MAPPING CATCHMENT INTERVENTIONS

- Mapping and quantifying catchment interventions in each catchment is an essential step for assessing their impact on water quality.
- Activities listed by project partners were re-classified into the relevant mitigation methods using the Farmscoper software to (1) homogenise the terminology used across partners and (2) identify the water quality parameters affected by each individual measure.
- Establishing new hedges, minimising the volume of dirty water produced (i.e. sent to dirty water store) and fencing off rivers and streams from livestock were the three main interventions used across the region. However, differences in recording methods, e.g. terminologies used, resulted in a large number of interventions falling into an "unclassified" category.
- This work has highlighted the need to establish a uniform and efficient way to record such information, as it has proven essential for further water quality assessment.

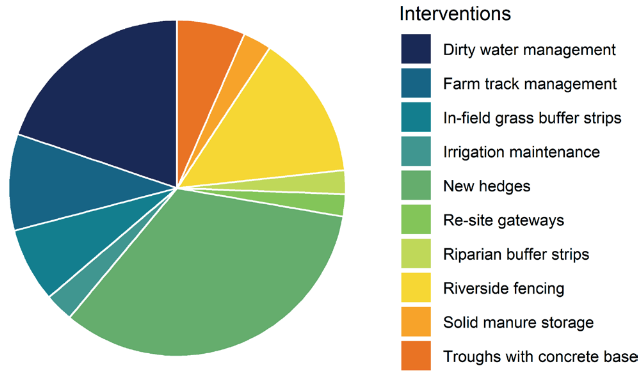
Mapping and quantifying in-catchment interventions

Over the course of the Upstream Thinking programme, project partners have worked in 11 catchments and carried out interventions aimed at reducing water pollution and improving biodiversity in a wide variety of ways. Mapping the extent and the type of such interventions is an important step to visualise and identify the direct impact on water quality, and for further modelling of potential water quality change. However, it is also a challenging exercise because of the diversity of interventions used throughout the region and the difficulty of quantifying direct impacts on water quality parameters.

Farm advisors use their experience and knowledge of catchments to engage with farmers. Through farm visits and discussions they work together to identify opportunities and challenges for the farm business and land management practices. The output of their work is the development of a targeted farm plan (also known as a Water and Environment Plan) which contains advice, recommendations and costed actions, which when implemented can improve land management, soil health and therefore, water quality. For example, reductions in nutrient or sediment losses to watercourses might occur following the identification of opportunities to create in-field buffers or by altering application timings and rates for manures, slurries, pesticides or herbicides.

A number of 'tool kits' are used for offering advice and to part-fund interventions: (1) funding schemes such as Upstream Thinking (through SWW investment), Countryside Stewardship or Catchment Sensitive Farming; and (2) the DEFRA/ADAS Farmscoper Inventory of Mitigation Methods[1], which is a decision support tool used to make an assessment of diffuse agricultural pollution loads on a farm and to quantify the potential impacts of the recommended on-farm mitigation methods (interventions) on those pollutants[2].

Figure 1 Top 10 interventions (as classified for Farmscoper) used in Upstream Thinking in all catchments ranked by occurrence.



The mapping of in-catchment interventions was done by the UoE, based on spatial data of catchment interventions provided by project partners. This allowed spatial analysis of Upstream Thinking activities, including an assessment of catchment coverage and an identification of the most commonly employed intervention activities used to tackle water pollution from agriculture, promote best farming practice and improve biodiversity.

In order to perform modelling of water quality change and to quantify the catchment coverage of specific interventions, the activities listed by partners were (where possible) re-classified into the relevant Farmscoper mitigation methods. This step enabled the understanding of water quality parameters affected by each individual measure, and also ensured that consistent terminology was used across partners and that data were comparable.

The spatial data were collected as points, lines and polygons. However, in order to gain an understanding of the area improved by the Upstream Thinking interventions that were implemented, a field-scale polygon area was applied to all point and linear interventions. These areas (expressed in hectares), combined with existing polygon data, provided a total cumulative area that could be assumed to be 'impacted' by interventions.

What are the main interventions delivered by Upstream Thinking?

Farm engagement by the Devon Wildlife Trust; photo by DWT.

Table 1 provides an overview of the top 10 interventions most often delivered by Upstream Thinking partners between 2015 and 2019, along with their occurrence (Figure 1). This is compiled from the re-classification of interventions into the mitigation measures used by the Farmscoper software. It should be noted however, that there are interventions for which there was either missing data, or there was no equivalent Farmscoper option to re-classify it into and so the list also includes an "Unknown/unclassified" option.

In addition to physical interventions, Upstream Thinking partners also provide advice and recommendations on land management activities and behavioural change to promote best farming practice. This accounts for a further 3,448 ha of activity within the Upstream Thinking catchments. Measures include those aimed at improving water quality and quantity such as access to machinery for soil aeration and also management plans and actions to promote and restore biodiversity and BAP (Biodiversity Action Plan) habitats (i.e. culm grassland restoration).

Intervention	Count	Area (ha)
Establish new hedges	219	7868
Minimise the volume of dirty water produced (sent to dirty water store)	130	5860
Fence off rivers and streams from livestock	92	3097
Farm track management	61	2538
Establish in-field grass buffer strips	47	2347
Construct troughs with concrete base	43	7960
Store solid manure heaps on an impermeable base and collect effluent	18	1067
Irrigation/water supply equipment is maintained and leaks repaired	18	944
Establish riparian buffer strips	15	357
Re-site gateways away from high-risk areas	14	424
Unknown/Unclassified	962	22861
Additional activities		
Revised land management (BAP and non-BAP work)		1788
Soil aeration		1279
Culm restoration		381

Table 1 Top 10 interventions used within the Upstream Thinking project, as defined by Gooday *et al.* (2015). The unknown category includes a wide range of interventions that cannot be classified using the Farmscoper interventions categories as they include broader interventions that do not solely tackle water quality issues (i.e. Biodiversity improvements). Future work will be using a more standardised recording methodology, which will improve the evaluation of catchment management interventions and their impact on WQ and biodiversity.

Figure 2 Planting of new hedges on the edge of a field; photo by DWT.

Figure 3 New water storage installed on a farm on the Dart to store dirty water and reduce the risk of nutrient loss to surface water; photo by DWT.

Figure 4 River fencing; photo by Ben Bennett (WRT).

The top 10 interventions contributing to water quality improvements/reduction in diffuse pollution from agriculture are presented in Table 1 and described below[2]:

1. Establish new hedges

This intervention aims to break-up the hydrological connectivity of the landscape (Figure 2). Hedges can also lower surface run-off volumes and 'trap' soil, thereby reducing sediment and associated nutrient loss. Hedges can also help to protect soils from wind erosion and improve biodiversity.

2. Minimise the volume of dirty water produced (sent to dirty water store)

Reducing the volume of dirty water produced, and therefore stored (Figure 3), means that farms are less likely to run out of storage space and be forced to spread dirty water (or slurry) at times of high risk of runoff, thereby reducing the associated losses of nutrients, Faecal Indicator Organisms (FIOs) and Biochemical Oxygen Demand (BOD) to (surface) water systems.

Figure 5 Cross drain and resurfaced track in the Barnstaple and Yeo catchment.

Figure 6 Buffer strip in the River Otter catchment; Photo by Yog Watkins (WRT).

3. Fence off rivers and streams from livestock

Riverbank trampling by livestock destroys the vegetative cover and can leave soils badly poached, leading to erosion which increases sediment inputs and nutrients to watercourses. Livestock can also add pollutants (nutrients and manure) directly by excreting into the water. Preventing access by fencing streams and rivers eliminates this source of pollution (Figure 4), as well as reducing incidents in livestock of liver fluke and tick-borne diseases, as both parasites dwell in wet areas of fields.

4. Farm track management/track re-surfacing

Farm tracks that are rutted, on sloping land or in poor condition can generate significant volumes of surface runoff in wet conditions, which mobilises sediment and manure-borne pollutants. Track re-surfacing (Figure 5) reduces the pathways of surface water run-off and can reduce the amount of poaching and soil erosion adjacent to the track. Furthermore, improving track drainage and diverting surface runoff to adjacent grass, soakaways or swales can reduce the mobilisation and transport of pollutants.

5. Establish in-field grass buffer strips

In fields where high volumes of surface runoff are generated, a vegetated strip of land (located along the land contour, on upper slopes or in valley bottoms) can reduce and slow down surface runoff (Figure 6), which will reduce sediment and nutrient loss. Buffer strips can also improve biodiversity.

REFERENCES

1. Gooday, R., *et al.* (2014). Modelling the cost-effectiveness of mitigation methods for multiple pollutants at farm scale. *Science of the Total Environment*, 468-469, 1198-1209.

2. Gooday, R., *et al.* (2015). Developing the Farmscoper Decision support tool. Final Report for Defra Project SCF0104.

Figure 7 Livestock trough on hardstanding base; photo by DWT.

6. Construct troughs with concrete base

Animal activity concentrated around drinking troughs leads to poaching and damage to soil, increasing risks of surface runoff and diffuse pollution. Large inputs of excreta in these areas can also be a source of nutrient and fecal matter input losses to nearby watercourses. Constructing water troughs with a firm base (Figure 7) can therefore prevent these types of pollution.

Figure 8 Before (left) and after (right) the installation of a new slurry storage with concrete base; photo by FWAG.

Figure 9 Unfenced stream with excessive poaching (left), and fenced stream with riparian buffer strip (right); photo by DWT.

Figure 10 Re-siting of access to field and watercourse fencing installed to prevent livestock access; photo by Devon Wildlife Trust.

7. Store solid manure heaps on an impermeable base and collect effluent

Storing manure on an impermeable base prevents the seepage and accumulation of nutrients in the soil below the heap, which otherwise may subsequently be lost in surface runoff/drainflow or leaching to ground water (Figure 8). Also, storage on an impermeable surface (e.g. a concrete base) reduces soil compaction caused by farm machinery during the forming and subsequent spreading of field heaps.

8. Irrigation/water supply equipment is maintained and leaks repaired

Losses through leakage can prove costly over time and also cause problems such as soil erosion, poaching, water contamination and increased dirty water disposal costs. These issues are addressed by maintaining irrigation equipment and repairing leaks.

9. Establish riparian buffer strips

A grass or woodland buffer strip can act as a 'natural' buffer distancing agricultural activity from the stream or river and intercepting surface runoff, thereby acting as a sediment trap and filter for nutrients (Figure 9). This reduces direct pollution from fertiliser and organic manure additions, and can also restrict direct livestock access to watercourses. An additional benefit of such features is that they make space for water in times of flood.

10. Re-site gateways away from high-risk areas

Gateways located in high-risk surface runoff areas, such as at the bottom of a slope and near to a watercourse, act as pathways for water runoff. Moving them to lower-risk areas on upper slopes will prevent polluted surface water from leaving fields and help to lessen the risk of surface runoff transporting sediment, associated nutrients and FIOs out of sloping fields and directly into watercourses or onto roads etc (Figure 10).