

20. On a scale of 0 to 5 how important is the control and restrictions of nitrate-based products used in agriculture for the preservation of freshwater wildlife?

0 (Not at all) 1 (very small degree) 2 (small degree) 3 (moderate degree) 4 (great degree) 5 (very great degree)

21. On a scale of 0 to 5 how much have farmers contributed to freshwater nitrate pollution?

0 (Not at all) 1 (very small degree) 2 (small degree) 3 (moderate degree) 4 (great degree) 5 (very great degree)

22. On a scale of 0 to 5 how much effort have farmers made to reduce nitrate pollution?

0 (Not at all) 1 (very small degree) 2 (small degree) 3 (moderate degree) 4 (great degree) 5 (very great degree)

23. Is protecting the environment a greater priority than the welfare of the agricultural industry?

Yes

No

Maybe

24. Should the rest of the UK also adopt a nationwide Nitrate Vulnerable Zone plan?

Yes

No

Maybe

25. Is there, in your opinion, any alternative ideas to protect the environment from nitrate pollution?