North Devon Biosphere Foundation
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Westcountry Rivers Trust

A Natural Capital Approach to Natural Flood Management

A Case Study of the Caen Catchment

Project Summary – *to be completed before final draft once comments received from NDBF*

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Revision History

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Contents

1. Project Background and Report Structure

This report describes a Natural Capital approach to natural flood management (NFM). It is based on a nested case study in the Caen catchment in North Devon where a pilot project is underway in Acland stream, a 2km^2 sub-catchment which flows into the Caen at Braunton. NFM measures are part of a wider management plan to reduce downstream flooding and enhance Natural Capital within the North Devon Biosphere (NDBF) through working in partnership with Devon County Council, the Environment Agency and Natural England.

Natural Capital is "the sum of our ecosystems, species, freshwater, land, soils, minerals, our air and our seas[1]" (HMG, 2018). Natural Capital features prominently in the recently published 25 Year Environment Plan (HMG, 2018). Our approach emphasises Natural Capital while taking account of other capitals. This is appropriate since flooding and NFM have widespread impacts not only on Natural Capital, but also on economic capital (man-made capital; infrastructure, equipment and other assets), human, social and cultural capital.

Westcountry Rivers Trust was commissioned by the North Devon Biosphere Foundation (NDBF) to develop a case study in the Acland stream and to assess the potential benefits of NFM in the entire Caen Catchment. The overall aim of the study being: *To inform development of shared, integrated Natural Capital delivery plans that are based on sound Natural Capital investment decisions.*

Specific study objectives were to:

- Collect, compile and analyse baseline information on Natural Capital assets and ecosystem services; and develop Natural Capital accounts.
- Use baseline information and Natural Capital accounts to inform the development, through participatory processes, of a shared integrated delivery plan; and to monitor change over time.
- Develop partner, landowner and community understanding of the Natural Capital approach.
- Assess the practical applicability of the integrated Natural Capital approach.
- Produce a final report of ~ 10 pages which identifies the approach followed and tabulates the main findings from the report in terms of the change in natural and economic capital as a result of NFM.

For our approach to work and be practicable it must be replicable, relatively simple and make sense to flooded communities, landowners and wider stakeholders (e.g. conservation NGOs). Freely available data is used to drive the approach so that it is transferable to other catchments and spurious levels of precision in the analysis is avoided since this can provoke disagreement. Instead the focus is on using Natural Capital concepts as an aid to participative decision making.

[1] HMG (2018) A Green Future: Our 25 Year Plan to Improve the Environment

2. Processing the Evidence Base for the Caen Catchment

2.1 Key data sets

The following data were used to underpin this case study.

Natural flood Management Potential Opportunity maps. (Environment Agency (a), 2017). The Environment Agency published the Working with Natural Processes (WwNP) maps in November 2017. These maps show the potential opportunities for:

- Offline storage. Ponds and bunds which can temporarily store water during a flood.
- Gully blocking. As above but on steeper land where leaky dams may be more appropriate.
- Floodplain storage. These are areas of land which could be reconnected to the river to provide additional floodplain storage.
- Riparian woodland. Woodland 50m either side of the river network.
- Floodplain woodland.
- Wider catchment woodland. There are no opportunities for this identified in the Caen.

All the opportunities identified in the maps are based on national data and modelling and take constraints into account so that they are as realistic as possible. This means that woodland opportunities are not identified where the land use is urban, roads or there are existing trees. This data was downloaded from data.gov and is freely available for every catchment in England.

Natural Flood Management Evidence Base. (Environment Agency (b), 2017). The Environment Agency also published the evidence base in November 2017 which draws together data for each type of NFM including its effectiveness at reducing flood risk and the multiple benefits that should come from its delivery. This provides the basis to identify the Natural Capital benefit of each type of NFM for each broad habitat type.

Natural Capital. The 'Living Maps'[2] supplied by the North Devon Biosphere Foundation were processed to show the nine broad habitat types identified by the UK National Ecosystem Assessment (Mace, Bateman et al., 2011)[3]. The land use type 'Enclosed farmland' was split into two classes 'Enclosed farmland (arable and improved grass) and 'Enclosed farmland: (semi-improved-grassland), with the aim of identifying higher value farmland where NFM interventions would be likely to impose a higher opportunity cost on the landowner.

The Living Map (LM) data is at an early stage of development and will require detailed community feedback to improve accuracy. A comparison of Living Map land use with that from

[2] Living Maps for biodiversity and natural capital, commissioned by Defra Earth Observation Centre for Excellence. These maps are being created from novel processing methods using Sentinel 1 and 2 and other data. See https://defradigital.blog.gov.uk/2017/04/07/why-defra-has-an-earth-observation-centre-of-excellence/

[3] Mace, M., Bateman, Ian et al., (2011) Conceptual Framework and Methodology. *In*: The UK National Ecosystem Assessment Technical Report. UK National Ecosystem Assessment, UNEP-WCMC, Cambridge.

Land Cover Map 2007 (CEH) and aerial photography reveals some differences, these are summarised in Annex 3, see section 6 for recommendations. It is not possible to identify which dataset is more reliable overall since they each represent a 'snapshot' of land use. The analysis in this report is based on LM data, for selection of priority sub-catchments. Natural Capital analysis is based on both data sets.

2.2 Developing an Initial Natural Capital Account

The initial Natural Capital account for the Caen catchment is based on the area of each broad habitat. This follows the approach adopted by the Office of National Statistics (ONS) (2015) to develop land cover ecosystem accounts for the UK using SEEA-EEA-based habitat classes which are similar to NEA broad habitat classes. Our analysis is based on data on the value of ecosystem services for different habitats in North Devon compiled by Natural England as part of planning for the North Devon Landscape Pioneer in 2017. This compilation draws on several sources including UK NEA, the Biosphere and Expert Opinion (Table A3.3). Natural Capital asset values are estimated from the value of annual ecosystem service flows as recommended by ONS (2017) namely 100-year asset life and a declining discount rate (3.5% up to 30 years; 3.0% for 31 to 75 years; 2.5% for 76 to 100 years). Assuming a constant flow of ecosystem service benefits, asset values are 31.4 times the annual value.

Based on the approach detailed above, we find that most Natural Capital asset value is associated with farmland and semi natural grassland (65%), woodlands (23%) and urban/built up areas (12%). The contribution of woodlands is greater than its area contribution, reflecting multiple benefits including flood alleviation, water purification, recreation and carbon sequestration. The Natural Capital contribution of farmland is less than its area contribution because provisioning services (food production) are offset by some adverse environmental effects. The higher value attributed to urban/built up areas reflects the high value that people put on Natural Capital in the areas where they live. The Natural Capital assets of the Caen catchment by area and value are summarized in Table 1. Breakdowns, per hectare values and detailed calculations by sub-catchment are included as Annex 3.

Table 1 Natural Capital Assets of the Caen Catchment: LCM 2007

	Area (hectares)	*%*	*Natural Capital asset value (£ millions)*	*%*
Broad Habitat (based on LCM 2007)				
1 Mountains, Moors and Heaths	*18*	*0%*	*0.3*	0%
2 Semi-natural Grassland	*170*	*3%*	*5*	7%
3.1 Enclosed Farmland	*4976*	*85%*	*47*	58%
4 Woodlands	*504*	*9%*	*19*	23%
5 Freshwater Openwater Wetlands and Floodplains	*1*	*0%*	*0.01*	0%
6 Urban	*198*	*3%*	*9*	12%
7 Coastal Margins	*0.5*	*0%*	*0.02*	0%
Total	***5867***		***80.8***	

Note: The gross Natural Capital values reported above should be regarded as indicative values that can be used to assess relative orders of magnitude. They are generally based on typical ecosystem service (ES) values for these habitat types and do not reflect evidence on the quality or value of assets in the Caen catchment. Input costs have not been deducted except for provisioning services. Valuation of ecosystem services is complex and may over emphasise ecosystem services that can more easily be valued e.g. recreation versus those that are much harder to value e.g. biodiversity or existence value.

The main ecosystem services contributing to these asset values are regulating services (~45%) – carbon sequestration, flood attenuation and water purification, cultural services (~45%) – community, heritage and generational links, recreation and tourism, provisioning services (~10%) – food and fibre[4] (See Annex 3).

2.3 Identification of priority catchments

Our overall approach to integrating a Natural Capital approach with NFM is to assess and prioritise interventions based on three factors:

1. Reduction in flood risk
    - Sub-catchments are assessed according to their relative effectiveness at reducing downstream flooding.
2. Natural Capital
    - What is the effect of interventions on Natural Capital?
3. Net effect on landowners
    - How are landowners affected? Do they lose the use of valuable assets? Do they benefit?

[4] Net return from agricultural production after adjustment for subsidies (ONS Resource Rent approach) is assessed as low or negative.

An indicator category (-, =, +) and score (0, 1, 2) are assigned for each of these factors

- 0 = There is a dis-benefit
= 1 = Location specific, not possible to say whether there is a benefit or dis-benefit.
+ 2 = There is a benefit

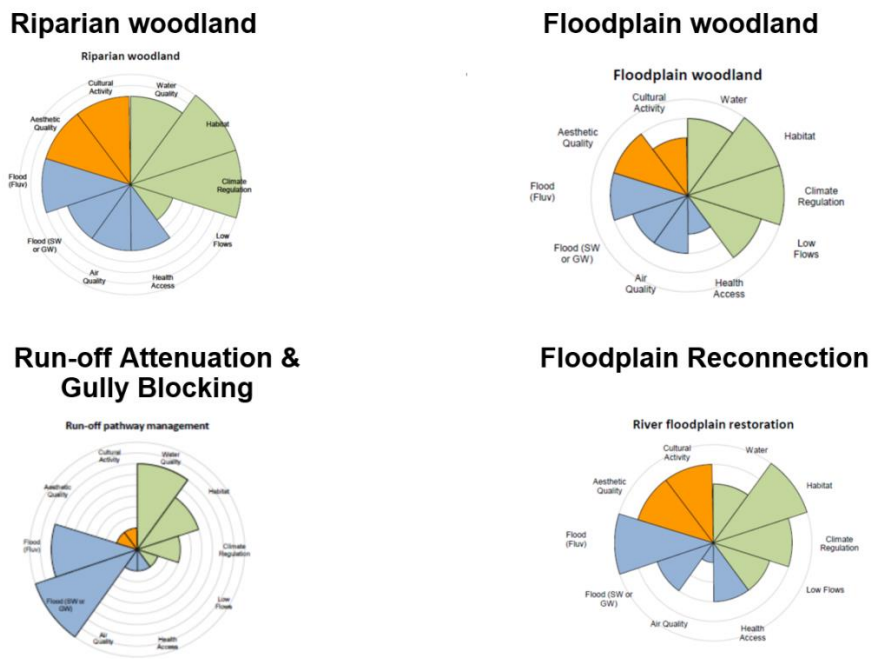
Approach. The focus of this project is on the impact of NFM on the Natural Capital of the catchment. As a result, the NFM opportunities were used as the primary data layer because they represent the opportunities to change the Natural Capital. Each type of NFM opportunity within a sub-catchment was treated as one opportunity. This one opportunity was then split by the broad habitat type so that each opportunity had a unique combination of 'NFM type' and 'Broad habitat type'. This enables us to identify the potential benefit, or dis-benefit, of each NFM opportunity in each sub-catchment.

Each of the categories identified above is assigned a score based on the analysis set out in the next paragraphs. Additionally, each category is assigned a "local" score which is determined through the participatory workshop (explained in detail in section 4). This local score is based on local, more detailed knowledge of the opportunities than can be accessed through the national data.

Natural Capital Benefits and Landowner Costs. The potential Natural Capital benefits of NFM interventions were assessed for each of the broad habitats (Table 2). Benefits were assessed on the assumptions that the intervention is implemented and managed to produce the greatest Natural Capital benefit; for example, gully blocking on arable farmland will entail a fenced off area that will bring ecosystem benefits greater than any loss in crop production. Based on advice from NE, planting of woodland on priority habitat (e.g. species rich grassland), was assigned a score of 0 (-) – because this *may* lead to a net decrease in Natural Capital. This is reflected in the local score and explained in more detail in section 4.

Our assessment of the multiple benefits of NFM interventions and their effects on Natural Capital draws on the extensive literature review summarized in the WwNP Evidence Directory (Environment Agency (a), 2017). The changes to Natural Capital that would result from NFM interventions by sub-catchment, intervention type and broad habitat are tabulated in Annex 4. Multiple benefits from four of the main interventions are summarized in Figure 2.

Figure 2 Multiple Benefits from NFM Interventions



Source: Environment Agency et al., (2017) WwNP Evidence Directory

Table 2: Potential Natural Capital Benefits of Natural Flood Management.

Broad habitat types	Run-Off Atten' Feature	Gully Blocking	Riparian Woodland	Flood-plain Woodland	Floodplair Recon'n
Coastal Margins	+	+	=	=	+
Enclosed Farmland (arable & imp grass)	+	+	+	+	+
Enclosed Farmland (semi-improved grass')	+	+	+	+	+
Freshwaters - Openwaters, Wetlands and Floodplains	+	+	=	=	+
Mountains, Moors and Heaths	+	+	=	=	+
Semi-natural grassland	+	+	=/-	=/-	+
Urban	+	+	=	=	=
Woodlands	+	+	=	=	+

The potential net effect of NFM interventions on landowners was assessed for each of the LM broad habitats (Table 3). This is an assessment of opportunity cost e.g. woodland replacing an arable field might deprive the landowner of income from growing maize. Cost scores were assigned on the assumption that net effects would be greatest for higher value land e.g. arable and improved grassland scored 0 (-), intermediate for semi-improved grassland scored 1 (=) and lower for other habitat categories scored 2 (+).

Originally the Agricultural Land Class maps from Natural England[5] were used to identify the potential dis-benefit of NFM to the landowner. However, a comparison of the land cover (LM and LCM) and agricultural land class maps suggested that the land cover maps are likely to provide a more meaningful indication.

Table 3: Net effect on financial profitability/benefit for landowner (excluding construction and maintenance costs)

Broad habitat types	Run-Off Atten' Feature	Gully Blocking	Riparian Woodland	Flood-plain Woodland	Floodplair Recon'n
Coastal Margins	+	+	+	+	+
Enclosed Farmland (arable & imp grass)	-	-	-	-	-
Enclosed Farmland (semi-improved grass')	=	=	=	=	=
Freshwaters - Openwaters, Wetlands and F	+	+	+	+	+
Mountains, Moors and Heaths	+	+	+	+	+
Semi-natural grassland	+	+	+	+	+
Urban	=	=	=	=	=
Woodland	+	+	+	+	+

Combining these two factors from Table 2 and 3 suggests:

- Arable and improved grassland should be avoided where possible because of the higher cost imposed on landowners.
- Priority should be given to woodlands on semi-improved grassland or other habitats – provided that local assessment indicates a net gain in Natural Capital.
- Run-off attenuation features, gully-blocking and floodplain reconnection will potentially increase Natural Capital and generally impose lower costs on landowners.

Flood risk and benefit. Community at Risk data is available from many Environment Agency regions that shows 'defended risk' (i.e. communities that may still flood even with the existing defences in place). This data was not available for the Caen catchment; however, the local Environment Agency team provided bespoke data that shows the location of all properties and other assets within each of the flood zones. This data was used to identify the relative 'benefit' of each NFM opportunity in reducing flood risk.

Where this data is not available, buildings data from MasterMap can be used to identify buildings within Flood Zones (Risk of Flooding from Rivers and Sea, available through the CaBA data package or EA).

Flood benefit opportunities were assessed manually to allow rapid classification based on whether NFM measures within each sub-catchment are likely to benefit communities at risk. Sub catchments where NFM is likely to have a greater effect were coded as 2 (+) "NFM more

[5] https://data.gov.uk/dataset/provisional-agricultural-land-classification-alc; Natural England, 2016

effective". In a second step, the score was refined for specific opportunities within each sub-catchment, for example:

- In a sub-catchment where the NFM will generally be beneficial for a downstream community there may be specific NFM opportunities which will increase risk due to backwater effects, slowing flows and increasing the volume of water retained upstream of the NFM and so risking flooding of the upstream area. These opportunities are modified from a score of '2' to a score of '0'.
- In a sub-catchment where NFM will have little impact there may be localised opportunities which will reduce localised surface water flooding and therefore have a positive benefit. These opportunities are modified from a score of '1' to a score of '2'.

The 'by hand' assessment of the flood risk benefit of NFM appears to be rather onerous and could lack objectivity. However, experience from other catchments suggest that nothing undermines confidence quicker than 'clearly incorrect' flood risk benefit assessments based on geospatial processing of data. The approach followed in this project ensures that the community can make local refinements to the flood risk benefit so that they are directly engaged in developing scores. The simplified grouping of NFM opportunities by land use type within each sub-catchment does cause some problems for flood risk benefits. In reality, and given more time, NFM opportunities would have been sub-divided further where there is an obvious change in their benefit, (i.e. above and below a flooded community).

NFM has the potential to reduce damage to buildings, roads & infrastructure (economic capital) and to reduce health impacts and stress on affected families and communities (human and social capital). A summary of the potential effect of NFM on properties at risk in each sub-catchment is provided in Annex 1.

Table 4 and Figure 2 detail the analysis of suitable opportunities following the approach laid out above. All NFM opportunities based on national data (WwNP) are broken down by area, by sub-catchment in columns 2&3. The "more effective opportunities", i.e. those that are likely to contribute to reducing flooding (score 2 for flooding, see section "flood risk and benefit" above) were detailed in column 4&5. Sub-catchments 1, 3, 6-8, 10-15 and part of catchment 9 are excluded as being less effective or ineffective. These opportunities were then narrowed down further by determining those likely to have a clear Natural Capital benefit (column 6&7) and where landowner cost is likely to be lower, relative to alternative opportunities in the last two columns.

Based on this analysis, sub-catchments 11 (Acland), 2 and 5 are identified as priority areas for NFM (Table 4 & Figure 2). NFM opportunities in these sub-catchments cover the largest areas that will contribute to reduced flooding and increase Natural Capital. They also have the largest areas where these opportunities can be implemented at relatively low cost.

Table 4: NFM Opportunities by Sub Catchment (hectares)

Sub Catch-ment	All NFM Opportunities		NFM More Effective		NFM More Effective and Natural Capital Benefit		NFM Effective, Nat Cap Ben, Lower Cost	
	Tree Planting Riparian & Floodplain	RAF and Flood Plain Reconn-ection	Tree Planting Riparian & Floodplain	RAF and Flood Plain Reconn-ection	Tree Planting Riparian & Floodplain	RAF and Flood Plain Reconn-ection	Tree Planting Riparian & Floodplain	RAF and Flood Plain Reconn-ection
11	35.5	0.3	31.8	0.3	12.8	0.3	3.9	0.2
1	4.2	0.0						
2	79.2	1.1	79.1	1.1	54.5	1.1	31.2	0.7
3	65.5	0.9						
4	9.4	0.2	9.4	0.2	1.5	0.1	1.2	0.1
5	40.0	1.7	40.0	1.7	23.3	1.7	18.4	1.3
6	8.1	0.2						
7	75.8	0.5						
8	40.3	0.5						
9	90.5	0.7	62.9	0.7	13.7	0.7	0.0	0.6
10	20.9	0.1						
12	14.1	0.1						
13	43.6	0.4						
14	16.8	0.5						
15	64.7	1.4						
Total	**608.5**	**8.6**	**223.2**	**4.0**	**105.7**	**3.9**	**54.7**	**2.9**

Note: Tree planting opportunity area on flood plain only included when it does not overlap with riparian opportunities

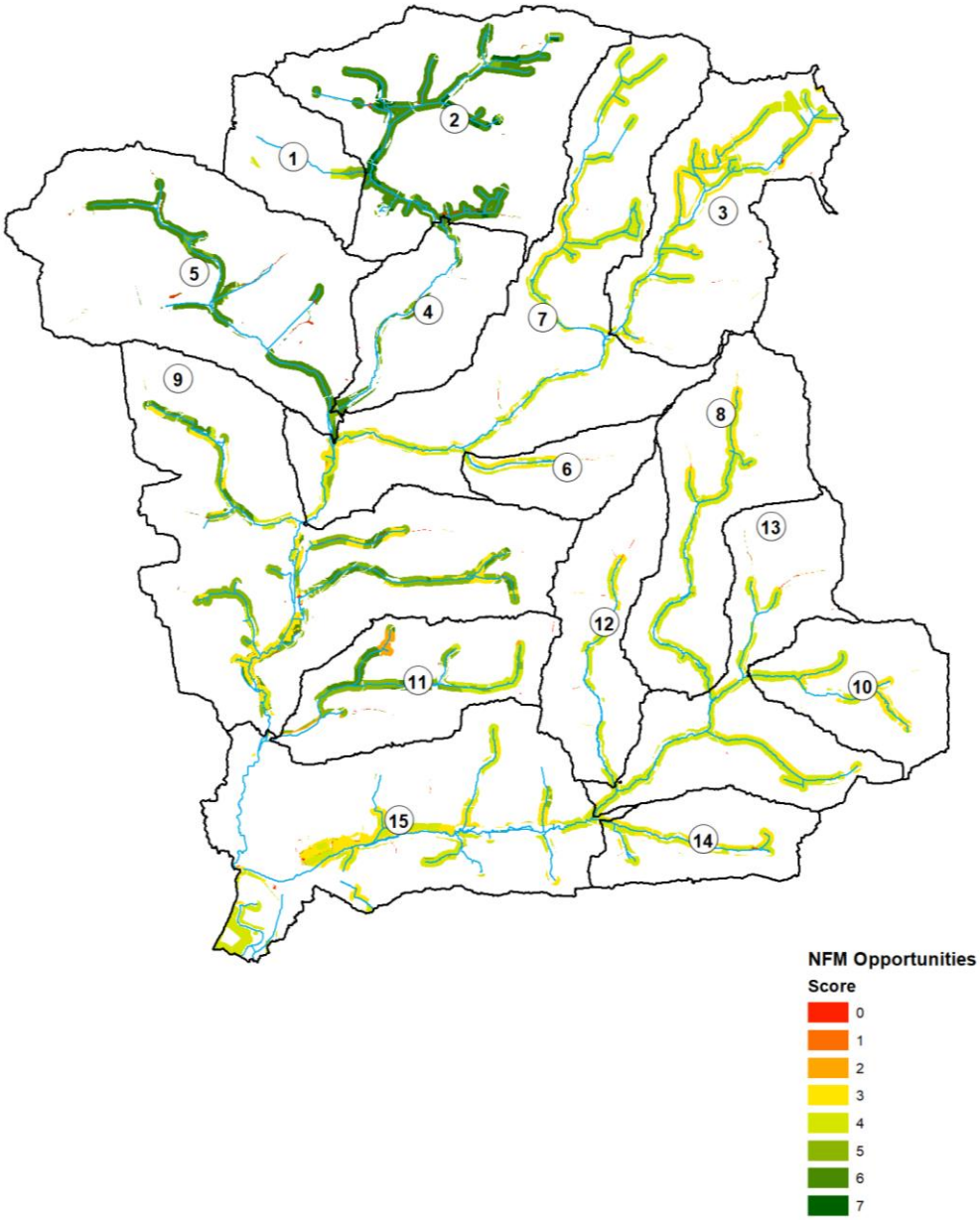
Detailed field work and a thorough understanding of the catchment hydrology and existing flow pathways will be required to assess all effective NFM opportunities in these catchments. This should include field level assessment of potential for Natural Capital gain and assessment of potential landowner cost. The prioritization process also took account of other local factors, raised and / or discussed during the participatory workshop (see Section 4). This local knowledge reinforces the selection of sub-catchments 2, 5 and 11 (Acland). Sub-catchment 9 is also identified as a priority catchment based on local concerns.

The scores identified through initial data analysis combined with the scores developed through the workshop form the final score for each opportunity. Each of the 3 categories (flood benefit, Natural Capital benefit, land owner benefit) can also be weighted should one category be identified as having higher priority. However, in this case, all categories were given the same weight. Weighted scores can be calculated using the following formula:

[Flood Benefit Weight(Local score + data analysis score)] + [Natural Capital Benefit Weight*(Local score + data analysis score)] + [Landowner cost Weight*(Local score + data analysis score)] = Final Score*

It is important to note that this approach is useful for giving a rapid assessment and an indication of suitability of different options, but it does not take account of the complexities of assessing different types of benefits on different scales. The final score is not an expression of the total magnitude of a benefit but rather the potential for delivering multiple benefits.

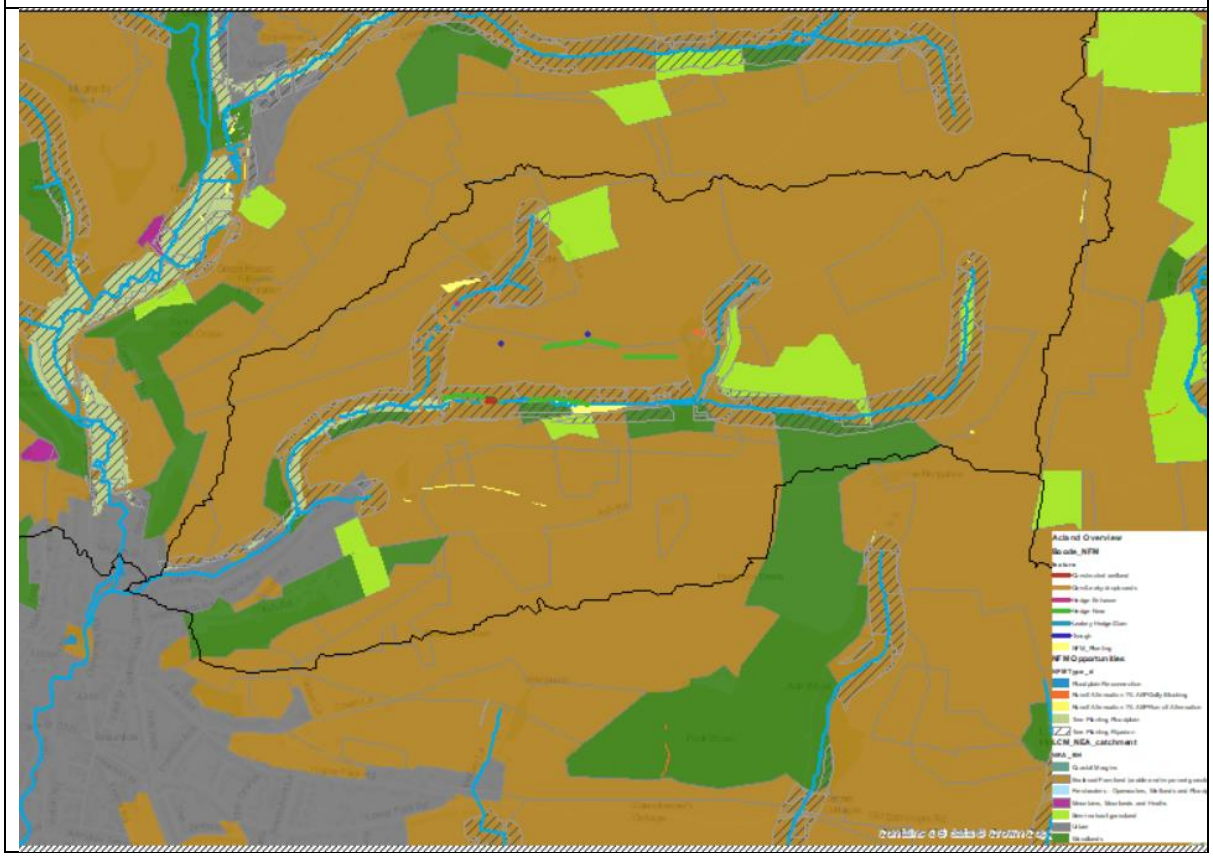
Figure 2: Selection of Priority Catchments



3. Review of Current Condition, Opportunities and Issues in the Acland Catchment

NFM interventions have already been delivered or are planned, including woodland creation and a series of woody debris dams. The 'real' NFM opportunities are less extensive and more targeted than those shown in the national WwNP maps (Figure 3). Hedgebanks were put in place during July 2017 and the key learning that can be derived to date is summarised below, based on available evidence and a targeted walkover during January 2018.

Figure 3: Map of the Acland sub-catchment showing WwNP opportunities as well as localised opportunities (delivered and planned). Landcover is based on LCM 2007.



Four hedgebanks were installed on two fields, sited along existing fence lines, rather than locations being chosen based on erosion risk or hydrological connectivity. The hedgebanks were designed based on specifications provided by the Devon Hedge Group. Additional planting of shrubs and trees may be carried out in the future to create hedges. The locations are shown in Figure 4 and the hedgebanks themselves shown in Figure 5.

Figure 4: Annotated map of existing and plan NFM measures

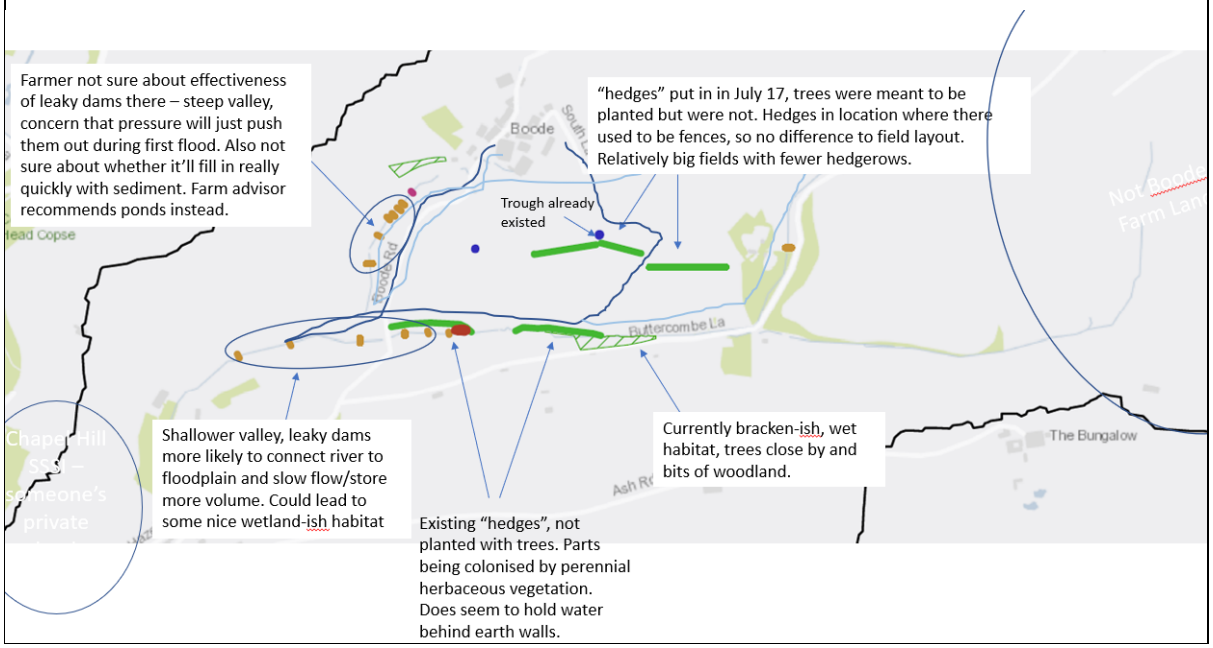


Figure 5: Existing "hedgebank" NFM features

Some water is being stored behind the hedgebanks, allowing sediment to settle and those closer to the river appear to be more effective. The farmer was unable to confirm whether the hedgebanks bring any significant benefit during flooding events or whether he has noticed any disruption of flow paths and he raised concern of the potential erosion risk without a stabilising root system.

The farmer perceives little if any economic benefits from the hedgebanks and does not think the planned NFM measures will benefit the farm business. His motivation is the desire to allow environmentally friendly measures to be taken on his land, and to potentially increase wildlife

habitat. However, he is supportive and positive and is planning additional NFM measures on his land including woodland planting, leaky dams and wetlands. These measures are likely to bring further benefits to flood storage and Natural Capital value, as they would allow reconnection of the floodplain and creation of new, valuable wetland habitat. Installation of the proposed dams needs to consider the evident energy of the stream under high flows, which could wash features away or reduce their effectiveness. Incorporating sediment ponds to reduce the stream energy in high flows is one option that could be considered, see section 7. A less incised stream would also benefit the farmer through reducing the risk of drowning for his cattle.

3.1 Ecological Condition

A general assessment of the current ecological conditions and any enhancements of habitats that could be achieved through the delivery of the planned NFM measures was made during the walkover.

The recently constructed hedgebanks are turfed earth banks which have some habitat value as they provide shelter and foraging opportunities for wildlife within a predominantly agricultural landscape. Hedges connected to other habitats would be more valuable as they offer commuting and dispersal routes for bats and other small mammals. The existing hedgebanks could be enhanced for wildlife by creating adjacent buffer strips of rough grassland; planting native and local trees and shrubs on top of the hedgebanks and creating habitat links to connect the new hedgebanks to existing hedges or woodland.

Tree planting will benefit the overall habitat value of the catchment, especially alongside the stream where it would extend existing habitat connectivity. As large parts of the catchment area are quite uniform and provide little habitat of interest, habitat creation and enhancement measures which add structural diversity and connecting features to the stream corridor would be highly beneficial. New habitats which are appropriate to the local area are particularly valuable, and could provide areas of UK BAP habitat, such as Wet Woodland. The planned wetland area would enhance habitat diversity in the catchment and the proposed leaky dams that allow a stronger connection to the floodplain will provide additional wetland habitat, including areas of reedbed, marsh and shallow pools to attract invertebrates, create cover for birds and small mammals, and increase foraging opportunities for bats, birds and other wildlife.

Overall, the habitat in the catchment was assessed as currently providing limited benefits to wildlife. NFM measures are very likely to add ecological value to the habitat, the extent of which will depend on the specific design and location.

3.2 Wider Farm Management Issues

During the walkover wider farm management / infrastructure issues were identified that if not resolved will offset much of the benefit derived through NFM measures, existing or planned. It is understood that these are already being addressed by NDBF working closely with the Environment Agency.

3.3 Hydrometric Monitoring

In January 2017, monitoring equipment was installed to establish baseline data before the construction of interventions. The approach taken by WRT sets out a practical, feasible approach to monitoring the NFM interventions which was possible within the time restrictions.

NFM measures were constructed in July 2017, this meant that baseline data (without any NFM measures) was only possible for 6 months. Therefore, it is not possible to compare the same month before and after NFM measures. However, a simple comparison of similar rainfall events and the response of the catchment to the events is possible. This will improve understanding of the response of the catchment to different types of rainfall events, categorised by factors such as:

- Amount of rain during event
- Amount of rain in preceding period
- Time of year
- Lag time between peak rain and peak flow
- Ratio between storm flow and baseflow
- Gradient of rising/falling limbs
- Total in (rainfall over catchment) vs total out (discharge)

A comparison of similar events may indicate an altered response of the catchment post implementation of NFM measures. The walkover has allowed a better understanding of how the measures are working and how the monitoring approach could be refined to capture the change in sub-catchment response. However, as mentioned above the walkover also highlighted other infrastructure and management issues on the farm that will be significantly dampening any signal associated with the existing and planned NFM measures.

Recommendations for enhancing monitoring:

At present, monitoring is located at a single point towards the base of the sub-catchment and as such will only capture significant changes in flow and water quality (in the order of + or – 20%) resulting from the combined effect of upstream NFM measures and farm management activities. Additional monitoring closer to the measures would be better suited to capture the impact of each cluster of NFM (e.g. leaky hedge and wetland at top of Acland, hedgebanks further downstream, series of leaky dams on the Boode road tributary etc).

In addition, simple monitoring techniques could be used to assess the performance of NFM features. This could be achieved by directly recording soil moisture and / or water level or even using time-lapse photography.

A clear understanding of NFM design and installation is essential to ensure ongoing monitoring is effective. This will require close collaboration between all parties involved in the delivery, installation and monitoring of the next suite of measures.

3.4 Summary of Natural Capital in the Acland

Table 5 provides a summary of Natural Capital based on the broad habitat types in the Acland catchment. This data combined with the summary of NFM vs benefits given in Table 4 and the actual/planned delivery of NFM in the Acland catchment allows us to assess whether the Natural Capital approach brings additional value to the development of NFM measures in the Caen.

If all the potential woodland NFM opportunities identified in the national WwNP maps were implemented they could significantly increase the Natural Capital in the Acland catchment and reduce flood risk. The assessment summarised in Table 4 shows that there is potential for an additional 32 hectares of woodland which would reduce flood risk, this would increase woodland in the Acland sub-catchment by 161%. However, only 12.8 hectares of this potential woodland would also provide clear Natural Capital benefits (an increase of 65%) and only 3.9 hectares (an increase of 20%) of the woodland opportunity would provide flood and Natural Capital benefits without significantly impacting the landowner. The implication of this is that ~12% of the potential woodland NFM opportunities from the national WwNP maps could be considered to provide combined flood and Natural Capital benefits without significant impact on landowners.

By contrast there are 0.3 hectares of increased storage NFM opportunities within the Acland catchment, all of which would benefit Natural Capital. Of these storage opportunities 0.2 hectares have been assessed as having a relatively low impact on landowners, this means that 65% of the potential storage opportunities from the national maps could be more acceptable to landowners.

It is important to recognise that the areas of storage created, cannot be directly compared with the areas of woodland planted, in terms of their impact on reducing flood risk. The creation of storage is likely to be significantly more effective, per hectare than woodland creation. The figures above suggest that the creation of additional storage may provide additional flood reduction and Natural Capital benefits while being more acceptable to landowners. This is born-out by the fact that the initial interventions in the Acland catchment have focused on increasing storage and intercepting runoff pathways, rather than woodland creation (i.e. changing land use).

The actual amount of NFM planned, or already delivered in the Acland catchment is ~ 0.6 hectares of woodland (planned) and ~ 0.2ha of increased storage (already delivered or planned). The case study of the Acland highlights that the national WwNP maps may provide a very significant over-estimate of the potential for woodland creation. The Natural Capital approach developed in section 2 estimates that 12% of potential woodland opportunities provide flood risk and Natural Capital benefits while having a relatively low impact on landowners. In this catchment only 2% of the potential woodland NFM opportunities are currently planned to be implemented. This contrasts with 65% of additional storage features which both benefit natural capital and are likely to have a relatively low impact on landowners.

It is important not to over interpret the data from this one small sub-catchment. However, the Natural Capital approach developed in this project significantly improves the identification and

targeting of NFM opportunities within the Caen catchment, and this can aid engaging landowners and delivery organisations.

Table 5: Natural Capital Assets in the Acland Catchment

	LM 2017 (ha)		***LCM 2007 (ha)***	***Natural Capital asset value (£m)***
1 Mountains. Moors and Heaths	***22.5***	***1 Mountains. Moors and Heaths***	***0***	***0.0***
Bracken	*2.5*			
Lowland Heathland	*20.0*			
Upland Flushes, Fens and				
2 Semi-natural Grassland	***25.6***	***2 Semi-natural***	***13***	***0.4***
Acid Grassland	*1.3*			
Lowland Dry Acid Grassland	*0.1*			
Lowland Meadows	*3.5*			
Maritime Cliff and Slopes	*12.6*			
Purple Moor Grass and Rush	*3.1*			
Scrub	*5.1*			
		Rough low-productivity	*13.0*	
3 Enclosed Farmland (total)	***173.2***	***3 Enclosed Farmland***	***228.6***	***2.2***
3.1 Enclosed Farmland (Arable	***121.4***			
Arable and Horticultural	*88.8*	*Arable unknown*	*101.6*	
Improved Grassland	*32.6*	*Hay*	*5.8*	
		Improved	*121.2*	
3.2 Enclosed Farmland (Semi-	***51.8***		*13.0*	
Coastal and Floodplain Grazing				
Semi-improved Grassland	*51.8*			
4 Woodlands	***22.1***		***19.7***	***0.7***
Traditional Orchards	*19.6*			
Wet Woodlands				
Broadleaved, Mixed and Yew	*2.5*	*Deciduous*	*13.9*	
Coniferous Woodlands		*Conifer*	*1.8*	
		Mixed	*4.0*	
5 Freshwater Openwater	***2.3***		***0***	***0.0***
Lowland Fens	*0.7*			
Surface Water	*1.6*			
6 Urban	***24.8***		***9.3***	***0.4***
Urban	*24.8*			
		Suburban	*8.2*	
		Urban	*1.1*	
Total (all habitats)	***270.5***	***Total (all habitats)***	***270.5***	***3.7***

Note: asset values should be regarded as indicative only – see note below Table 1. Values are based on LCM areas and per hectare values outline in Table A3.3

4. Participatory Workshop

4.1 Workshop Plan

The agenda for the workshop (see Annex 2), was developed by the Devon Biosphere Foundation and project team to fulfil the following aims:

- To improve the understanding of, and confidence in, NFM and the Natural Capital approach.
- To elicit local understanding and knowledge about the catchment to improve the picture available from the national data.
- To identify priority sub-catchments where targeted delivery of NFM will bring the greatest benefit to the flooded communities and Natural Capital while minimising any potential negative impacts on the landowner.

4.2 Revised Approach Following Workshop

The methodology allows for the indicator scores for each of the three factors (flood risk, Natural Capital and net effect on landowners) to be augmented by a 'local' score derived from the engagement with stakeholders at the workshop. The following changes were made to the scoring after the workshop:

- Flood risk. Add a score of '1' for NFM opportunities upstream of locally important flooding issues. Stakeholders identified local hotspots of flooding which were not captured on the Environment Agency maps, including road flooding and localised flooding from drains. These 'nuisance' flooding incidents are often more amenable to NFM solutions than fluvial flooding.
- Natural Capital. A score of '-1' was added where NFM could reduce the Natural Capital of the habitat e.g. woodland on species rich grassland. This highlights the potential for Natural Capital dis-benefit of certain types of NFM on highly valued habitats.
- Net effect on landowner. No local scores were added, as a result of the workshop. However, comments from landowners at the workshop demonstrated that it is important to allow for landowners to identify parcels of land where NFM is beneficial to their business as well as parcels of land where NFM has a larger than anticipated dis-benefit.
- Multiple benefits. Workshop attendees identified locations where water quality and soil quality could be improved by the delivery of NFM. Opportunities in these locations were given an addition score of '1' each for localised water quality and soil quality improvements. The Environment Agency WwNP maps do not include soil runoff hotspots because this process is dependent on land use (which changes due to crop rotations) and land management practices (which vary due to the farm business).
- Opportunistic. NFM is reliant on landowner consent. Attendees identified locations where landowners are known to be willing to consider NFM. Opportunities these locations were given an additional score of '1' to highlight locations where delivery organisations will encounter the least resistance to NFM.

The methodology also allowed for the relative importance of each of the three factors to be weighted according to its perceived importance to the catchment stakeholders, for example, flood risk could be weighted to be twice as important as Natural Capital if stakeholders wanted

to prioritise flood risk benefits. This refinement to the methodology was not supported by the discussions at the workshop and all weights were retained at unity.

A number of comments were made by attendees which have not altered the methodology, but are worth considering for future work:

- Shared understanding of how NFM works is necessary if catchment scale delivery is to be acceptable. Engagement opportunities like the workshop allow stakeholders to understand how their work can be refined to reduce flood risk. At the workshop both landowners and Natural England staff identified areas of the catchment where they could use existing funding from HLS to reduce flood risk.
- The attendees want to understand the evidence and have access to it. One attendee asked for the paper copy of the A0 maps used in the workshop. It is possible, and a number of communities are now doing this, to share the mapping online via 'Storymaps' This type of approach could work well for this catchment.
- NFM can benefit farm businesses. The example given for the Acland catchment is the use of debris dams that it is hoped will make the stream less incised and reduce livestock mortality.
- Flooded communities want to understand flood risk. It is important for them to build this technical capacity within the catchment so that they can pass it on to the wider community.
- Riparian woodland opportunities from the EA WwNP maps are unrealistic in steep rural valleys. (50m either side of a water course).
- The flooded community is very positive (probably overly so) about the flood risk benefits of the recently delivered NFM.

5. Summary of findings

5.1 Natural Capital Approach for the Caen Catchment

A Natural Capital approach to NFM is proposed, in which interventions are assessed and prioritised based on the potential for reduction in flood risk and increase in Natural Capital. We also consider the net effect on landowners to ensure that cost effective interventions are prioritised – those that maximise economic, social and environmental benefits while minimising costs and potential opposition from landowners. This approach is considered practical and widely applicable / transferable outside the Caen catchment.

The approach involves collection, compilation and analysis of baseline information on Natural Capital assets, ecosystem services and Natural Capital accounts. This baseline information has been used to inform the development, through participatory processes, of a shared integrated delivery plan and can be used to monitor change over time. A workshop and walkover were used to collect local evidence / data and develop partner, landowner and community understanding of the Natural Capital approach.

The approach is summarised as follows:

1. Download natural flood management potential opportunity maps. (Environment Agency (a), 2017), Living Maps for biodiversity and Natural Capital (Defra, 2017), sub-catchment boundaries, Communities at Risk (Environment Agency) and Risk of Flooding from Rivers and Sea (Environment Agency).
2. Categorise NFM opportunities by type and broad habitat (based on Living Maps). Code for potential Natural Capital benefit and landowner cost based on broad habitat. Code for relative benefit/dis-benefit of NFM.
3. Identify the sub-catchments which have the largest areas of NFM opportunities that will contribute to reduced flooding and increase Natural Capital. Also consider which of these have the largest areas where these opportunities can be implemented at relatively low cost to landowners.
4. Hold stakeholder workshop to review prioritisation, collect local understanding of natural and economic benefits and refine scoring to capture this local knowledge. Create a narrative to go with each priority sub-catchment that is consistent with national data and local data (where available).
5. Revise prioritisation in the light of the stakeholder workshop and recommend priorities for NFM in the catchment.

Prioritisation of NFM is an iterative process. Local communities are more than capable of understanding a coherent narrative about flood risk in their catchment and refining it based on their local knowledge and expertise. Outside experts need to be willing to listen and accept/challenge local knowledge if an improved shared understanding is to emerge. The early stages of NFM delivery in the Caen can be based on the opportunities available (to build momentum and create NFM champions in the landowner community) but should be planned and based on evidence if the initial momentum is to be retained. Communicating the benefits of working in headwater catchments will take time; time for the community to understand that the source of the flood issue and the flooding itself are not necessarily coincident. The Acland catchment represents the easiest 'sell' and is therefore a natural place to start delivery and build confidence. Ongoing engagement is required to maintain interest and grow local technical capacity and understanding.

5.2 Potential for NFM to Change Natural Capital

LM (2017) data was used to assess the potential Natural Capital gain resulting from catchment scale delivery of NFM in the Caen catchment. The summary data, from Table 4, highlights that the three priority sub-catchments (2, 5 and 11) have the largest areas of potential NFM interventions which are expected to result in a net gain in Natural Capital.

For the Caen catchment we identify 223 hectares of riparian or floodplain tree planting opportunities which will bring flood risk benefits to communities at risk. Of these ~ 106 hectares of woodland will also bring Natural Capital benefits (50% of potential opportunities) and 55 hectares (24% of potential opportunities) will deliver flood and Natural Capital benefits

while imposing lower costs on landowners[6]. The detailed case study of the Acland suggests that the feasible potential for increasing woodland may be significantly less than indicated above.

Increasing storage in the priority sub-catchments through the delivery of RAFs and flood plain reconnection highlights that 4 hectares of storage opportunity will provide flood benefits to communities at risk. Almost all opportunities, 3.9 hectares (98%) will provide Natural Capital benefits and 2.9 hectares (75%) will provide flood and Natural Capital benefits while imposing lower costs on landowners. The detailed case study in the Acland suggests that this sub-group of storage opportunities (2.9 hectares) could be a realistic estimate of the potential long-term delivery of storage related NFM in the Caen.

5.3 Priority Sub-catchments for NFM Delivery

Based on the Natural Capital approach, the following priority sub-catchments have been identified:

- The Acland. The NFM opportunities in this catchment provide significant Natural Capital benefits, however, it is the proximity to Braunton and the main areas of fluvial and surface water flooding in the catchment that really confirms that this sub-catchment is the ideal location to focus initial NFM delivery in the Caen. Feedback at the workshop confirmed that the flooded community value, and are reassured by, the delivery of NFM in this sub-catchment. It is clear that delivery has enabled the community to build technical capacity so that local 'ambassadors' can talk to residents about flood risk and identify what they can and, just as importantly, cannot do to reduce their flood risk. There is a danger that the expectations of local residents will be unrealistically high. The best way to manage this is through opportunities like the workshop where local residents can question FCRM professionals and improve their own understanding of flood risk.
- Sub-catchments 2 and 5. These headwater catchments present real opportunities for larger scale interventions and therefore greater impacts on the flooding in Braunton. These sub-catchments should be the long-term focus area for NFM in the Caen catchment.
- Sub-Catchment 9. The potential Natural Capital benefits of NFM in sub-catchment 9 appear to be smaller than for 2 and 5 above. However, local residents and businesses in Braunton who are impacted by flooding focussed on these steep tributaries joining the Caen just upstream of Braunton. The patchy nature of the opportunities in this sub-catchment reflects the potential dis-benefits, identified in the workshop, of exacerbating flooding (through backwater effects) and 'degrading' species rich grassland by planting trees.

[6] Interventions on semi-improved grassland are assumed to impose lower costs. Further work is required to check the accuracy of LM identification of this land use category.

6. Recommendations

1. Improved Land Use data is required for the baseline Natural Capital assessment and to monitor change over time.
    a. The Living Maps component habitat data appears to be less accurate than LCM 2007. Substantial improvements in accuracy will be required to underpin a robust assessment of changes Natural Capital at the catchment level.
    b. LM data potentially allows us to identify semi-improved grassland and to prioritise NFM interventions on this land, over land used for arable and improved grassland. The accuracy of LM identification of these two categories should be reviewed.
2. More targeted assessments of the current quality and trajectory of Natural Capital assets are required for sound Natural Capital investment decisions. Such local assessment data is scarce and mainly lacking for the Caen.
    a. Bio-diversity opportunity maps could be used to highlight where the greatest Natural Capital gains could be realised through measures that effectively reconnect important habitats.
    b. This would facilitate analysis of the potential Natural Capital benefits by habitat type and further refine the scoring approach depicted in Table 2.
3. Further analysis of the landowner costs associated with different NFM interventions, by habitat type is required. The aim would be to refine the scoring approach depicted in Table 3.
4. Additional work to assess Natural Capital benefits will be required, in areas where RAF's and Floodplain Reconnection constitute a significant proportion of all potential NFM interventions. Currently the Environment Agency opportunity maps provide the area of interventions – but not the area of Natural Capital that would be affected by an intervention. For example, a floodplain reconnection opportunity to remove 200 m^2 of flood bank might increase flooding and change Natural Capital on an area of several hectares. A similar issue exists with respect to connecting existing habitat patches. For example, one hectare of habitat creation which connects existing patches increases Natural Capital more than one hectare of isolated habitat.
5. Natural Capital assessment should focus on identifying the net benefits of NFM, as an aid to the development of shared, integrated delivery plans. More detailed Natural Capital accounting at the catchment or sub-catchment level is constrained by data availability (see recommendation 1 above).

6. Further work is required to refine the flood risk benefit assessment process. In our approach NFM opportunities were grouped by land use type within each sub-catchment. In some cases, NFM opportunities needed to be further sub-divided into areas where NFM would have a positive or negative effect (i.e. above and below a flooded community). This refinement could be fully implemented with a modest extension in project timescales.
7. Further work may be required to consider the implications of the sub-catchment prioritisation system when applied to other catchments. The Natural Capital approach that we outline is a form of multi-criteria analysis. As such issues can arise when values are summed since categories cannot be assumed to be equal in magnitude.
8. Future NFM monitoring should be based on the detailed guidance for catchment partnerships which will be released by the Environment Agency. As experience grows the monitoring approach can be refined to provide communities with the data they need to understand flood risk in their catchment and how they can better manage this risk.
9. Any monitoring of the effectiveness of measures should be considered and informed by their design and ideally in place ahead of delivery to enable a robust before and after assessment. Or alternatively a comparison of the response by parallel monitoring in a control catchment.
10. The quantification of the impact of individual NFM interventions on other capitals (buildings, roads, infrastructure) and human and social capital (human life, health, quality of life etc) is rarely possible and should not be required for the NFM prioritisation process. It is possible to quantify the benefit of NFM interventions with the use of modelling and monitoring. However, this is a research endeavour requiring significant resource. The learning from the NERC funded NFM projects led by Lancaster University, Manchester University and Reading University as well as the CASI project led by Leeds University should be used to build confidence in the efficacy of NFM. http://www.nerc.ac.uk/research/funded/programmes/nfm/

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Annex 1: Potential number of flooded properties affected by NFM

Sub - Catchment	# of properties at risk of flooding within sub-catchment	Area flooded (hectares)	Downstream sub-catchments	# of downstream properties that may benefit (excl Braunton)	Potential benefit to Braunton?	Notes
1	0	0,00	2,4,7,9,15	83	✓	small catchment, downstream impact may be limited
2	7	0,02	4,7,9,15	82	✓	priority catchment
3	4	NA	7,9,15	68	✓	
4	17	0,10	7,9,15	56	✓	downstream properties likely to benefit more
5	5	NA	7,9,15	56	✓	priority catchment
6	0	0,00	7,(9,15)	65	✓	small catchment, downstream impact may be limited
7	26	0,12	9,15	39	✓	
8	0	0,00	13,15	0		catchment discharges at lower end of Braunton
9	96	0,59	15	0	✓	catchment just above Braunton
10	0	0,00	13, (15)	0		catchment discharges at lower end of Braunton
Acland	42	0,26	15	0	✓	catchment just above Braunton
12	0	0,00	13,15	0		catchment discharges at lower end of Braunton
13	0	0,00	15	0		catchment discharges at lower end of Braunton
14	0	0,00	15	0		catchment discharges at lower end of Braunton
15	731	4,05	-	-	x	This catchment includes Braunton - properties here will not be affected by NFM within this catchment
Total	***928***					

Footnote Data was provided by the Environment Agency. It includes buildings at high/medium/low risk of flooding based on modelled flood zones. "Properties that may benefit" includes properties that could potentially be affected by implementation of NFM measures in the given catchment, i.e. that lie on the main watercourse that would receive flow from the given catchment.
Braunton includes 731 buildings flooded, these are not included in the "# of downstream properties flooded" column.

The number of properties that may benefit is the total number of properties at risk of flooding in catchments downstream of the given sub-catchment, excluding those on tributaries that would not be affected by reducing flooding from the main river. This means a delivery of NFM in the given sub-catchment would *contribute* to reduce flood risk in the given number of properties, but further action (in additional sub catchments) would likely need to be taken to achieve the full benefit.

Annex 2: Workshop Agenda

Maximising the Natural Capital of the Caen Catchment by the delivery of Natural Flood Management (NFM)

Date: 15th January 2018

Location: Vivian Moon Community Centre, Chaloners Rd, Braunton EX33 2ES

Facilitators DPJ/DM/KB (one for each table)

Ref.	Item	Who	Time
	Aims for the meeting: ➢ Understand the current Natural Capital of the Caen catchment based on best available data AND local understanding ➢ Co-design NFM delivery plan to increase the Natural Capital of the Caen. ➢ Agree how the delivery plan can be monitored so we can see how the Natural Capital within the Caen catchment grows as a result of NFM delivery		
	Tea and coffee		9.30
1	**What is Natural Capital? Why is it important?** ➢ Underpins the 25 year environment plan ➢ Leave the Caen in a better condition for our children **What is NFM and why is it important** ➢ Video of NFM ➢ Natural Flood (NFM) Opportunities in the Caen (from the EA) ➢ What does the research say?	**DM** **DPJ**	10:00 10.15
2	**What is the current Natural Capital of the Caen?** ➢ Natural Capital (based on broad habitat type) ➢ Landowner cost (based on landuse) ➢ Communities at Risk (based on flood risk, buildings and infrastructure) ➢ Natural Flood Opportunity maps (WwNP maps from the EA) **Discussion on each table:** Do the maps of current NC make sense to you if you live and work in this catchment. If not, why not? Copies of maps will be on the table for folk to annotate. Facilitator feeds back to whole group. ➢ Maps of Natural Flood Opportunities ➢ Map of flood risk ➢ Map of landuse ➢ Map of Broad habitat types (Natural Capital)	**DM/KB**	10:30 1045
3	**Where could NFM make the most difference to Natural Capital (pos. & neg.)**	**DPJ/KB**	11:00

	➢ Traffic light NFM opportunities (Nat capital) ➢ Traffic light NFM opportunities (Landowner cost) ➢ Traffic light NFM opportunities (Flood risk) ➢ We will show these maps on GIS on the screen **Discussion on table:** Do the maps of NFM opportunity help target NFM so we can leave the Caen in a better state for our children? How should we refine them? **Facilitator feeds back to whole group.**		11.15
4	**What else is going on in the catchment?** ➢ Experience gained in Boode ➢ Diffuse pollution and SuDs work in the Caen ➢ Monitoring that has been done.....and what it is showing **Discuss if you have any questions**	**Sophia**	11.30
5	**Shared delivery plan** ➢ This is where we would spend money on NFM to maximise the Natural Capital in the Caen AND reduce flood risk AND minimise landowner costs **Discussion on table:** How would you change the scale of NFM (Increase/decrease) and location of the NFM to leave the Caen in a better state for our children? **Facilitator feeds back to whole group.**	**DPJ**	12:00 12.15
6	**How do we monitor to make sure that the Caen improves?** ➢ Does the nat cap approach above reflect how you 'value' your catchment? ➢ What other data/knowledge exists which can turn this into a meaningful relative measure of quality of life in the Caen? **Discussion in whole group:** What next steps do we need to do to make this project output as useful as possible for your catchment? ➢ Online map of opportunities? Show example. ➢ Skeleton business cases? Show example. ➢ Something else?	**DM/DPJ**	12:30 12.40
7	**Finish**		13:00
8	**Follow-on session** for any individuals or groups who want to ask more questions or make additional suggestions.		Optional

List of Workshop Participants

Name	***Organisation***
Dave Johnson	*The Rivers Trust*
Kathi Bauer	*West Country Rivers Trust*
Dan Marsh	*West Country Rivers Trust*
Sophia Craddock	*Devon County Council*
Caroline Chugg	*Councillor at Devon County Council*
Phil Metcalfe	*Devon County Council*
Martin Hutchings	*Devon County Council*
Gemma Carter	*Devon County Council*
Brett Grosvenor	*Environment Agency*
Siobhan Murphy	*Natural England*
Tracey Lovell	*Braunton Parish Council*
Byron ?	*Flood Warden*
Derrick Spear	*Chair of parish council/district council*
P Farrelly	*Braunton flood group*
?	*Farmer*

Annex 3: Natural Capital in Caen sub-catchments

Table A3.1: Natural Capital by broad habitat (hectares)

Sub-catchment	Acland 11	1	2	3	4	5	6	7	8	9	10	12	13	14	15	Total for Caen
Broad Habitat (Living Maps 2017)																
1 Mountains, Moors and Heaths	22.5	0.0	13.9	5.5	15.7	14.3	3.2	29.7	31.9	54.4	8.8	26.2	34.3	12.9	9.7	283.1
2 Semi-natural Grassland	25.6	3.2	25.2	43.0	33.2	38.2	7.4	76.3	5.4	142.3	14.7	19.3	30.4	12.4	41.3	517.9
3.1 Enclosed Farmland (Arable & Imp' Grassland)	121.4	100.2	207.8	224.1	61.6	277.8	68.7	308.9	248.6	375.1	116.9	160.5	181.5	102.3	199.3	2754.7
3.2 Enclosed Farmland (Semi-imp' grassland)	51.8	31.1	193.3	59.9	32.3	150.3	35.8	150.7	52.9	131.7	31.4	10.4	78.0	14.3	96.8	1120.7
4 Woodlands	22.1	8.0	59.6	23.0	48.7	102.4	2.5	96.6	22.7	76.3	16.8	24.3	54.1	16.8	73.7	647.6
5 Freshwater Openwater Wetl'nds & Floodplains	2.3	0.2	2.9	29.2	1.7	10.6	0.3	9.3	0.2	1.5	5.9	0.0	4.9	0.0	7.4	76.6
6 Urban	24.8	3.1	45.6	9.3	26.0	21.0	0.1	20.8	5.0	45.3	14.7	7.0	15.1	9.0	158.3	405.0
7 Coastal Margins	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	5.1	0.0	2.0	1.8	0.8	31.5	43.3
8 Marine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Total	**270.5**	**145.8**	**548.3**	**394.1**	**219.3**	**616.7**	**118.0**	**692.2**	**366.7**	**831.6**	**209.1**	**249.7**	**400.1**	**168.7**	**618.1**	**5848.9**
Broad Habitat (LCM 2007)																
1 Mountains, Moors and Heaths			0.6	3.4		6.7	1.2	0.9	1.1	1.2	0.7	1.3	1.2		0.0	18.2
2 Semi-natural Grassland	13.0	1.4	8.0	10.9	6.6	24.2	0.8	25.7	4.0	17.2	3.7	29.7	7.8		16.8	169.8
3.1 Enclosed Farmland (Arable & Imp' Grassland)	228.6	145.2	515.1	363.7	154.2	499.0	112.4	588.5	352.7	735.5	189.2	207.6	347.8	156.1	379.9	4975.5
4 Woodlands	19.7		9.6	18.0	47.8	86.0	3.5	71.8	8.9	59.8	14.6	10.2	35.4	10.9	107.8	503.9
5 Freshwater Openwater Wetl'nds & Floodplains								0.8								0.8
6 Urban	9.3	0.0	15.1	0.9	10.8	2.2		4.6	0.0	18.7	1.0	0.8	8.0	1.8	124.9	198.1
7 Coastal Margins															0.5	0.5
Total	**270.5**	**146.6**	**548.5**	**396.9**	**219.3**	**618.1**	**118.0**	**692.2**	**366.8**	**832.3**	**209.2**	**249.7**	**400.1**	**168.8**	**629.9**	**5866.9**
Discrepancy (Living Maps - LCM)																
1 Mountains, Moors and Heaths	22.5	0.0	13.3	2.1	15.7	7.7	2.0	28.8	30.8	53.2	8.1	24.9	33.2	12.9	9.7	264.9
2 Semi-natural Grassland	12.6	1.8	17.2	32.1	26.6	14.0	6.5	50.6	1.4	125.0	11.0	-10.4	22.6	12.4	24.5	348.1
3.1 Enclosed Farmland	-55.4	-13.9	-114.0	-79.6	-60.2	-70.9	-8.0	-128.9	-51.2	-228.6	-41.0	-36.7	-88.3	-39.4	-83.9	-1100.1
4 Woodlands	2.4	8.0	49.9	5.1	0.9	16.4	-1.1	24.8	13.8	16.5	2.2	14.1	18.8	6.0	-34.1	143.7
5 Freshwater Openwater Wetl'nds & Floodplains	2.3	0.2	2.9	29.2	1.7	10.6	0.3	8.5	0.2	1.5	5.9	0.0	4.9	0.0	7.4	75.8
6 Urban	15.5	3.1	30.5	8.3	15.2	18.8	0.1	16.1	4.9	26.6	13.7	6.2	7.2	7.2	33.5	206.8
7 Coastal Margins	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	5.1	0.0	2.0	1.8	0.8	31.0	42.8
Total	**0.0**	**-0.8**	**-0.2**	**-2.8**	**0.0**	**-1.4**	**0.0**	**0.0**	**0.0**	**-0.7**	**-0.1**	**0.0**	**-0.1**	**-0.1**	**-11.9**	**-18.1**

Table A3.2: Indicative Natural Capital asset value in Caen sub-catchments by broad habitat (£ million)

Sub-catchment	Acland 11	1	2	3	4	5	6	7	8	9	10	12	13	14	15	Total for Caen
Broad Habitat (Living Maps 2017)																
1 Mountains, Moors and Heaths	0.4	0.0	0.2	0.1	0.2	0.2	0.1	0.5	0.5	0.9	0.1	0.4	0.5	0.2	0.2	4.4
2 Semi-natural Grassland	0.8	0.1	0.8	1.4	1.0	1.2	0.2	2.4	0.2	4.5	0.5	0.6	1.0	0.4	1.3	16.3
3.1 Enclosed Farmland (Arable & Imp' Grassland)	1.1	0.9	2.0	2.1	0.6	2.6	0.6	2.9	2.3	3.5	1.1	1.5	1.7	1.0	1.9	25.9
3.2 Enclosed Farmland (Semi-imp' grassland)	0.5	0.3	1.8	0.6	0.3	1.4	0.3	1.4	0.5	1.2	0.3	0.1	0.7	0.1	0.9	10.6
4 Woodlands	0.8	0.3	2.2	0.9	1.8	3.9	0.1	3.6	0.9	2.9	0.6	0.9	2.0	0.6	2.8	24.4
5 Freshwater Openwater Wetl'nds & Floodplains	0.0	0.0	0.0	0.5	0.0	0.2	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.1	1.2
6 Urban	1.2	0.1	2.1	0.4	1.2	1.0	0.0	1.0	0.2	2.1	0.7	0.3	0.7	0.4	7.5	19.1
7 Coastal Margins	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.1	0.1	0.0	1.2	1.6
8 Marine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**4.8**	**1.8**	**9.2**	**5.9**	**5.3**	**10.5**	**1.4**	**12.0**	**4.6**	**15.3**	**3.4**	**3.9**	**6.8**	**2.8**	**15.8**	**103.5**
Broad Habitat (LCM 2007)																
1 Mountains, Moors and Heaths	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
2 Semi-natural Grassland	0.4	0.0	0.3	0.3	0.2	0.8	0.0	0.8	0.1	0.5	0.1	0.9	0.2	0.0	0.5	5.3
3.1 Enclosed Farmland (Arable & Imp' Grassland)	2.2	1.4	4.9	3.4	1.5	4.7	1.1	5.5	3.3	6.9	1.8	2.0	3.3	1.5	3.6	46.9
4 Woodlands	0.7	0.0	0.4	0.7	1.8	3.2	0.1	2.7	0.3	2.3	0.5	0.4	1.3	0.4	4.1	19.0
5 Freshwater Openwater Wetl'nds & Floodplains	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 Urban	0.4	0.0	0.7	0.0	0.5	0.1	0.0	0.2	0.0	0.9	0.0	0.0	0.4	0.1	5.9	9.3
7 Coastal Margins	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**3.7**	**1.4**	**6.2**	**4.5**	**4.0**	**8.9**	**1.2**	**9.3**	**3.8**	**10.6**	**2.5**	**3.3**	**5.2**	**2.0**	**14.1**	**80.8**

Note: Values in this table are based on median values from Table A3.3, summed across all categories of ES where value estimates are available

Table A3.3: Indicative ecosystem service values in North Devon by broad habitat (£/ha)

		Provisioning		Regulating						Cultural	
Ecosystem Service		Food	Fibre	Air Quality	Climate (Global)	Water Regulation	Erosion & Natural Hazard Regulation	Water Purific-ation & waste treatment	Spiritual and religious values	Aesthetic Values	Rec-reation and Tourism
Broad Habitats											
Coastal Margins											
	Coastal wetlands	low	Zero/v. low	Zero/v. low	medium	high ?	Zero/v. low	high ?	?	?	medium
	Estuary	low	Zero/v. low	Zero/v. low	low	high ?	Zero/v. low	low	?	?	medium
	Dunes	low	Zero/v. low	Zero/v. low	medium	medium	Zero/v. low	medium	?	?	medium
Enclosed Farmland											
	Permanent grassland	low	Zero/v. low	Zero/v. low	medium	?	?	low	low	?	medium
	Improved pasture	low	Zero/v. low	Zero/v. low	(medium)	?	?	low	low	?	medium
	Arable	low	Zero/v. low	Zero/v. low	(low)	?	?	low	low	?	medium
Freshwater	Open Water	?	Zero/v. low	Zero/v. low	Zero/v. low	?	Zero/v. low	?	?	?	medium
Mountains, Moors and Heaths											
	Upland bogs	low	Zero/v. low	Zero/v. low	low	Zero/v. low	?	medium	low	?	?
	Heath&moorland	low	Zero/v. low	Zero/v. low	low	?	?	low	low	?	medium
Semi-natural grassland											
	Culm Grassland	low	?	Zero/v. low	medium	medium	?	medium	low	?	medium
	Scrub	Zero/v. low	Zero/v. low	Zero/v. low	low	medium	?	?	?	?	?
Urban	Urban	Zero/v. low	Zero/v. low	?	Zero/v. low	?	?	?	medium	?	high ?
Woodland											
	Coniferous woodland	low	low	?	medium	medium	?	low	low	?	medium
	Deciduous woodland	low	low	?	medium	medium	?	medium	low	?	medium

Note this table has been compiled based on data from several sources including UK NEA, Biopshere and Expert Opinion.

KEY	(medium)	negative hundreds	?	Don't Know / No evidence	low	tens
	(low)	negative tens	Zero/v. low	Zero/very low	medium	hundreds
	?	Don't know, -ve	?	Don't know, +ve	high	thousands

Annex 4: Potential Natural Capital benefits from NFM

Note: Only interventions which are potentially effective for flood risk reduction and expected to have Natural Capital benefit are included

Table A4.1: Tree Planting NFM Interventions by Catchment (hectares)

Catchment	***Acland***	***2***	***4***	***5***	***9***	***Total***
Tree Planting Riparian						
Enclosed Farmland (semi-improved grassland)	*3.9*	*31.2*	*1.2*	*18.4*	*0.0*	*54.7*
Enclosed Farmland (arable & improved grassland)	*8.9*	*23.3*	*0.2*	*4.9*	*13.7*	*51.0*
Total	*12.8*	*54.5*	*1.5*	*23.3*	*13.7*	*105.7*

Note: In catchments 11 (Acland), 2, 4, 5 & 9 there are no floodplain tree planting interventions additional to the areas detailed above.

Table A4.2: Runoff Attenuation and Floodplain Reconnection Interventions by broad habitat (hectares)

Broad Habitat	***Flood-plain Reconn-ection***	***Runoff Attenuation 1% AEP Gully Blocking***	***Runoff Attenuation 1% AEP Run-off Attenuation***	***Total***	
Coastal Margins		*0.01*	*0.18*	*0.19*	*5%*
Enclosed Farmland	*0.19*	*0.23*	*0.77*	*1.19*	*31%*
Enclosed Farmland (Arable)		*0.05*	*0.90*	*0.95*	*24%*
Freshwater Openwater wetlands and Floodplains		*0.06*	*0.20*	*0.26*	*7%*
Mountains, Moors and Heaths		*0.14*	*0.00*	*0.14*	*4%*
Semi-natural Grassland		*0.08*	*0.01*	*0.09*	*2%*
Urban		*0.13*	*0.17*	*0.30*	*8%*
Woodland	*0.03*	*0.51*	*0.23*	*0.77*	*20%*
Grand Total	***0.2***	***1.2***	***2.5***	***3.9***	