



Cornwall

Area of Outstanding Natural Beauty (AONB)

Natural Capital Assessment

Technical Appendices

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Appendix A

CAONB Natural Capital Mapping & Physical Change Analysis

To map Natural Capital assets in the Cornwall AONB digital Geographical Information System (GIS) layers provided by the CAONB Partnership and the Environmental Records Centre for Cornwall and the Isles of Scilly (ERCCIS) were analysed and manipulated for the purpose of this investigation. Three GIS layers were assessed for this project:

- Cornwall broad habitat layer 1995,
- Cornwall broad habitat layer 2005, and
- Cornwall Biodiversity Action Plan (BAP) Priority Habitat layer 2003

The digital layers were created by ERCCIS and are based on aerial photography surveys. Similar methods and frameworks for land cover classification were used for the 1995 and 2005 broad habitat layer analysis which allowed an analysis of land cover changes.¹ For the purpose of this investigation six Natural Capital Asset Categories were defined after consultation with the CAONB management group and ERCCIS:

- Coast (COA)
- Heathland, Wetland & Disturbed Ground (HWD)
- Open Water (OWA)
- Semi-Natural Grassland (SNG)
- Woodland, Scrub & Bracken (WSB)
- Arable Land & Improved Grassland (AIG)
- Built Environment (BEN)

The main focus of the assessment was on the first five categories whilst the built environment serves mainly as reference category. We acknowledge the value of Natural Capital assets within the built environment but the available data did not provide the level of detail to assess Natural Capital assets within the BEN category. Table A.1 summarises the physical change analysis for broad habitat categories within the CAONB and also shows which land cover types were included in each category.

¹ ERCCIS and Cornwall Wildlife Trust 2010.

Table A.1 CAONB Physical Natural Capital Asset Changes 1995-2005

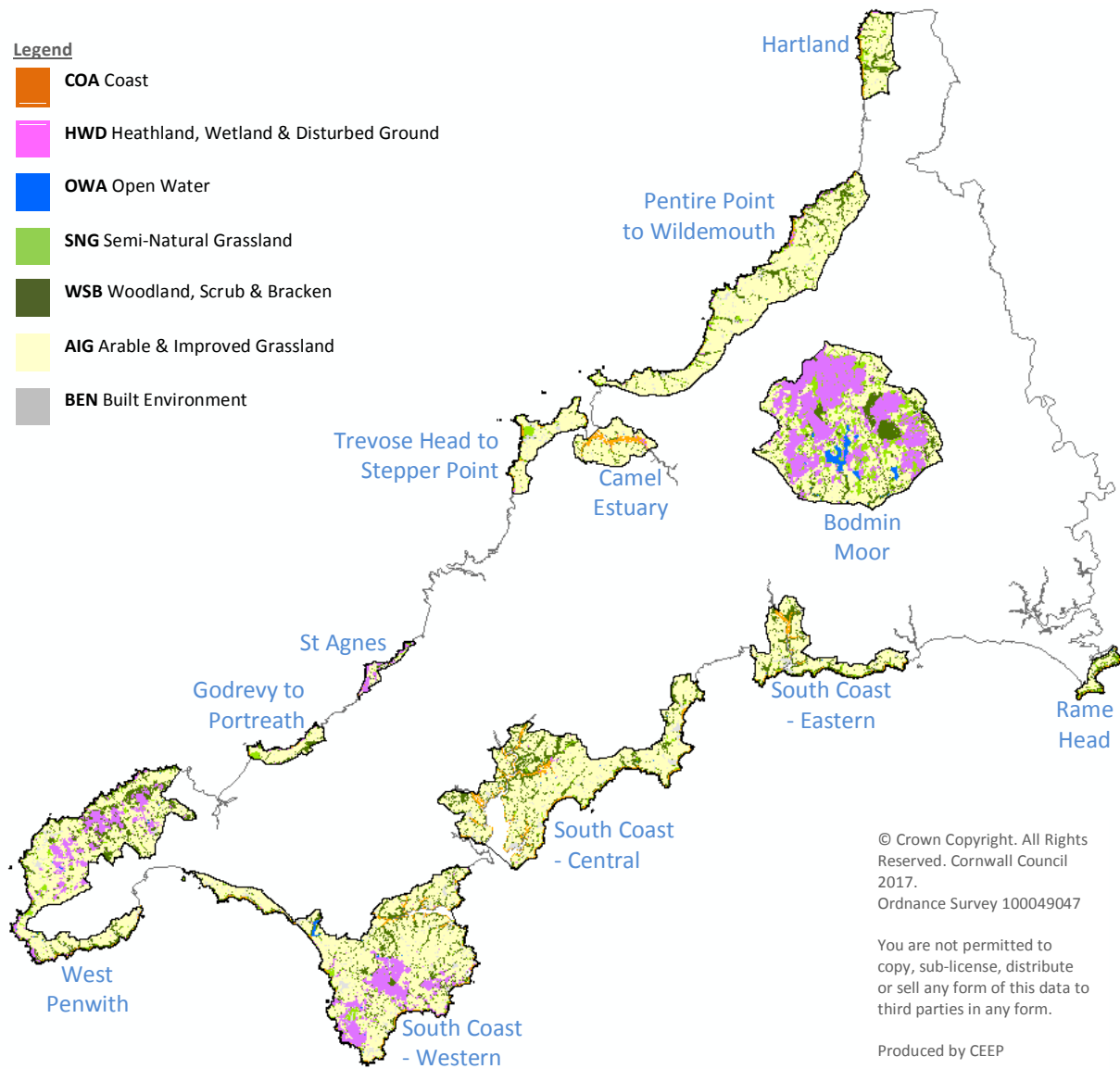
Natural Capital Assets Category Land Cover Class Sub-category	Area in ha in 1995	Area in ha in 2005	Area change in ha	Area change in %
Coast (COA)	4,006.1	4,001.3	-4.8	-0.1%
Above High Water Mark Coastland	721.7	721.1	-0.7	-0.1%
Intertidal Coastland	3,284.4	3,280.2	-4.2	-0.1%
Heathland, Wetland & Disturbed Ground (HWD)	12,639.7	12,695.3	+55.6	+0.4%
Disturbed Ground	44.4	81.8	+37.4	+84.3%
Heathland	3,434.0	3,430.6	-3.4	-0.1%
Wetland	9,161.3	9,182.9	+21.6	+0.2%
Open Water (OWA)	590.8	633.9	+43.1	+7.3%
Semi-Natural Grassland (SNG)	5,585.6	5,577.3	-8.3	-0.1%
Coastal & Dune Grassland	673.5	673.4	-0.1	-0.0%
Unimproved Grassland	4,912.1	4,903.9	-8.2	-0.2%
Woodland, Scrub & Bracken (WSB)	11,472.9	11,758.7	+285.8	+2.5%
Bracken	2,339.1	2,318.8	-20.3	-0.9%
Broadleaved & Mixed Woodland	5,977.3	6,426.9	+449.6	+7.5%
Coniferous Woodland	1,340.3	1,166.5	-173.8	-13.0%
Felled Woodland	71.4	105.2	+33.8	+47.3%
Scrub	1,744.8	1,741.3	-3.5	-0.2%
Arable Land & Improved Grassland (AIG)	56,045.7	55,680.9	-364.8	-1.3%
Arable	11,889.9	11,819.7	-70.2	-0.6%
Improved Grassland	44,155.7	43,861.1	-294.6	-0.7%
Built Environment (BEN)²	3,993.9	3,965.5	-28.4	-0.7%
Total	94,334.8	94,312.9	-21.8	-0.0%

Source: Author calculation based on data provided by ERCCIS.

To explain the rather unusual decline of BEN: In Bodmin Moor between 1995 and 2005 about 5 ha of built environment were converted to disturbed ground. In the same area about 33 ha were converted to open water, about 16 ha to unimproved grassland and about 1.5 ha to broadleaved woodland. However, after 2005 the extend of BEN will have increased and is likely to increase further due to new development.

² The 2005 figure has been adjusted by +20 ha as about 20 ha which were classified as built environment in 1995 were not assessed in 2005.

Figure A.1 CAONB Natural Capital Assets Overview



Source: **Based on GIS data provided by Cornwall Council and ERCCIS**

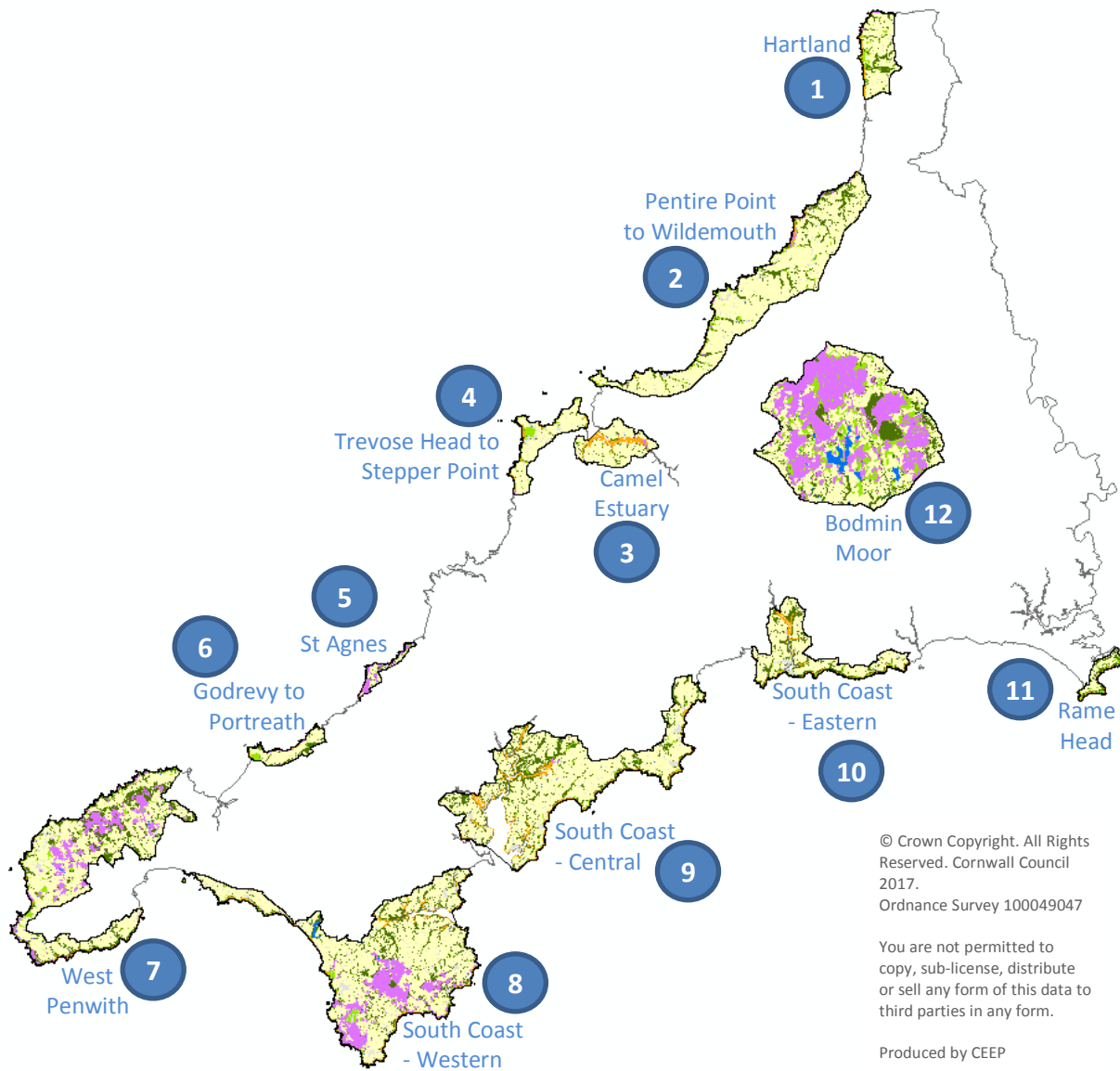
Appendix B

CAONB Management Area Natural Capital Asset Maps

Below you can find an overview of all CAONB management areas followed by more detailed maps for each of the CAONB management areas. The maps are based on the Cornwall land cover assessment from 2005 provided by ERCCIS. The following legend applies for all Figures in this Appendix:

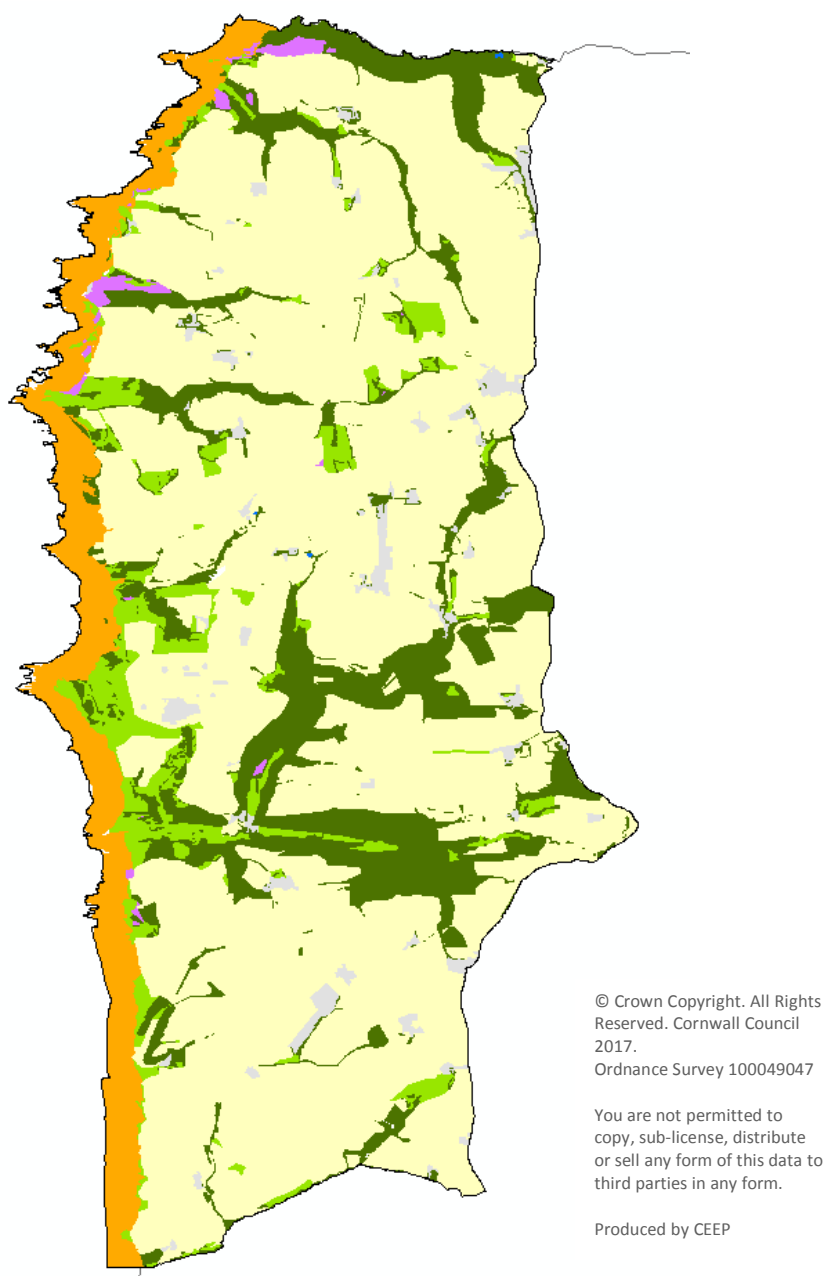
-  **COA** Coast
-  **HWD** Heathland, Wetland & Disturbed Ground
-  **OWA** Open Water
-  **SNG** Semi-Natural Grassland
-  **WSB** Woodland, Scrub & Bracken
-  **AIG** Arable & Improved Grassland
-  **BEN** Built Environment

Figure A.2 CAONB Management Areas Overview



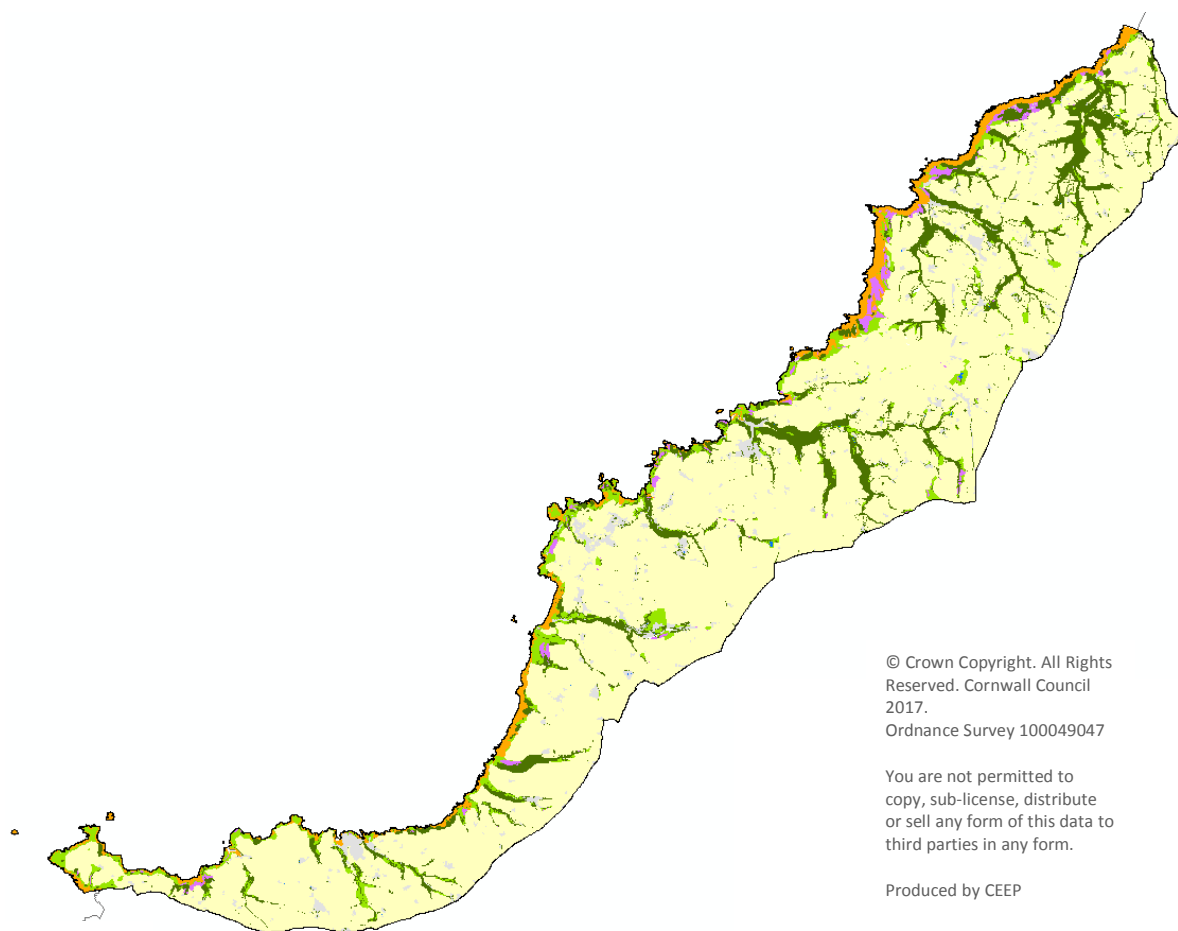
Source: ***Based on GIS data provided by Cornwall Council and ERCCIS***

Figure A.3 Area 1: Hartland



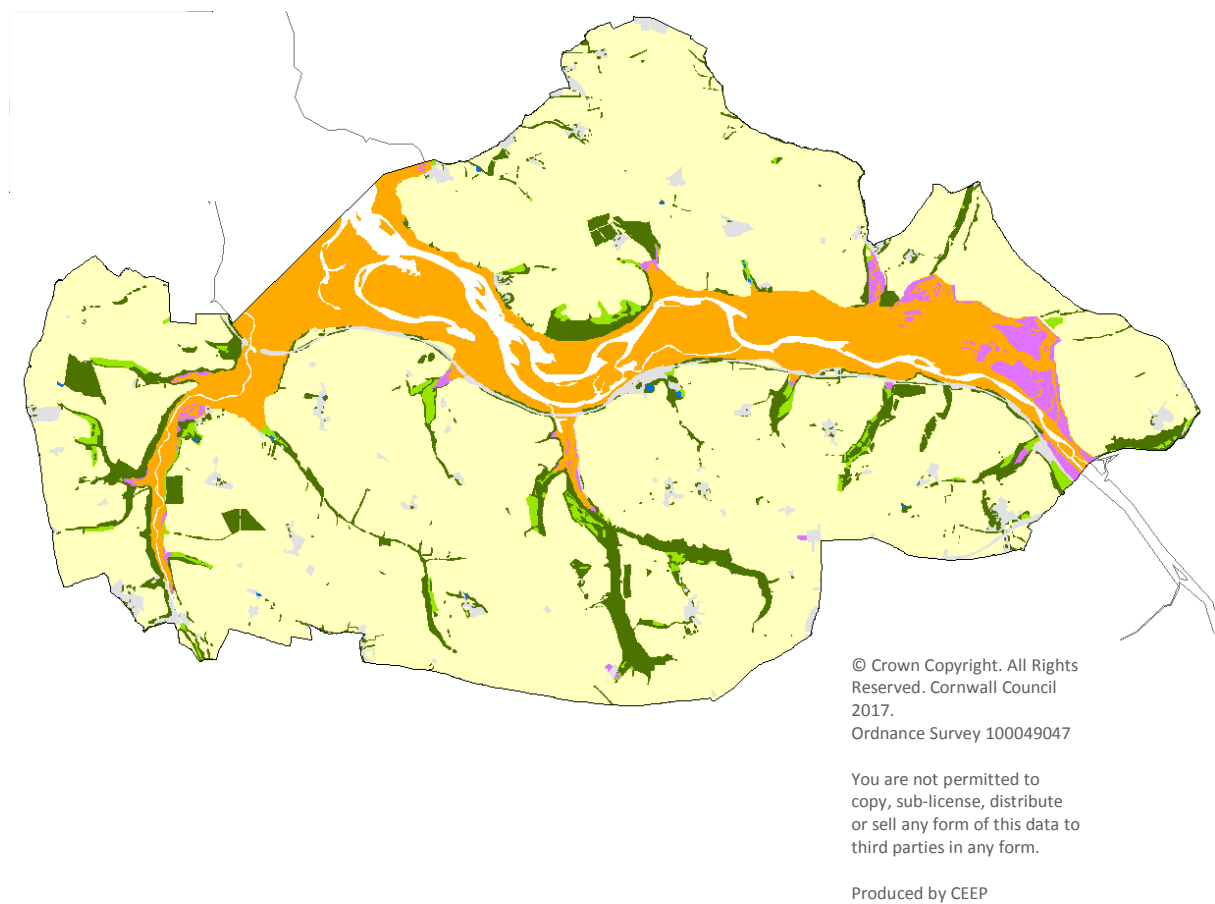
Source: Based on GIS data provided by Cornwall Council and ERCCIS

Figure A.4 Area 2: Pentire Point to Wildemouth



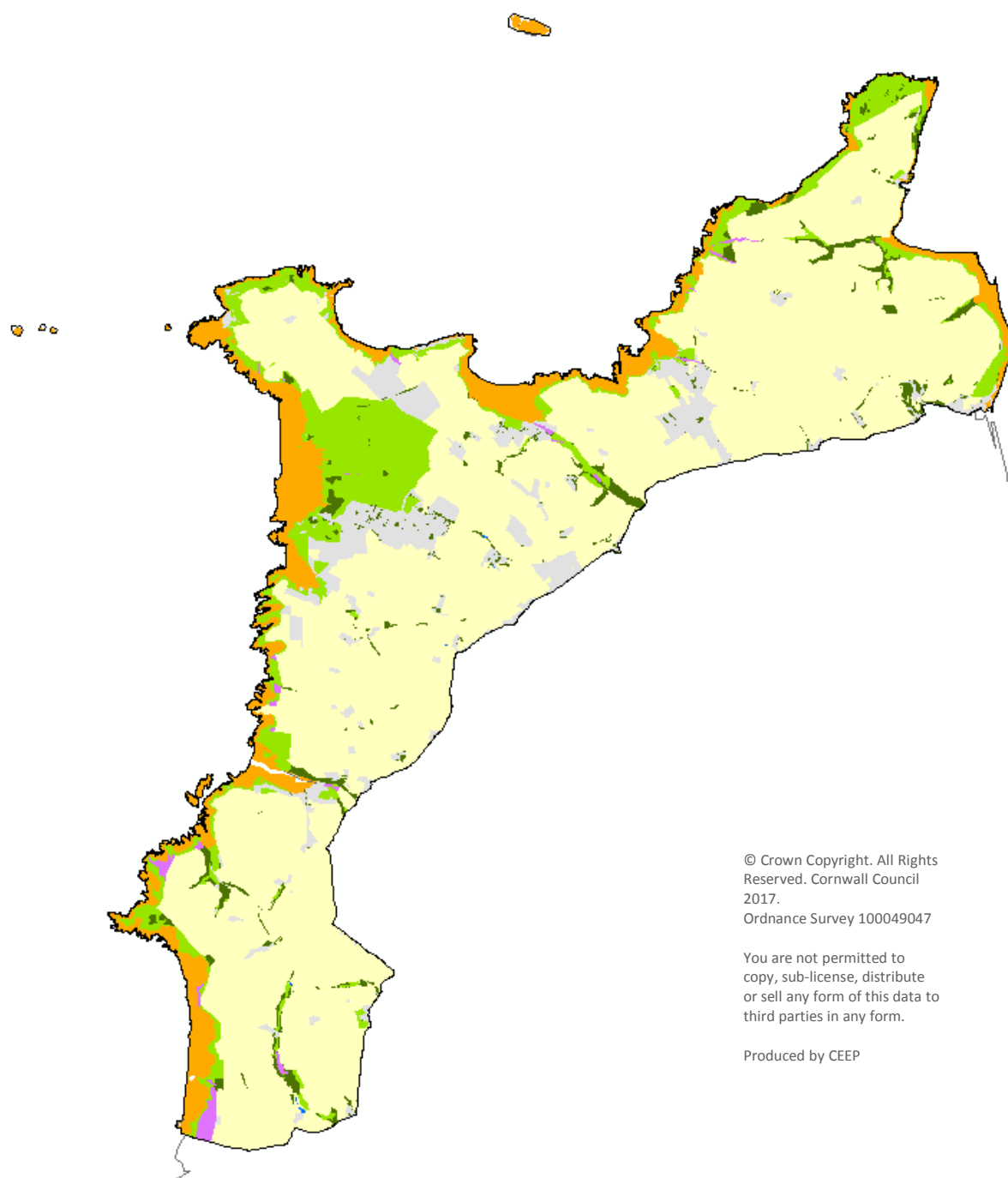
Source: Based on GIS data provided by Cornwall Council and ERCCIS

Figure A.5 Area 3: Camel Estuary



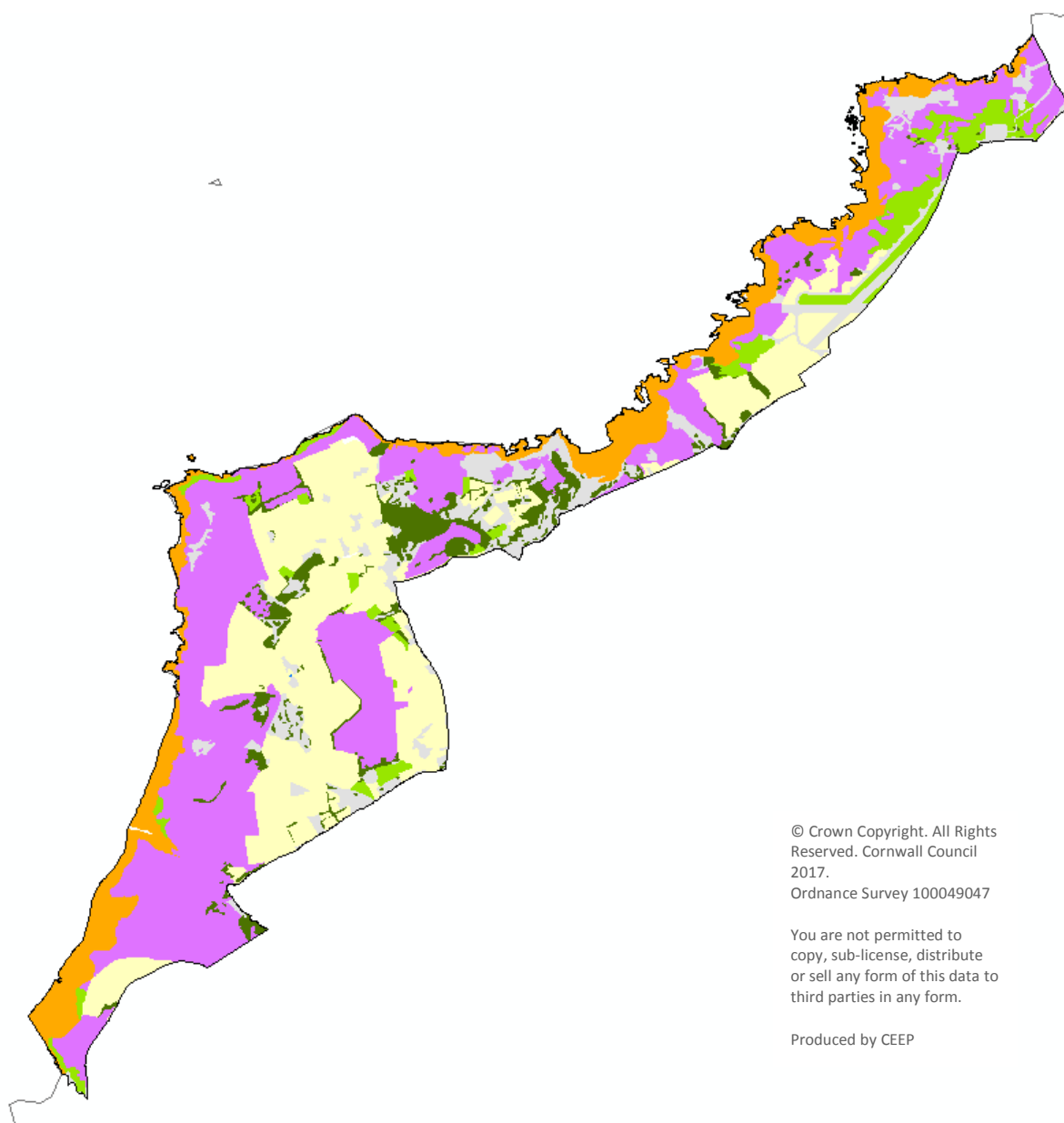
Source: Based on GIS data provided by Cornwall Council and ERCCIS

Figure A.6 Area 4: Trevoze Head to Stepper Point



Source: Based on GIS data provided by Cornwall Council and ERCCIS

Figure A.7 Area 5: St Agnes



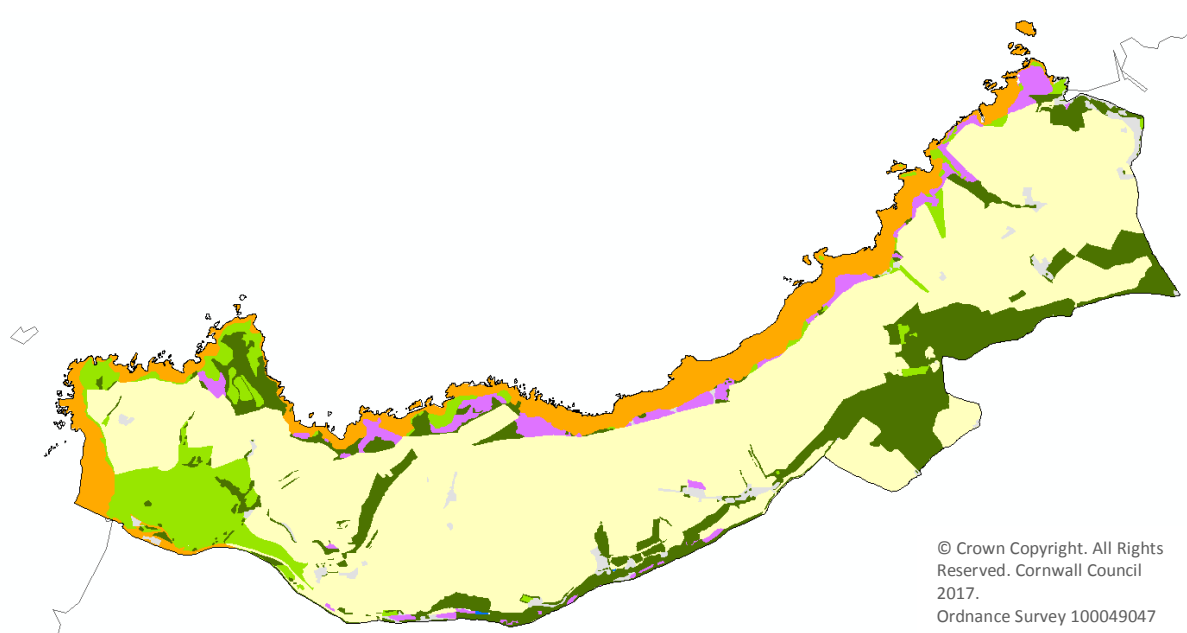
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Source: Based on GIS data provided by Cornwall Council and ERCCIS

Figure A.8 Area 6: Godrevy to Portreath



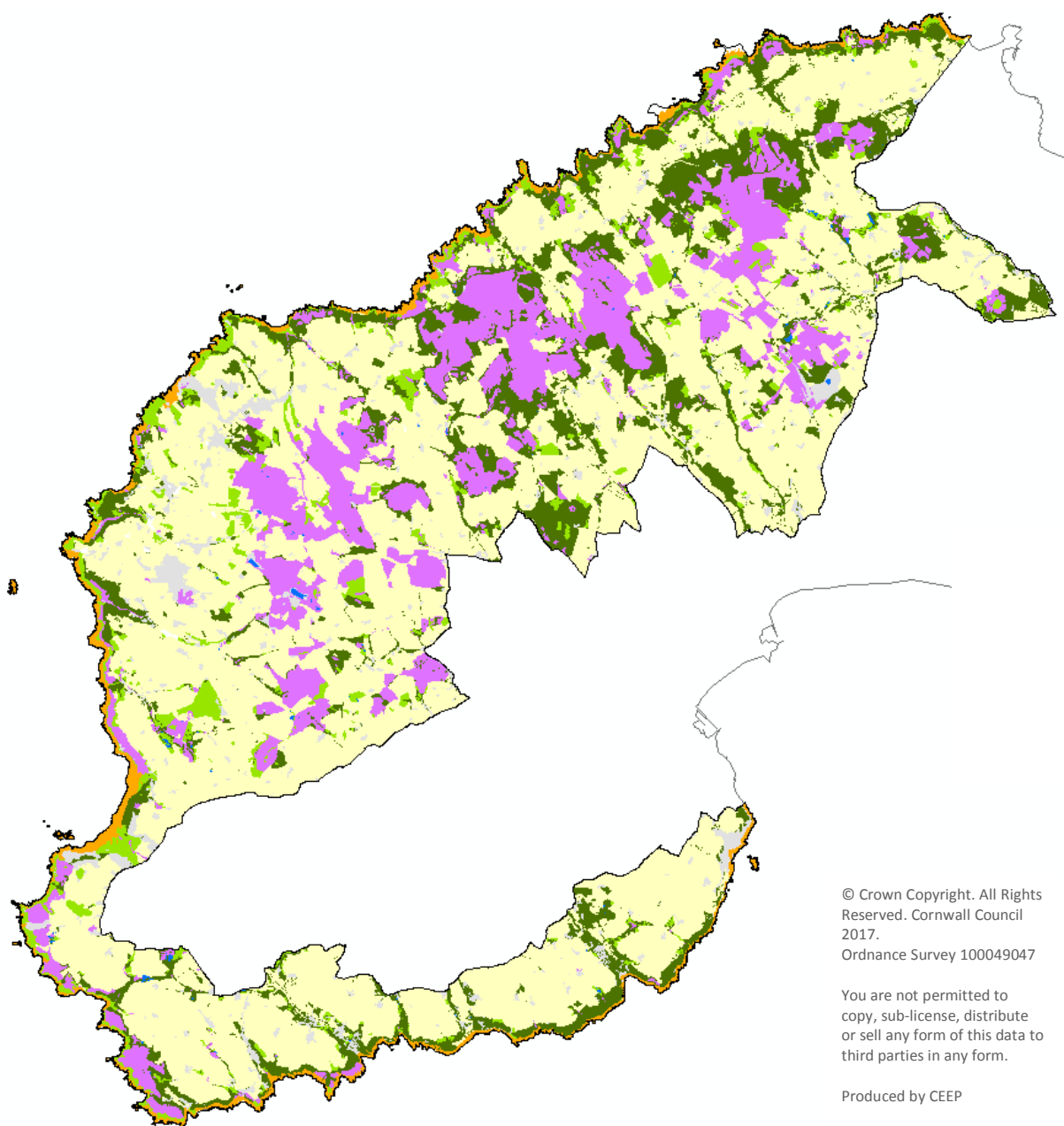
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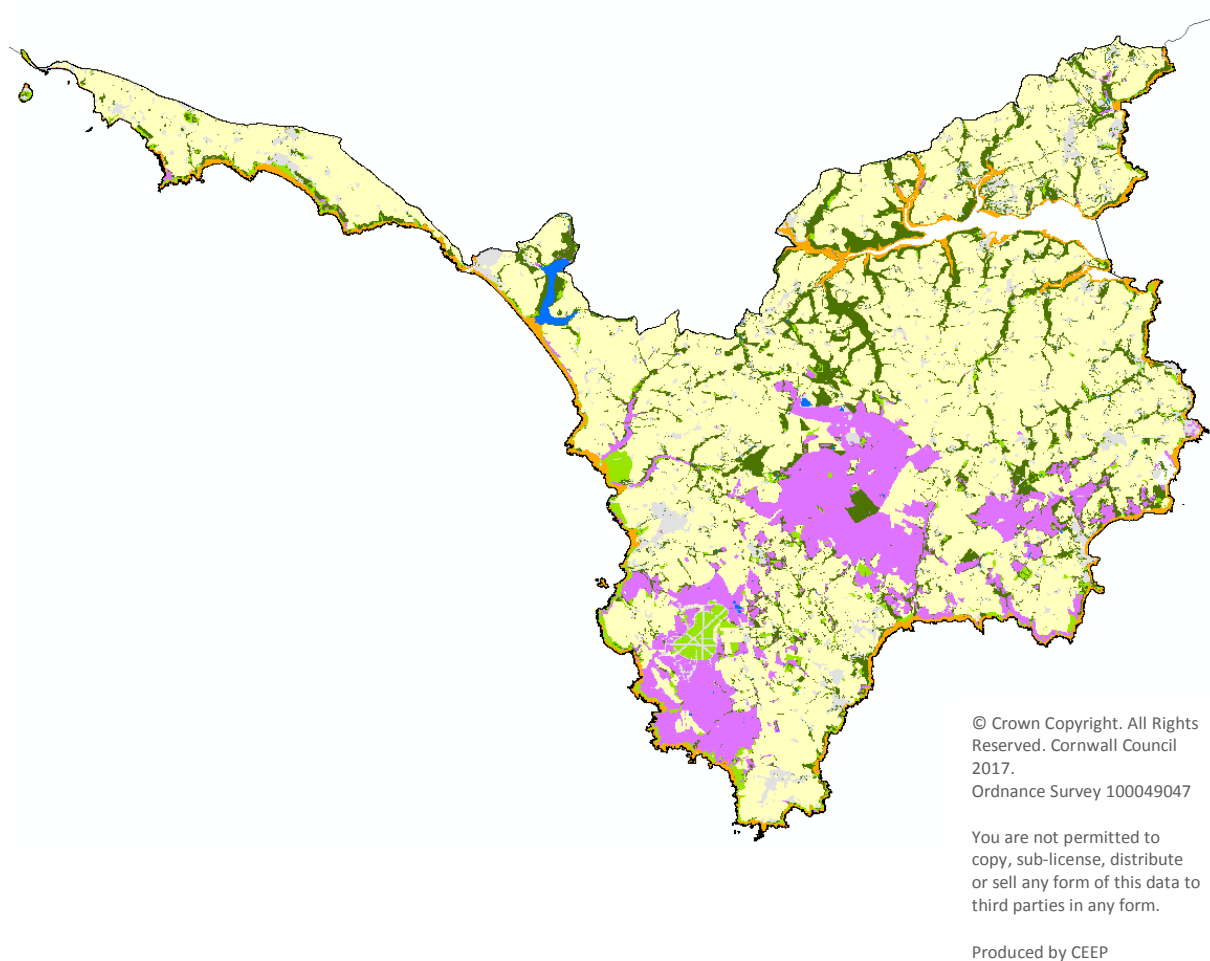
Source: Based on GIS data provided by Cornwall Council and ERCCIS

Figure A.9 Area 7: West Penwith



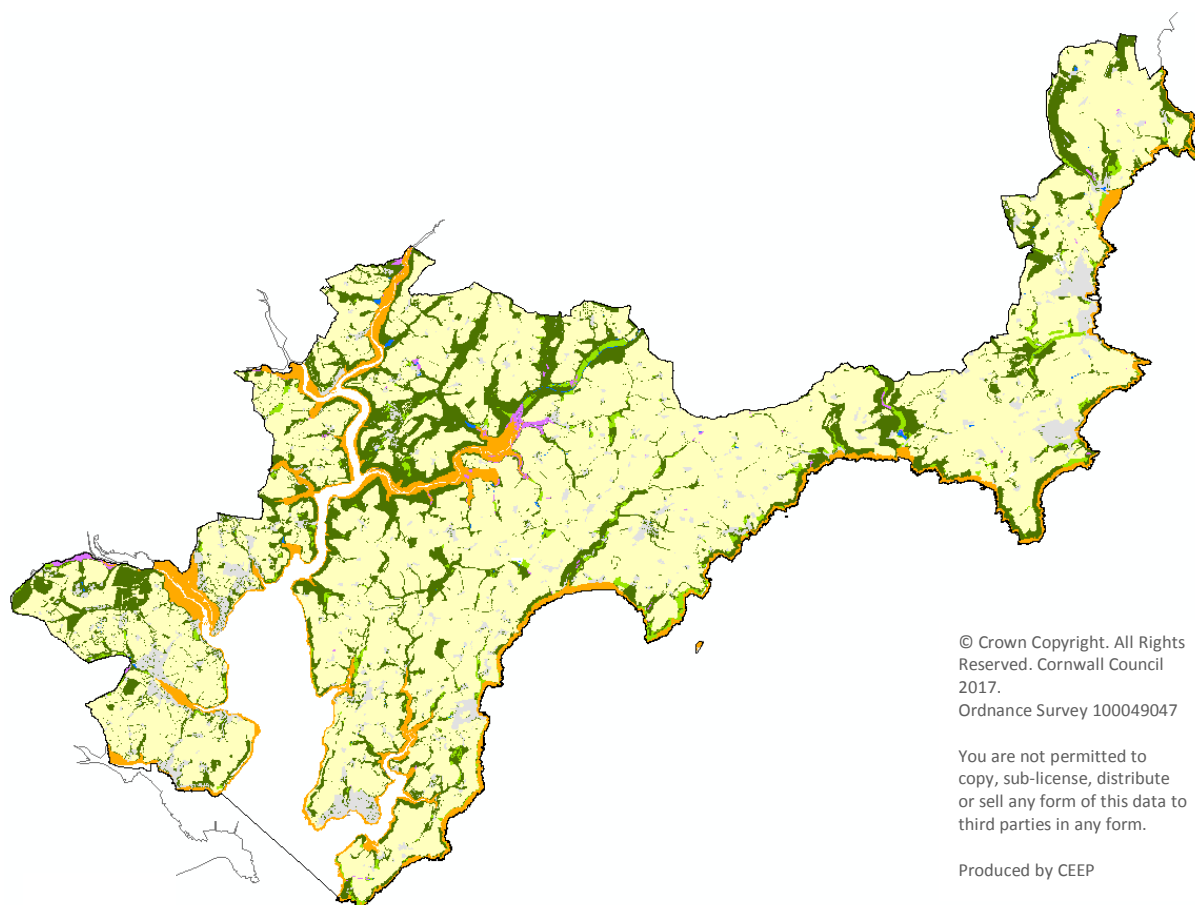
Source: Based on GIS data provided by Cornwall Council and ERCCIS

Figure A.10 Area 8: South Coast - Western



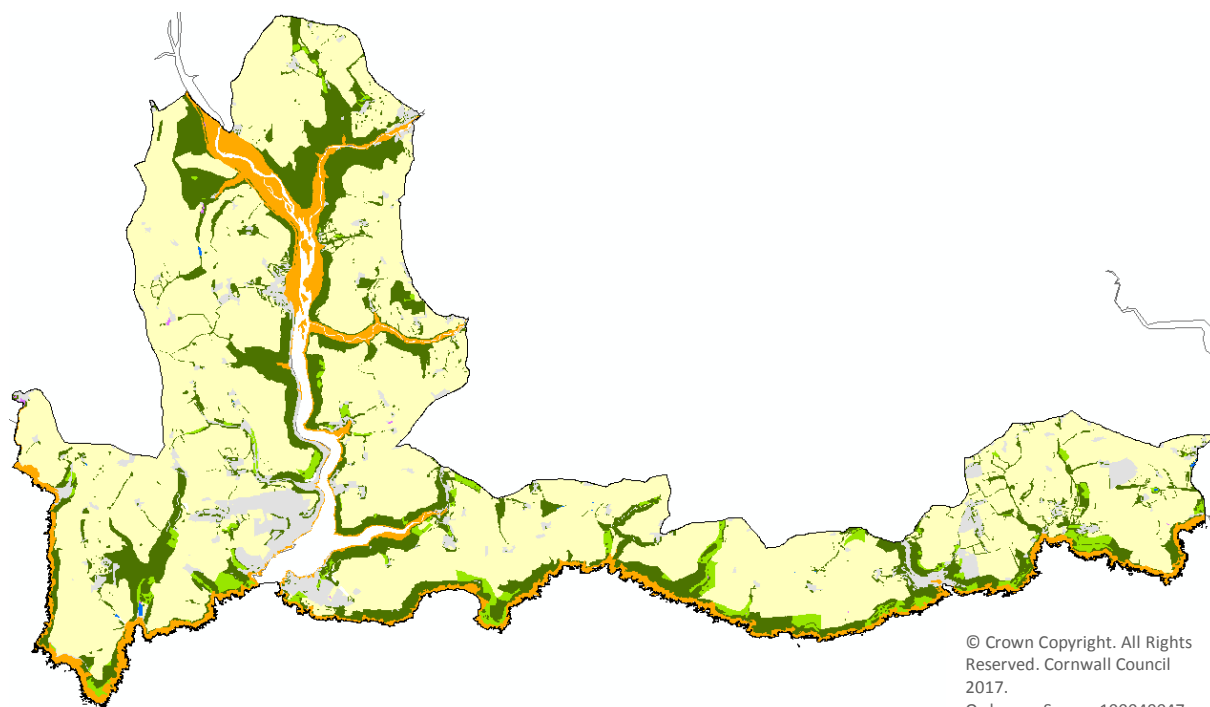
Source: Based on GIS data provided by Cornwall Council and ERCCIS

Figure A.11 Area 9: South Coast - Central



Source: Based on GIS data provided by Cornwall Council and ERCCIS

Figure A.12 Area 10: South Coast - Eastern



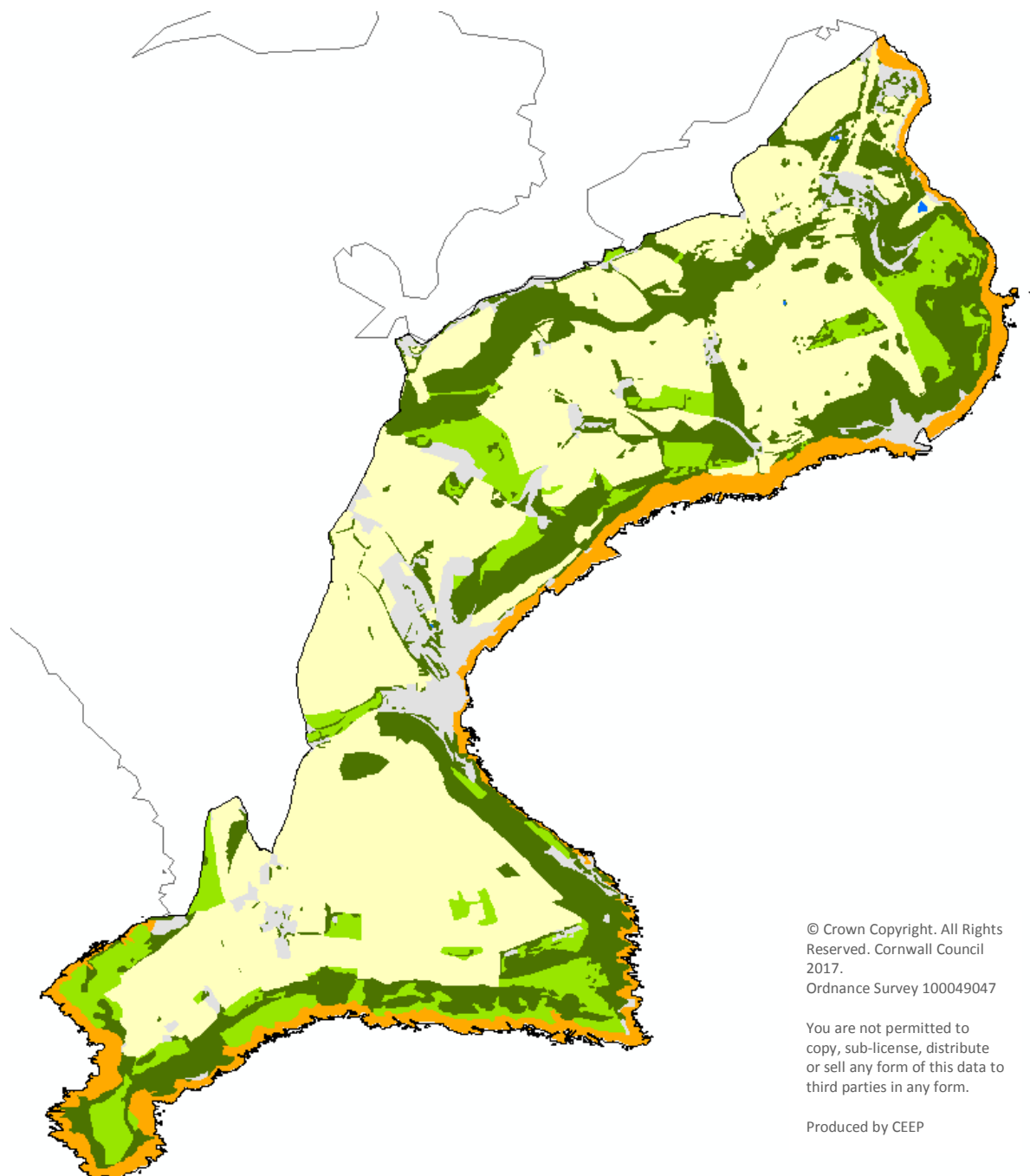
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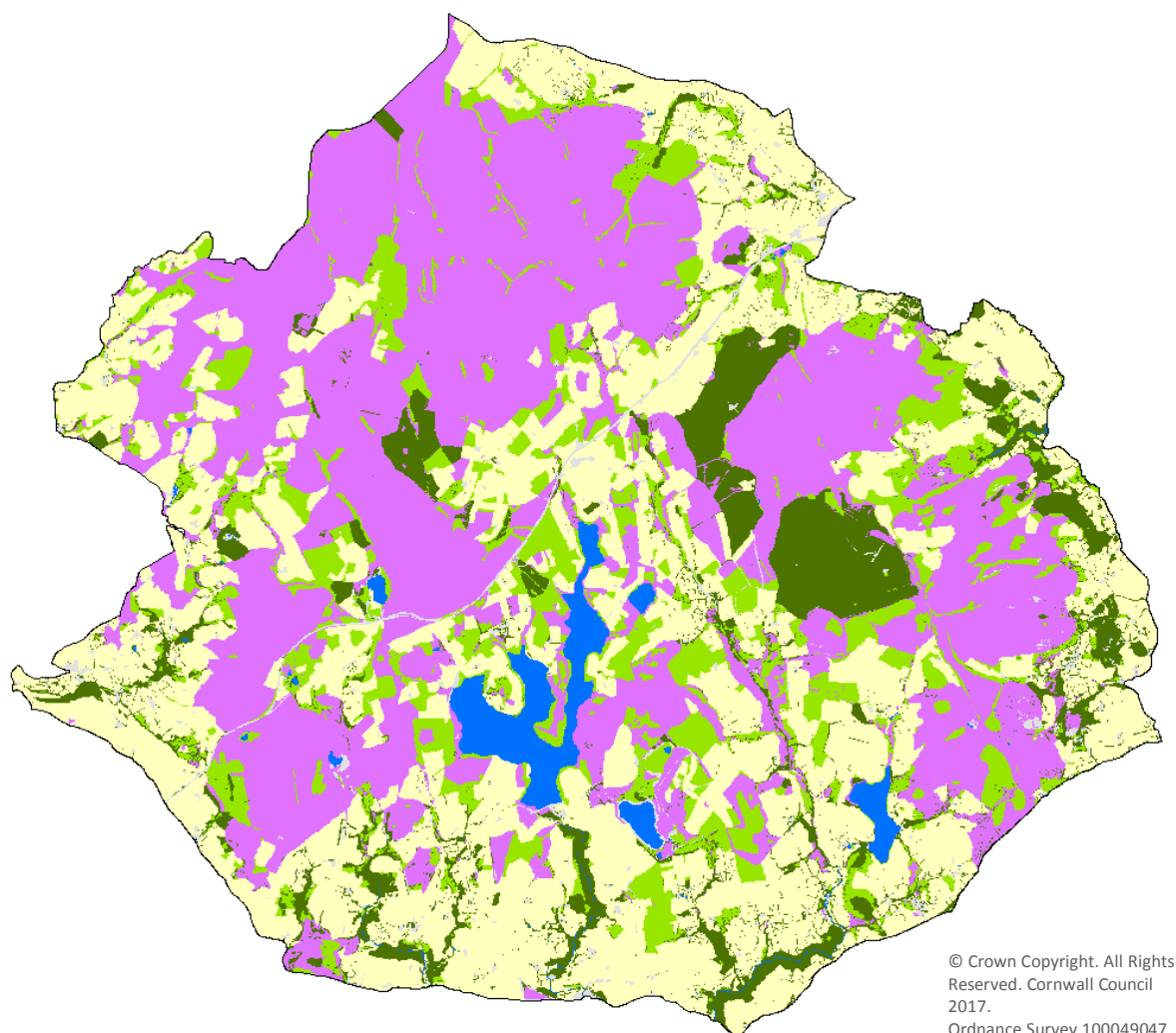
Source: Based on GIS data provided by Cornwall Council and ERCCIS

Figure A.13 Area 11: Rame Head



Source: Based on GIS data provided by Cornwall Council and ERCCIS

Figure A.14 Area 12: Bodmin Moor



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Source: Based on GIS data provided by Cornwall Council and ERCCIS

Appendix C

Relative Ecosystem Service Provision & Change Analysis: Methods, Caveats & Protocols

This Appendix provides more detailed information about how the information in Section 2.1 and in particular Figure 2.1 has been generated and which caveats and limitations should be acknowledged. It also contains a protocol for each Natural Capital asset/ecosystem service combination outlining why a certain value/trend has been ascertained.

The analysis was mainly based on an analysis and review of (1) changes to the physical extend of Natural Capital assets including habitat changes within each Natural Capital asset category between 1995 and 2005, (2) national trends such as the reduction in fertiliser usage and evidence such as the National Ecosystem Assessment³, (3) national and local statistics related to productivity such as for food crops, (4) where relevant local evidence such as from the CAONB monitoring project⁴, and (5) the expertise of the consultants and local experts/stakeholders. After an initial assessment a draft figure including draft protocols were shared with relevant local stakeholders allow for comments. The protocols also contain an indication of the confidence in the ascertained relative importance as well as the direction of change, each. The purple colour code of the box frames in Figure 2.1 was always based on the lower confidence level. So if the confidence in the relative level of ecosystem service provision was high but the confidence in the direction of change was low (or *vice versa*), then the box frame will indicate low overall confidence.

It is important to stress that the assessment has been undertaken in a relatively short time (rapid assessment) and is based on a limited amount of evidence. An in-depth analysis was limited by a lack of or gaps in the data and evidence available as well as by resource constrains. Spatial landcover information to assess physical habitat changes was for example only available for 1995 and 2005 so often it had to be assumed that an observed trend continued afterwards. Local evidence also revealed many gaps which is why often national

³ UK NEA 2011b.

⁴ Land Use Consultants 2013.

evidence was the basis for the local assessment even if we tried to acknowledge the specific and somewhat unique context and circumstances of the CAONB as far as possible.

Relative Ecosystem Service Importance and Direction of Change Protocols

Provisioning Services: Food

Natural Capital Asset	Coast	COA
Ecosystem Service	Food	Provisioning
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Low
Confidence		Low
Narrative	The UK NEA suggests that provisioning services provided by coastal margins nationally are relatively minor. There is (or has been) some cattle grazing on the coast of west Penwith between Porthgwarra and Lamorna and on coastal land near Zennor but likely to be of low significance in an CAONB-wide context. There may also be some harvesting of mushrooms, berries and other plants from sand dunes and shingle but not in significant amounts. ⁵ We found no evidence that this service should be more relevant in the CAONB.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No net change
Confidence		Low
Narrative	Between 1995 and 2005 there was only a marginal change of -4.8 ha mapped for the physical extend of the coastal Natural Capital assets. This could be due to some erosion but could also be explained by the adjustment of GIS boundaries with no actual physical change to the asset. A small area in the Camel Estuary has been lost due to wetland expansion. Because we could not identify evidence for changes to the food production practices we have to assume no net change (negligible decline) for the overall direction of change.	

⁵ Jones et al. 2011.

Natural Capital Asset	Heathland, Wetland & Disturbed Ground	HWD
Ecosystem Service	Food	Provisioning
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Low
Confidence		Low
Narrative	There may be some sheep grazing on heathland habitats and potentially some fishing activity within wetland habitats. But this is unlikely to be commercially significant within the CAONB.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Unknown
Confidence		Low
Narrative	Whilst the physical extend of heathland has slightly declined between 1995 and 2005 (-3.4 ha) the extend of wetland and disturbed ground has increased by 21.6 ha and 37.4 ha, respectively. Notably, this is an increase of almost 85% for disturbed ground. Information about changes to the use and productivity of HWD for food production could not be identified. Because we could not identify if the physical habitat changes affected areas where food is produced the direction of change remains uncertain.	

Natural Capital Asset	Open Water	OWA
Ecosystem Service	Food	Provisioning
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Low
Confidence		Low
Narrative	Lakes and ponds provide valuable recreational fishing opportunities. However, the commercial value of the product ‘fish’ in this respect is less significant than the recreational value of fishing as an activity which is covered under the cultural ecosystem service recreation within this framework. Often fish is actually released after catching them which shows that the main purpose of game fishing is the activity itself rather than the product value of the harvested fish.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Some improvement
Confidence		Low
Narrative	The extent of open water (only mapped for inland lakes, ponds etc. excl. rivers and canals) has increased quite significantly between 1995 and 2005 by 43.1 ha or 7.3%. This is mainly due to the creation of a 32 ha lake (presumably) in Bodmin Moor. The rest seems to be related mainly to the creation of new ponds across several locations within the CAONB. The creation of new lakes and ponds is likely to have some positive effect on food provision even if it is not clear if the created resources are managed for fishing etc.	

Natural Capital Asset	Semi-Natural Grassland	SNG
Ecosystem Service	Food	Provisioning
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Medium
Confidence		Medium
Narrative	The main provisioning service provided by semi-natural grasslands is livestock farming and related products such as meat and milk. Semi-natural grasslands are less productive in terms of providing fodder for livestock than fertilised improved grasslands. But there is some evidence supporting the view that the quality of meat and dairy products in terms of nutritional value, taste, appearance and smell may be better for livestock fed on semi-natural grasslands. This could justify a price premium for such products from semi-natural grassland habitats to make up some of the quantity loss when compared to improved grassland livestock. Apart from the direct on-site effect there are also ‘spill-over’ effects. Semi-natural grasslands have a higher biodiversity value which supports pollination and pest control. Evidence suggests that this spill-over effect supports productivity on nearby arable fields. ⁶ This means that part of the food production ecosystem service on such arable fields is in fact related to the semi-natural grasslands and should therefore be accounted for as such. The extent of this spill-over effect, however, is uncertain.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No net change
Confidence		Low
Narrative	Between 1995 and 2005 there was a slight decline in the physical extend of (possibly) unimproved grassland of 8.3 ha. The extent of coastal and dune grassland remained virtually unchanged. Some area in Bodmin Moor (about 10 ha) has been mapped as possibly unimproved grassland in 1995 and has been mapped as improved grassland in 2005, for example. But this could well be due to variations in aerial photography interpretation rather than changes of actual management practice on the ground. Information about possible changes to the management and productivity of semi-natural grassland for food production was not obtained. Therefore we assume that the overall provision food is likely to be unchanged; based on the information available.	

⁶ Bullock et al. 2011.

Natural Capital Asset	Woodland, Scrub & Bracken	WSB
Ecosystem Service	Food	Provisioning
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Low
Confidence		Medium
Narrative	WSB in the UK is not a traditional source for food products but it provides for example fruits and fungi for private and sometimes commercial consumption. But the overall significance for food production is relatively low.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Some Improvement
Confidence		Low
Narrative	The WSB asset category has seen the greatest physical increase between 1995 and 2005 with 285.8 ha or 2.5% of WSB created. The area of broadleaved and mixed woodland has been extended by almost 450 ha (7.5%) whilst at the same time the extent of coniferous woodland and bracken was reduced by 174 ha (13%) and 20 ha (0.9%), respectively. This is likely to have had some positive effect on food provision even if information about the use of these resources is not known.	

Natural Capital Asset	Arable & Improved Grassland	AIG
Ecosystem Service	Food	Provisioning
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		High
Narrative	Food production is usually the primary purpose of arable fields and improved grassland. Whilst arable fields are managed to grow crops, improved grassland is usually managed to provide fodder and space for livestock production. ⁷	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No Net Change
Confidence		Low
Narrative	<p>With -365 ha or -0.7%, AIG has experienced the greatest decline in physical extend between 1995 and 2005. The relative decline was more or less equally distributed between arable land (-0.6%) and improved grassland (-0.7%). The changes were mainly related to afforestation, especially in South Coast – Central, but also many other smaller areas of the CAONB. UK wide the productivity by land was virtually unchanged within the same time period has however increased by almost 8% by 2015.⁸ Assuming that the UK-wide productivity gains also apply in the CAONB, which the trend towards farm amalgamation between 2007 and 2010 may support⁹, then the decline of the physical extend of farmland may have been offset by productivity gains since 1995. It is also quite likely that afforestation took place on land that is less valuable for agriculture. Therefore there may have been no significant net change in food provision despite the declines in physical extend.</p> <p>An economic analysis for the CAONB (resident based) indicates that there may have actually been a small increase of GVA of the agriculture, forestry and fishing sector from £43.6 million for the period 1997-2004 to £44.6 million for the period 2010-2014; an increase of £1.0 million or 2.2%.¹⁰ However, a range of caveats apply which means that the figures should be treated with caution.¹¹ Also, specific data for agriculture alone was not available.</p>	

⁷ Firbank et al. 2011.

⁸ Total factor productivity of the UK agricultural industry 2015, Defra

⁹ Land Use Consultants 2013.

¹⁰ Many thanks to Stephen Horscroft from Cornwall Council for sharing and manipulating this data.

¹¹ The analysis is based on the 'best fit' of Output Areas with the AONB management areas as GVA data for the AONB itself was not available. The data is based on resident employment rather than workplace which means that it is based on the GVA generated by people living within the assessed Output Areas rather than businesses located within the Output Areas. As the GVA data has been downscaled to the Output Areas using employment data the figures could also be biased if for example per-head productivity is higher/lower within the AONB Output Areas as compared to the rest of Cornwall.

Provisioning Services: Non-food Products

Natural Capital Asset	Coast	COA
Ecosystem Service	Non-food products	Provisioning
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Low
Confidence		Medium
Narrative	The UK NEA suggests that provisioning services provided by coastal margins nationally are relatively minor. Historically, some dune grasses were used for mat- and basket-weaving but this has now very low economical relevance. There may also be some abstraction of water from shingle and sand dunes of reasonable depth and extend for commercial uses but only to very limited extends. ¹² We found no evidence that this service should be more relevant in the CAONB.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No net change
Confidence		Low
Narrative	Between 1995 and 2005 there was only a marginal change of -4.8 ha mapped for the physical extend of the coastal Natural Capital assets. This could be due to some erosion but could also be explained by the adjustment of GIS boundaries with no actual physical change to the asset. A small area in the Camel Estuary has been lost due to wetland expansion. We have not found evidence of changes to the provision of non-food products so we estimate that there was no net change of significance.	

¹² Jones et al. 2011.

Natural Capital Asset	Heathland, Wetland & Disturbed Ground	HWD
Ecosystem Service	Non-food products	Provisioning
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Low
Confidence		Medium
Narrative	Reedbeds provide material for example used for basket making but the extent of the reedbeds area within this category is small (about 3.5%). Heather cuttings are also sometimes used as mulch for the restoration of bare peat or for bio-filtration. ¹³ But overall the importance of these habitats for the provision of non-food products is relatively low.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Unknown
Confidence		Low
Narrative	Whilst the physical extend of heathland has slightly declined between 1995 and 2005 (-3.4 ha) the extent of wetland and disturbed ground has increased by 21.6 ha and 37.4 ha, respectively. Notably, this is an increase of almost 85% for disturbed ground. If the changes especially to wetland extend had an impact on the provision of non-food products is not known.	

¹³ Van der Wal et al. 2011.

Natural Capital Asset	Open Water	OWA
Ecosystem Service	Non-food products	Provisioning
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Low
Confidence		Medium
Narrative	There may be some reed harvested in shallow waters but unlikely to be of greater commercial significance.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No net change
Confidence		Medium
Narrative	The extent of open water (only mapped for inland lakes, ponds etc. excl. rivers and canals) has increased quite significantly between 1995 and 2005 by 43.1 ha or 7.3%. This is mainly due to the creation of a 32 ha lake (presumably) in Bodmin Moor. The rest seems to be related mainly to the creation of new ponds across several locations within the CAONB. However, this is unlikely to have a noticeable effect on the provision of non-food products.	

Natural Capital Asset	Semi-Natural Grassland	SNG
Ecosystem Service	Non-food products	Provisioning
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Low
Confidence		High
Narrative	The provision of commercially relevant non-food products from semi-natural grasslands is very limited but there may be the potential for the use for fuel-crops from such habitats. ¹⁴ Furthermore semi-natural grasslands provide some wild flowers collected for decorative purposes.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No net change
Confidence		Medium
Narrative	Between 1995 and 2005 there was a slight decline in the physical extend of (possibly) unimproved grassland of 8.3 ha. The extent of coastal and dune grassland remained virtually unchanged. Some area in Bodmin Moor (about 10 ha) has been mapped as possibly unimproved grassland in 1995 and has been mapped as improved grassland in 2005, for example. But this could well be due to variations in aerial photography interpretation rather than changes of actual management practice on the ground. The extent of non-food provision is likely to be strongly correlated to the physical extend of semi-natural grassland which means that a significant change is unlikely.	

¹⁴ Bullock et al. 2011.

Natural Capital Asset	Woodland, Scrub & Bracken	WSB
Ecosystem Service	Non-food products	Provisioning
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		Low
Narrative	Especially woodland is a significant resource for timber and increasingly woodfuel as well; despite the fact that most woodland products are imported to the UK. The vast extent of woodland harvested for commercial purposes is conifers for softwood but there is also a small amount of hardwood used mainly for woodfuel. The relevance of this sector in the CAONB, however, is uncertain.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Unknown
Confidence		Low
Narrative	The WSB asset category has seen the greatest physical increase between 1995 and 2005 with 285.8 ha or 2.5% of WSB created. The area of broadleaved and mixed woodland has been extended by almost 450 ha (7.5%) whilst at the same time the extent of coniferous woodland and bracken was reduced by 174 ha (13%) and 20 ha (0.9%), respectively. A significant increase of woodland in management between 2009 and 2013 (45% increase to 2,485 ha of the Forestry Commission’s English Woodland Grant Scheme plus an increase in Higher Level Stewardship of 261 ha) may also indicate an increase of woodland in sustainable management for timber production. ¹⁵ The decline in coniferous woodland extend indicates a decline in timber production whilst the increase in woodland in management may indicate an increase of woodland production. The net effect, however, is unknown.	

¹⁵ Land Use Consultants 2013.

Natural Capital Asset	Arable & Improved Grassland	AIG
Ecosystem Service	Non-food products	Provisioning
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Low
Confidence		Low
Narrative	Biomass production on farmland in the UK for energy production is at a relatively low level but likely to increase in the future. The magnitude of biomass production within the CAONB is unknown but likely to be relatively small. A review of Natural England’s Energy Crops Scheme in 2008 and 2012 supports this view as no farmland related schemes were identified. ¹⁶	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No net change
Confidence		Low
Narrative	With -365 ha or -0.7% AIG has experienced the greatest decline in physical extend between 1995 and 2005. The relative decline was more or less equally distributed between arable land (-0.6%) and improved grassland (-0.7%). The changes were mainly related to afforestation; especially in South Coast – Central but also many other smaller areas of the CAONB. The provision of non-food products from AIG is likely to be stable on a very low level.	

¹⁶ Ibid.

Provisioning/Cultural Services: Wild Species Diversity

Natural Capital Asset	Coast	COA
Ecosystem Service	Wild Species Diversity	Provisioning/Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		High
Narrative	Coastal habitats contain a wide range of ecological niches supporting a wide range of highly specialised and distinctive flora and fauna species; many of which are priority species. The species diversity supports many other ecosystem services in the CAONB including aesthetic values (e.g. bird watching) and education. Local cliffs, sand dunes, beaches and rocky shores within the CAONB have been identified to provide significant habitats for bird nesting of international importance. ¹⁷	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No net change
Confidence		Medium
Narrative	Between 1995 and 2005 there was only a marginal change of -4.8 ha mapped for the physical extend of the coastal Natural Capital assets. This could be due to some erosion but could also be explained by the adjustment of GIS boundaries with no actual physical change to the asset. A small area in the Camel Estuary has been lost due to wetland expansion. The available evidence did not suggest that this had an impact on bird nesting sites or wild species diversity in general.	

¹⁷ Land Use Consultants 2010.

Natural Capital Asset	Heathland, Wetland & Disturbed Ground	HWD
Ecosystem Service	Wild Species Diversity	Provisioning/Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		High
Narrative	The importance of HWD habitats within the CAONB for biodiversity can already be seen by the large extent of associated BAP priority habitats such as lowland and upland heathland (about 8,500 ha), fens (980 ha), blanket bogs (660 ha), mudflats (870 ha) and reedbeds (460 ha) within the AONB (2003 data provided by ERCCIS, rounded). This is in line with national assessments of the biodiversity importance of HWD habitats. ¹⁸	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Some improvement
Confidence		Low
Narrative	Whilst the physical extend of heathland has slightly declined between 1995 and 2005 (-3.4 ha) the extent of wetland and disturbed ground has increased by 21.6 ha and 37.4 ha, respectively. Notably, this is an increase of almost 85% for disturbed ground. Unfortunately evidence for the biodiversity value of disturbed ground and the impact of its expansion within the CAONB could not be identified. However, the expansion of wetland is likely to have a positive effect on with species diversity which should well overcompensate for the small loss of heathland.	

¹⁸ Van der Wal et al. 2011; Maltby et al. 2011.

Natural Capital Asset	Open Water	OWA
Ecosystem Service	Wild Species Diversity	Provisioning/Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Unknown
Confidence		Low
Narrative	The biodiversity of ponds and lakes depends on the management and water quality and little is known about which elements of the OWA category qualifies as BAP priority habitat, for example.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Improving
Confidence		Low
Narrative	The extent of open water (only mapped for inland lakes, ponds etc. excl. rivers and canals) has increased quite significantly between 1995 and 2005 by 43.1 ha or 7.3%. This is mainly due to the creation of a 32 ha lake (presumably) in Bodmin Moor. The rest seems to be related mainly to the creation of new ponds across several locations within the CAONB. This is likely to have a positive effect on biodiversity as well assuming that the creation of ponds was mainly for conservation reasons. However, more information would be necessary to increase confidence into this assessment.	

Natural Capital Asset	Semi-Natural Grassland	SNG
Ecosystem Service	Wild Species Diversity	Provisioning/Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Medium
Confidence		Low
Narrative	Species diversity is key to the value of semi-natural grasslands and supports many other services such as recreation, tourism and pollination supporting food production on other habitats. However, in the CAONB there are only relatively small pockets of BAP priority grassland habitats such as purple moor grass and rush pastures (42.8 ha), coastal and floodplain grazing marsh (18.5 ha) and lowland calcareous grassland (9.2 ha; 2003 data). The value of SNG could be increased by establishing more priority habitats which would also support other services on- and off site.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No net change
Confidence		Low
Narrative	Between 1995 and 2005 there was a slight decline in the physical extend of (possibly) unimproved grassland of 8.3 ha. The extent of coastal and dune grassland remained virtually unchanged. Some area in Bodmin Moor (about 10 ha) has been mapped as possibly unimproved grassland in 1995 and has been mapped as improved grassland in 2005, for example. But this could well be due to variations in aerial photography interpretation rather than changes of actual management practice on the ground. Considering the evidence to hand a significant change is unlikely but additional evidence would be welcome.	

Natural Capital Asset	Woodland, Scrub & Bracken	WSB
Ecosystem Service	Wild Species Diversity	Provisioning/Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		Medium
Narrative	Especially woodland provides a habitat for a wide range of species and people recognise the biodiversity value as one of the main benefits of woodlands. However, the value varies with woodland type, maturity and management. Mature/ancient broadleaved woodlands are usually deemed to have the highest biodiversity value. Bracken can provide a habitat for a number of rare plant and bird species but generally with limited biodiversity value. But overall the WSB category can be assumed to be of high biodiversity value.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Some improvement
Confidence		Medium
Narrative	The WSB asset category has seen the greatest physical increase between 1995 and 2005 with 285.8 ha or 2.5% of WSB created. The area of broadleaved and mixed woodland has been extended by almost 450 ha (7.5%) whilst at the same time the extent of coniferous woodland and bracken was reduced by 174 ha (13%) and 20 ha (0.9%), respectively. A significant increase of woodland in management between 2009 and 2013 (45% increase to 2,485 ha of the Forestry Commission’s English Woodland Grant Scheme plus an increase in Higher Level Stewardship of 261 ha) may also indicate an increase in woodland managed for biodiversity. ¹⁹ Both, the significant broadleaved woodland afforestation as well as the increase of woodland under management are very likely to have a positive effect on biodiversity. However, especially woodland habitats need a long time to mature before they reach their full biodiversity value. New created woodland is therefore of less value compared to mature woodland which is why ‘some improvement’ rather than ‘improving’ has been ascertained.	

¹⁹ Land Use Consultants 2013.

Natural Capital Asset	Arable & Improved Grassland	AIG
Ecosystem Service	Wild Species Diversity	Provisioning/Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Medium
Confidence		Low
Narrative	Large scale intensive monoculture farming provides little opportunities for biodiversity and changes to farming practices in the UK in the 20 th century have put significant pressure on overall species diversity. ²⁰ However, the CAONB farming landscape is still characterised by relative heterogeneity including important nieces such as Cornish hedgerows and arable field margins. This means that farmland within the CAONB is likely to be more supportive for biodiversity than many other farming areas across the UK; especially for specialised species that require the diversity of different habitat types. Considering the large extent of farmland within the CAONB and the potential biodiversity richer alternatives such as semi-improved and species-rich grasslands the biodiversity value of arable fields and improved grassland is still likely to be relatively low. But the relatively large extend of (Cornish) hedgerows and other biodiversity nieces increases the value if factored in. A field survey of a sample concluded that most boundary features are intact. ²¹ Therefore it may be sensible to preserve farming areas with high quality biodiversity features whilst other areas of farmland may provide opportunities for the creation of biodiversity richer habitats.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Unknown
Confidence		Low
Narrative	With -365 ha or -0.7% AIG has experienced the greatest decline in physical extend between 1995 and 2005. The relative decline was more or less equally distributed between arable land (-0.6%) and improved grassland (-0.7%). The changes were mainly related to afforestation; especially in South Coast – Central but also many other smaller areas of the CAONB. A more rapid decline of land under agricultural use of -226 ha has been monitored between 2007 and 2010 alone. ²² Because this Natural Capital asset has mainly been replaced by biodiversity richer habitats it can be assumed the decline in extend has no overall negative biodiversity impact. A sample square field survey has shown a slight decline of Cornish hedgebanks of -0.2% between 2005 and 2012 in South Coast Central and Camel Estuary. ²³ This indicates a slight decline in wild species support of AIG habitats. The continuing reduction of fertiliser use, on the other hand, is likely to improve conditions for biodiversity. ²⁴ The net effect is not clear, however.	

²⁰ Firbank et al. 2011.

²¹ Land Use Consultants 2013.

²² {Citation}

²³ Land Use Consultants 2013.

²⁴ Firbank et al. 2011.

Cultural Services: Recreation

Natural Capital Asset	Coast	COA
Ecosystem Service	Recreation	Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		High
Narrative	A review of accessibility has revealed that about 16% of the coastal Natural Capital asset is open access land and that more than 40 km of Public Rights Of Way (PROW) is located on the coast which represents a ratio of 10.1 metres per ha. Not surprisingly much of the Open Access Land and PROW is on Coastland Above High Water Mark. The coastal environment of the CAONB, where accessible to the public, offers a main recreational resource also attracting many tourists. Referring to the MENE survey in 2014/15 there were about 27 million visits to the natural environment within Cornwall and the Island of Scilly. More than 50% of these visits were to a beach or coastline; some of the main Natural Capital features of the CAONB. ²⁵ This is not only good for the local economy (for example more than 50% of the visitors to beaches and coastlines spend money on food and drinks during their visit) but also for people’s wellbeing and health. One can argue that people would not choose to visit the CAONB if they would not enjoy and therefore benefit from the experience; much of which is related to the Natural Capital assets of the coasts.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Unknown
Confidence		Low
Narrative	Between 1995 and 2005 there was only a marginal change of -4.8 ha mapped for the physical extend of the coastal Natural Capital assets. This could be due to some erosion but could also be explained by the adjustment of GIS boundaries with no actual physical change to the asset itself. A small area in the Camel Estuary has been lost due to wetland expansion. Overall there has been a significant increase in PROW of more than 100km monitored in the AONB between 2009 and 2013. However, data was insufficient to allow an assessment of changes for each Natural Capital category. Therefore it is difficult to make a judgement about changes to the accessibility of COA and therefore its recreational value even if it is likely that at least some of the created access land and PROW has been established on coastland.	

²⁵ Monitoring the Engagement with the Natural Environment;
<https://www.gov.uk/government/collections/monitor-of-engagement-with-the-natural-environment-survey-purpose-and-results>

Natural Capital Asset	Heathland, Wetland & Disturbed Ground	HWD
Ecosystem Service	Recreation	Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		High
Narrative	Wetlands often provide a setting for activities such as bird watching and recreational fishing and wetlands within the AONB are very accessible as more than 87% is Open Access Land. Heathland within the AONB is also very accessible with more than 91% being Open Access Land. Overall it is likely that HWD habitats significantly contribute to the recreational value of the CAONB. The value of disturbed ground is uncertain and accessibility is generally limited (6% Open Access Land; ratio of 8.7 metres of PROW per ha) but this landcover type is very limited in extend anyway.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Some improvement
Confidence		Medium
Narrative	Whilst the physical extend of heathland has slightly declined between 1995 and 2005 (-3.4 ha) the extent of wetland and disturbed ground has increased by 21.6 ha and 37.4 ha, respectively. Notably, this is an increase of almost 85% for disturbed ground. Most of the wetland, mainly in Bodmin Moor, has been created on Open Access Land which indicates some improvement of this Natural Capital asset for providing recreational services. The significant increase in PROW of more than 100km monitored across the AONB between 2009 and 2013 is likely to add to HWD accessibility as some of the PROW will probably have been created on this asset. However, data was insufficient to allow an assessment of changes for each Natural Capital category. Depending on how much of the additional PROW was established on HWD it could also be classified ‘improving’.	

Natural Capital Asset	Open Water	OWA
Ecosystem Service	Recreation	Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Medium
Confidence		Low
Narrative	The recreational value of open water, in particular lakes and ponds, is mainly related to activities like boating, swimming and recreational fishing. It depends on the water quality but overall it is likely to be of less value than the see surrounding the CAONB.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Unknown
Confidence		Low
Narrative	The extent of open water (only mapped for inland lakes, ponds etc. excluding rivers and canals) has increased quite significantly between 1995 and 2005 by 43.1 ha or 7.3%. This is mainly due to the creation of a 32 ha lake in Bodmin Moor. The rest seems to be related mainly to the creation of new ponds across several locations within the CAONB. It is unknown, however, if these resources are managed/used for recreational activities. The created Bodmin Moor lake for example is not.	

Natural Capital Asset	Semi-Natural Grassland	SNG
Ecosystem Service	Recreation	Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		Medium
Narrative	Almost 60% of coastal and dune grassland and nearly 1/3 of unimproved grassland in the AONB is Open Access Land. The ratio of 27.3 metres of PROW per ha of SNG is also the highest for all Natural Capital asset types; slightly higher than for WSB. This makes this asset a valuable resource for recreational activities like walking, picnicking etc.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Unknown
Confidence		Low
Narrative	Between 1995 and 2005 there was a slight decline in the physical extend of (possibly) unimproved grassland of 8.3 ha. The extent of coastal and dune grassland remained virtually unchanged. Some area in Bodmin Moor (about 10 ha) has been mapped as possibly unimproved grassland in 1995 and has been mapped as improved grassland in 2005, for example. But this could well be due to variations in aerial photography interpretation rather than changes of actual management practices on the ground. Overall there has been a significant increase in PROW of more than 100km monitored across the AONB between 2009 and 2013. However, data was insufficient to allow an assessment of changes for each Natural Capital category. Therefore it is difficult to make a judgement about changes to the accessibility of SNG and impacts on its recreational value even if it is likely that at least some of the created access land and PROW has been established on semi-natural grassland.	

Natural Capital Asset	Woodland, Scrub & Bracken	WSB
Ecosystem Service	Recreation	Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		Medium
Narrative	The area of WSB on Open Access Land is relatively low with less than 16% compared to many other categories and mainly related to bracken (52% access land) and Scrub (25% access land). However, with a ratio of 26m of PROW per ha of WSB this category has one of the highest PROW proportions and it is likely that this will provide access to much of the woodland resource within the AONB even if not classified as Open Access Land. Especially accessible broadleaved woodland is known to be of very high recreational value.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Improving
Confidence		Medium
Narrative	The WSB asset category has seen the greatest physical increase between 1995 and 2005 with 285.8 ha or 2.5% of WSB created. The area of broadleaved and mixed woodland has been extended by almost 450 ha (7.5%) whilst at the same time the extent of coniferous woodland and bracken was reduced by 174 ha (13%) and 20 ha (0.9%), respectively. Hardly any broadleaved and mixed woodland has been created on Open Access Land but many new woodland patches are connected to PROW which makes ‘informal’ accessibility likely. A significant increase of woodland in management between 2009 and 2013 (45% increase to 2,485 ha of the Forestry Commission’s English Woodland Grant Scheme plus an increase in Higher Level Stewardship of 261 ha) may also indicate an increase of recreational opportunities in CAONB woodlands. ²⁶ Furthermore it is likely that some of the significant increase in PROW of more than 100km monitored across the AONB between 2009 and 2013 has been in WSB. However, data was insufficient to allow an assessment of changes for each Natural Capital category. But overall a significant improvement to recreational services provided by WSB seems likely.	

²⁶ Land Use Consultants 2013.

Natural Capital Asset	Arable & Improved Grassland	AIG
Ecosystem Service	Recreation	Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Low
Confidence		Medium
Narrative	The general recreational value of farmland is likely to be much lower than for other Natural Capital assets in the AONB. This is because of the characteristics of arable fields and improved grassland (with livestock grazing) which are not generally used for many recreational activities and would also conflict with food production. With a ratio of 13.5 metres of PROW per ha AIG also has one of the lowest PROW ratios across all Natural Capital asset categories. The area of AIG on Open Access Land is also the lowest across asset categories with only 0.7%. The vast majority of this Open Access Land is related to improved grassland. This is likely to be mainly amenity grassland rather than improved grassland in agricultural use. Please note that amenity grassland is not part of this assessment category even if a small fraction of improved grassland will be amenity grassland.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Unknown
Confidence		Low
Narrative	With -365 ha or -0.7% AIG has experienced the greatest decline in physical extend between 1995 and 2005. The relative decline was more or less equally distributed between arable land (-0.6%) and improved grassland (-0.7%). The changes were mainly related to afforestation; especially in South Coast – Central but also many other smaller areas of the CAONB. Overall there has been a significant increase in PROW of more than 100km monitored in the AONB between 2009 and 2013. However, data was insufficient to allow an assessment of changes for each Natural Capital category. Therefore it is difficult to make a judgement about changes to the accessibility of AIG and its recreational value. There may be some improvement by the uptake of Higher Level Stewardship Agreements but the effect on recreational opportunities remains unclear.	

Cultural Services: Aesthetic Values & Sense of Place

Natural Capital Asset	Coast	COA
Ecosystem Service	Aesthetic Values & Sense of Place	Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		High
Narrative	The designation as AONB already highlights how important the CAONB areas are in terms of aesthetic value; for the local community but also nationwide and beyond. Whilst part of the aesthetic and landscape value is for example related to historic buildings and other man-made features it is clear that much of the value is related to Natural Capital such as beaches, cliffs and the coast. Without these high quality Natural Capital assets it is arguable that the areas would not have received AONB status. Evidence clearly suggests that people have a preference for living in areas within short distance to/with a view on high quality Natural Capital features such as beaches. The CAONB coastline also provides a pleasant scenery when watched from the sea for example as part of a boat trip.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No net change
Confidence		Low
Narrative	Between 1995 and 2005 there was only a marginal change of -4.8 ha mapped for the physical extend of the coastal Natural Capital assets. This could be due to some erosion but could also be explained by the adjustment of GIS boundaries with no actual physical change to the asset. A small area in the Camel Estuary has been lost due to wetland expansion. It is unlikely that this had a noticeable effect on aesthetic values but further information would be required to make a judgement with higher confidence.	

Natural Capital Asset	Heathland, Wetland & Disturbed Ground	HWD
Ecosystem Service	Aesthetic Values & Sense of Place	Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		Medium
Narrative	HWDE habitats contribute to the diversity of the CAONB landscape and such habitats are usually highly valued in terms of aesthetic values contributing to the ‘wildness’ and diversity of spaces and landscapes.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Unknown
Confidence		Low
Narrative	Whilst the physical extend of heathland has slightly declined between 1995 and 2005 (-3.4 ha) the extent of wetland and disturbed ground has increased by 21.6 ha and 37.4 ha, respectively. Notably, this is an increase of almost 85% for disturbed ground. The significant increase of disturbed ground is likely to have to strongest effect on the aesthetic value of the AONB landscape; even if the total extend of disturbed ground is very small when compared to other Natural Capital asset types. However, there is very limited evidence on the effect of disturbed ground on aesthetic values and it is likely that effects will be very location and context specific which makes a final judgement about the overall impact difficult.	

Natural Capital Asset	Open Water	OWA
Ecosystem Service	Aesthetic Values & Sense of Place	Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		Medium
Narrative	Landscapes with a mixture of green and blue features are often valued as natural and the blue infrastructure adds to the habitat mix defining the CAONB.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Improving
Confidence		Low
Narrative	The extent of open water (only mapped for inland lakes, ponds etc. excl. rivers and canals) has increased quite significantly between 1995 and 2005 by 43.1 ha or 7.3%. This is mainly due to the creation of a 32 ha lake (presumably) in Bodmin Moor. The rest seems to be related mainly to the creation of new ponds across several locations within the CAONB. This is likely to contribute positive to the aesthetic value of the landscape as it adds to the diversity of distinctive habitats within the AONB. Also, the blue infrastructure is generally highly appreciated for its aesthetic value.	

Natural Capital Asset	Semi-Natural Grassland	SNG
Ecosystem Service	Aesthetic Values & Sense of Place	Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		Medium
Narrative	Semi-natural grasslands contribute to the overall complexity and diversity of the CAONB landscape and therefore to its natural beauty. Much of the CAONB is characterised by its meadow landscapes which makes semi-natural grasslands a valuable part of the mix defining the CAONB landscape.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No net change
Confidence		Low
Narrative	Between 1995 and 2005 there was a slight decline in the physical extend of (possibly) unimproved grassland of 8.3 ha. The extent of coastal and dune grassland remained virtually unchanged. Some area in Bodmin Moor (about 10 ha) has been mapped as possibly unimproved grassland in 1995 and has been mapped as improved grassland in 2005, for example. But this could well be due to variations in aerial photography interpretation rather than changes of actual management practice on the ground. As no information about the condition of this Natural Capital asset category was available we have to assume that there was no significant net change of the aesthetic value.	

Natural Capital Asset	Woodland, Scrub & Bracken	WSB
Ecosystem Service	Aesthetic Values & Sense of Place	Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		Medium
Narrative	WSB contribute to the general and distinct diversity of habitats in the CAONB which makes this place so special. The naturalness of a place is often associated with especially mature/ancient woodlands.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Improving
Confidence		Medium
Narrative	The WSB asset category has seen the greatest physical increase between 1995 and 2005 with 285.8 ha or 2.5% of WSB created. The area of broadleaved and mixed woodland has been extended by almost 450 ha (7.5%) whilst at the same time the extent of coniferous woodland and bracken was reduced by 174 ha (13%) and 20 ha (0.9%), respectively. Broadleaved woodland usually has higher aesthetic values ascertained than coniferous woodland which means that the overall extend combined with the shift from coniferous to broadleaved and mixed woodland is likely to have a significant positive effect on aesthetic values.	

Natural Capital Asset	Arable & Improved Grassland	AIG
Ecosystem Service	Aesthetic Values & Sense of Place	Cultural
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		Medium
Narrative	The rather small-scale and diverse field systems in the CAONB including traditional farm buildings are meant to contribute significantly to the natural beauty and character of the CAONB and have a high value in terms of aesthetics and sense of place including the sense for historical farm living. However, the proportion of straight and sinuous field boundaries varies significantly across the AONB. The latter, indicating more historic patterns, range from close to 0% in Trevoise Head to Stepper Point to over 60% in Rame. ²⁷ Please note that the field boundary assessment was based on a sample.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Some deterioration
Confidence		Low
Narrative	With -365 ha or -0.7% AIG has experienced the greatest decline in physical extend between 1995 and 2005. The relative decline was more or less equally distributed between arable land (-0.6%) and improved grassland (-0.7%). The changes were mainly related to afforestation; especially in South Coast – Central but also many other smaller areas of the CAONB. A sample square field survey has shown a slight decline of Cornish hedgebanks of -0.2% between 2005 and 2012 in South Coast Central and Camel Estuary. ²⁸ This is likely to have a small negative impact on the aesthetic appearance because such boundary features are often seen as the main aesthetic features of agricultural field systems and are appreciated for the AONB landscape character. However, more holistic monitoring of such boundary features across the AONB would be recommended to improve the assessment base in the future.	

²⁷ Ibid.²⁸ Ibid.

Regulating Services: Flood Risk Regulation

Natural Capital Asset	Coast	COA
Ecosystem Service	Flood Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		Medium
Narrative	Coastal habitats reduce the for example the energy of waves and can significantly reduce the need for man-made flood defence such as sea walls. Sea cliffs can replace the need for local man-made defence altogether. ²⁹ The CAONB is not likely to be an exception from the national picture.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No net change
Confidence		Medium
Narrative	Between 1995 and 2005 there was only a marginal change of -4.8 ha mapped for the physical extend of the coastal Natural Capital assets. This could be due to some erosion but could also be explained by the adjustment of GIS boundaries with no actual physical change to the asset. A small area in the Camel Estuary has been lost due to wetland expansion. It is likely that the marginal physical changes had no significant effect on the flood risk regulation services of coastal Natural Capital assets.	

²⁹ Jones et al. 2011.

Natural Capital Asset	Heathland, Wetland & Disturbed Ground	HWD
Ecosystem Service	Flood Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		Low
Narrative	Wetland vegetation can significantly reduce water run-off in flooding events and therefore reduce flood peaks. Wetlands often also have a storage capacity when capturing and retaining flooding water. However, the effect is limited in wetland habitats with saturated soils, with a water table near the surface. ³⁰ The effect of heathland is less well established and very context and location depending. ³¹ However, the vegetation cover is likely to contribute to some extent to water run-off reduction and therefore flood risk regulation. Overall the flood regulation services provided by HWD is likely to be significant but confidence is relatively low because local flood modelling, for example, was not conducted as part of this project.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Some improvement
Confidence		Medium
Narrative	Whilst the physical extend of heathland has slightly declined between 1995 and 2005 (-3.4 ha) the extent of wetland and disturbed ground has increased by 21.6 ha and 37.4 ha, respectively. Notably, this is an increase of almost 85% for disturbed ground. Especially the expansion of wetland habitats is likely to improve the capacity of HWD to store flooding water and reduce water run-off in case of a flooding event to some extent.	

³⁰ Maltby et al. 2011.

³¹ Van der Wal et al. 2011.

Natural Capital Asset	Open Water	OWA
Ecosystem Service	Flood Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Medium
Confidence		Low
Narrative	In principle open waters can contribute to as well as mitigate flooding events. However, as the scope of this category is limited to standing open water like lakes and ponds not directly connected to the sea or rivers it is reasonable to assume that these lakes and ponds have additional capacity to store water in case of a flooding event and are therefore likely to contribute positively to flood risk regulation.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Improving
Confidence		Medium
Narrative	The extent of open water (only mapped for inland lakes, ponds etc. excl. rivers and canals) has increased quite significantly between 1995 and 2005 by 43.1 ha or 7.3%. This is mainly due to the creation of a 32 ha lake (presumably) in Bodmin Moor. The rest seems to be related mainly to the creation of new ponds across several locations within the CAONB. This is likely to create additional capacity for flooding water and therefore contribute to flood risk regulation.	

Natural Capital Asset	Semi-Natural Grassland	SNG
Ecosystem Service	Flood Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Medium
Confidence		Medium
Narrative	Semi-natural grassland is usually less intensively managed than improved grassland. This also means that soils are less intensively compacted by heavy machinery. Compaction of soils decreases infiltration and increases water run-off. ³²	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No net change
Confidence		Medium
Narrative	Between 1995 and 2005 there was a slight decline in the physical extend of (possibly) unimproved grassland of 8.3 ha. The extent of coastal and dune grassland remained virtually unchanged. Some area in Bodmin Moor (about 10 ha) has been mapped as possibly unimproved grassland in 1995 and has been mapped as improved grassland in 2005, for example. But this could well be due to variations in aerial photography interpretation rather than changes of actual management practice on the ground. Because mapped changes are either very marginal or only related to differences in interpretation it is likely that the change is within the marginal limits of no significant change.	

³² Bullock et al. 2011.

Natural Capital Asset	Woodland, Scrub & Bracken	WSB
Ecosystem Service	Flood Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Medium
Confidence		Low
Narrative	Woodland cover in particular can have a positive impact on flood risk regulation by mitigating rainfall and slowing down/delaying water run-off. However, the effect is context and location specific. ³³ Scrub and bracken are also likely to contribute to flood risk regulation because the vegetation cover contributes to the roughness of the surface which slows down water-run-off.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Some improvement
Confidence		Medium
Narrative	The WSB asset category has seen the greatest physical increase between 1995 and 2005 with 285.8 ha or 2.5% of WSB created. The area of broadleaved and mixed woodland has been extended by almost 450 ha (7.5%) whilst at the same time the extent of coniferous woodland and bracken was reduced by 174 ha (13%) and 20 ha (0.9%), respectively. This is likely to have a net positive effect on flood risk regulation; even if the actual effect of each created woodland patch in their local setting is not known.	

³³ Quine et al. 2011.

Natural Capital Asset	Arable & Improved Grassland	AIG
Ecosystem Service	Flood Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Potentially negative
Confidence		Low
Narrative	Intensive drainage of agricultural land has the effect that water is shifted off the land surface quickly which can add to flood pressure downstream. This effect can be mitigated by waterside vegetation such as grasses and trees. The loss of sediment from farmland can also lead to sedimentation of water bodies which in turn reduces storage capacity and contributes to flood risk. But farmland can also be managed to hold and store flooding water and therefore contribute positively to flood risk regulation – especially in floodplains. ³⁴ The effect very much depends on management practices. More information about the management practices in the CAONB would be needed to allow a final judgement but the net effect is potentially negative; especially when considering alternative management practices and land-use options.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Unknown
Confidence		Low
Narrative	With -365 ha or -0.7% AIG has experienced the greatest decline in physical extend between 1995 and 2005. The relative decline was more or less equally distributed between arable land (-0.6%) and improved grassland (-0.7%). The changes were mainly related to afforestation; especially in South Coast – Central but also many other smaller areas of the CAONB. This is likely to have an overall positive effect on flood risk regulation but this improvement is related to other habitat types (especially created woodland) rather than the remaining AIG resource. Information about potential changes in management (for example the introduction of buffer strips) which could impact upon the flood regulation services of AIG was not available.	

³⁴ Firbank et al. 2011.

Regulating Services: Water Quality Regulation

Natural Capital Asset	Coast	COA
Ecosystem Service	Water Quality Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		Low
Narrative	There is evidence that sand dunes and shingle reduce diffuse pollution to the marine environment with positive effects on bathing water quality. In the Netherlands sand dunes are used for water purification but research in the UK is lacking. ³⁵ But there is no evidence why coastland in the AONB should perform differently.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No net change
Confidence		Low
Narrative	Between 1995 and 2005 there was only a marginal change of -4.8 ha mapped for the physical extend of the coastal Natural Capital assets. This could be due to some erosion but could also be explained by the adjustment of GIS boundaries with no actual physical change to the asset. A small area in the Camel Estuary has been lost due to wetland expansion. This also means that the effect on water quality is likely to remain mainly unchanged.	

³⁵ Jones et al. 2011.

Natural Capital Asset	Heathland, Wetland & Disturbed Ground	HWD
Ecosystem Service	Water Quality Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		Medium
Narrative	Wetland habitats play a significant role in water quality regulation for example by denitrification, nitrification and mineralisation of pollutants. ³⁶ The effect of heathland is not well established. ³⁷ But considering that about 2/3 of the HWD category in the CAONB is made up of wetland habitats one can conclude that the overall effect is likely to be significant and positive.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Some improvement
Confidence		Low
Narrative	Whilst the physical extend of heathland has slightly declined between 1995 and 2005 (-3.4 ha) the extent of wetland and disturbed ground has increased by 21.6 ha and 37.4 ha, respectively. Notably, this is an increase of almost 85% for disturbed ground. The wetland creation is likely to have a moderate positive effect on water quality regulation. However, the effect of disturbed ground could not be assessed which means that the score should be treated with some caution.	

³⁶ Maltby et al. 2011.

³⁷ Van der Wal et al. 2011.

Natural Capital Asset	Open Water	OWA
Ecosystem Service	Water Quality Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Medium
Confidence		Low
Narrative	Vegetation in open waters can rap, breakdown, process and transform pollutants such as from diffuse agricultural pollution. ³⁸ However, the effect is context specific and it is therefore not clear to which extend open water in the CAONB contributes to water quality regulation.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Some improvement
Confidence		Low
Narrative	The extent of open water (only mapped for inland lakes, ponds etc. excl. rivers and canals) has increased quite significantly between 1995 and 2005 by 43.1 ha or 7.3%. This is mainly due to the creation of a 32 ha lake (presumably) in Bodmin Moor. The rest seems to be related mainly to the creation of new ponds across several locations within the CAONB. This is likely to have a limited positive effect on water quality regulation.	

³⁸ Maltby et al. 2011.

Natural Capital Asset	Semi-Natural Grassland	SNG
Ecosystem Service	Water Quality Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Medium
Confidence		Low
Narrative	The effect on water quality needs to be seen in the context of other optional land-use options such as arable land or improved grassland. In this context semi-natural grassland is the favourable option in terms of water quality because of lower levels of diffuse pollution. ³⁹	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No net change
Confidence		Medium
Narrative	Between 1995 and 2005 there was a slight decline in the physical extend of (possibly) unimproved grassland of 8.3 ha. The extent of coastal and dune grassland remained virtually unchanged. Some area in Bodmin Moor (about 10 ha) has been mapped as possibly unimproved grassland in 1995 and has been mapped as improved grassland in 2005, for example. But this could well be due to variations in aerial photography interpretation rather than changes of actual management practice on the ground. A significant effect of these potential marginal changes to the physical extend of SNG is unlikely.	

³⁹ Bullock et al. 2011.

Natural Capital Asset	Woodland, Scrub & Bracken	WSB
Ecosystem Service	Water Quality Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Medium
Confidence		Low
Narrative	Woodlands can regulate diffuse pollution and therefore contribute to water quality even if the magnitude of the effect is not clear. Scrub and bracken also have a positive effect as pollutants are trapped in vegetation when polluted water flows through it.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Some improvement
Confidence		Low
Narrative	The WSB asset category has seen the greatest physical increase between 1995 and 2005 with 285.8 ha or 2.5% of WSB created. The area of broadleaved and mixed woodland has been extended by almost 450 ha (7.5%) whilst at the same time the extent of coniferous woodland and bracken was reduced by 174 ha (13%) and 20 ha (0.9%), respectively. This is also likely to have a positive effect on water quality regulation services. Due to the slow maturing nature of especially woodland this effect may be stronger in the long term than in the short term (assessment timescale).	

Natural Capital Asset	Arable & Improved Grassland	AIG
Ecosystem Service	Water Quality Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Negative
Confidence		Low
Narrative	On farmland nitrogen compounds are removed when crops are harvested. They are often replaced through fertilisers. The more intensive the fertilisation the more excess nitrogen compounds which cannot be taken up by plants can be released as nitrate to ground and surface water having a significant negative effect on water quality inland and at the coast. Other agricultural contaminants include phosphorus, sediments and pesticides. ⁴⁰ The level of diffuse pollution from farming can be mitigated e.g. by introducing grass buffer strips and ponds to trap contaminants but the overall effect in the CAONB is likely to be negative in line with the national picture.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Improving
Confidence		Medium
Narrative	With -365 ha or -0.7% AIG has experienced the greatest decline in physical extend between 1995 and 2005. The relative decline was more or less equally distributed between arable land (-0.6%) and improved grassland (-0.7%). The changes were mainly related to afforestation; especially in South Coast – Central but also many other smaller areas of the CAONB. Nationally, the use of inorganic fertilisers and excessive use of pesticides has been steadily reduced within the past 30 years or so. ⁴¹ We couldn’t identify evidence indicating that the trend of reducing fertilisers and pesticides in the AONB was different from the national picture. The reduction in physical extend is adding to this improvement. However, the net effect of AIG on water quality is still likely to be negative - just not as bad as before.	

⁴⁰ Firbank et al. 2011.

⁴¹ Ibid.

Regulating Services: Air Quality Regulation

Natural Capital Asset	Coast	COA
Ecosystem Service	Air Quality Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Low
Confidence		High
Narrative	The rather sparse and usually short green vegetation types with smaller leaf areas occurring on coastal habitats play some but no major role in air quality regulation. ⁴²	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No net change
Confidence		Medium
Narrative	Between 1995 and 2005 there was only a marginal change of -4.8 ha mapped for the physical extend of the coastal Natural Capital assets. This could be due to some erosion but could also be explained by the adjustment of GIS boundaries with no actual physical change to the asset. A small area in the Camel Estuary has been lost due to wetland expansion. The overall effect on air quality regulation is likely to be very marginal.	

⁴² Jones et al. 2011.

Natural Capital Asset	Heathland, Wetland & Disturbed Ground		HWD
Ecosystem Service	Air Quality Regulation		Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service			
Indicative relative importance for delivering this ecosystem service			Low
Confidence			Medium
Narrative	Air quality regulation services strongly depend on vegetation cover and leaf area. The effect of HWD habitats is likely to be positive but limited. ⁴³		
Assessment of the direction of change for the flow of this ecosystem service since 1995			
Indicative direction of change			Unknown
Confidence			Low
Narrative	Whilst the physical extend of heathland has slightly declined between 1995 and 2005 (-3.4 ha) the extent of wetland and disturbed ground has increased by 21.6 ha and 37.4 ha, respectively. The positive effect of wetland increase may be outbalanced by the increase of disturbed ground which may have very little to offer in terms of air quality regulation services. The net effect is not clear.		

⁴³ Van der Wal et al. 2011; Maltby et al. 2011.

Natural Capital Asset	Open Water	OWA
Ecosystem Service	Air Quality Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		N/A
Confidence		High
Narrative	The air quality regulation service capacity of open water in the CAONB is limited to some vegetation reaching out of the water and therefore negligible.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Some deterioration
Confidence		Medium
Narrative	The extent of open water (only mapped for inland lakes, ponds etc. excl. rivers and canals) has increased quite significantly between 1995 and 2005 by 43.1 ha or 7.3%. This is mainly due to the creation of a 32 ha lake (presumably) in Bodmin Moor. The rest seems to be related mainly to the creation of new ponds across several locations within the CAONB. The creation of open water habitats may have caused some decline of air quality regulating services overall as it is likely that other habitats providing air quality regulating services have been replaced.	

Natural Capital Asset	Semi-Natural Grassland	SNG
Ecosystem Service	Air Quality Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Medium
Confidence		Medium
Narrative	Semi-natural grasslands usually have significant vegetation cover which contributes to air quality regulation but is less significant than for high-standing vegetation such as woodlands. The negative effect of heavy machinery for habitat management is less intense than on arable land or improved grassland.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		No net change
Confidence		Medium
Narrative	Between 1995 and 2005 there was a slight decline in the physical extend of (possibly) unimproved grassland of 8.3 ha. The extent of coastal and dune grassland remained virtually unchanged. Some area in Bodmin Moor (about 10 ha) has been mapped as possibly unimproved grassland in 1995 and has been mapped as improved grassland in 2005, for example. But this could well be due to variations in aerial photography interpretation rather than changes of actual management practice on the ground. The effect on air quality regulation services is likely to be negligible.	

Natural Capital Asset	Woodland, Scrub & Bracken	WSB
Ecosystem Service	Air Quality Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		High
Confidence		Medium
Narrative	Leaf area is a main factor for air quality regulation which makes trees and woodland areas particularly valuable. Scrub and to a lesser extend bracken also have a positive effect on air quality regulation. The tree location and species composition in this respect is important and needs to be carefully planned. In general trees are well placed as buffer next to the pollution source such as main roads but they can also have a negative effect on local pollution levels if the tree cover creates a tunnel trapping pollutants in a street corridor.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Improving
Confidence		Medium
Narrative	The WSB asset category has seen the greatest physical increase between 1995 and 2005 with 285.8 ha or 2.5% of WSB created. The area of broadleaved and mixed woodland has been extended by almost 450 ha (7.5%) whilst at the same time the extent of coniferous woodland and bracken was reduced by 174 ha (13%) and 20 ha (0.9%), respectively. Also because the expansion of broadleaved woodland has increased overproportionally to the total area expansion this is likely to have a significant positive effect on air quality regulation services, even if newly created woodlands need a longer time to mature to develop their full air quality regulation potential.	

Natural Capital Asset	Arable & Improved Grassland	AIG
Ecosystem Service	Air Quality Regulation	Regulating
Assessment of the relative importance of Natural Capital asset for delivering the ecosystem service		
Indicative relative importance for delivering this ecosystem service		Unknown
Confidence		Low
Narrative	On the one hand vegetation on farmland has some positive effect on air quality regulation by capturing pollutants from the air. On the other hand farmland is a major source for ammonia which is a nitrogen compound released by the breakdown of livestock urine, manure and inorganic fertiliser. Ammonia harms biodiversity and can cause odour nuisance. The net effect on air quality in the CAONB is not clear.	
Assessment of the direction of change for the flow of this ecosystem service since 1995		
Indicative direction of change		Some improvement
Confidence		Low
Narrative	With -365 ha or -0.7% AIG has experienced the greatest decline in physical extend between 1995 and 2005. The relative decline was more or less equally distributed between arable land (-0.6%) and improved grassland (-0.7%). The changes were mainly related to afforestation; especially in South Coast – Central but also many other smaller areas of the CAONB. The reduction in fertiliser usage and the reduction in habitat extend are likely to have some positive effect on air quality regulating services.	

Appendix D

Godrevy to Portreath Valuation Case Study: Methods & Calculations

1. Approach & Caveats

Aim of this case study was to establish an indicative monetary assessment of ecosystem services provided by the Natural Capital assets woodland, wetland, heathland and unimproved grassland within the Godrevy to Portreath section of the Cornwall AONB. This appendix should be read in line with Section 2.2 of the report.

It should be acknowledged that a number of limitations and caveats apply. Willingness-To-Pay (WTP) techniques applied in primary valuation studies have their own imperfections such as the social desirability bias⁴⁴ or a potential inability of survey participants to perceive hypothetical markets and goods. Another limitation may occur from applying the benefit transfer approach. Usually, the study area (where primary valuation studies were conducted) and the policy area (in this case the Godrevy to Portreath section of the CAONB) are not entirely similar. Therefore, adjustments were required for some socio-economic influencing variables such as income or population density as well as local context (for example the availability of substitute habitats and services). But even if these adjustments were applied as carefully as possible, a benefit transfer error can never be ruled out. Further limitations are linked to general scientific uncertainties such as the future impacts of climate change. For these reasons, calculated values should be regarded as essentially indicative of the magnitude of the service. Method-specific caveats are explained in more detail where relevant further below.

The ecosystem services values assessed within scope of this project are not only stated as annual values; they are also stated as capitalised value over 50 years. To calculate the 'net present value' of future benefit it is common to apply a discount rate. This discount rate is used to convert future benefits (and costs) to present values which make them comparable over time. For the purpose of this investigation, a discount rate of 1.5% has been applied to calculate the net present value of future benefits. Applying this discount rate was suggested

⁴⁴ The interviewees may like to make out that they value an ecosystem service more than they actually do

in the Ecosystem Assessment Guidance⁴⁵ which was published as part of the National Ecosystem Assessment Follow-On (NEAFO).⁴⁶ But because HM Treasury recommends a higher discount rate of 3.5% for periods of up to 30 years and then gradually declining⁴⁷, this rate has been applied to the lower threshold of the sensitivity analysis. To ensure transparency and comparability with other related publications within the UK, the ‘central estimate’ capitalised values have also been stated applying the discount rate recommended by HM Treasury. For the upper threshold of the sensitivity analysis a discount rate of 0% has been applied, also adopting the recommendations of NEAFO Ecosystem Assessment Guidance.⁴⁸ The findings are summarised in Section 2.2. Below you can see the methods and calculation for each applied primary valuation study and how the benefit transfer approach was used to transfer values to Godrevy to Portreath.

2. Methods & Calculations: Wetland Benefits

To calculate the benefits provided by wetlands in Godrevy to Portreath a benefit transfer function created by Brander et al. (2008) has been used. Brander et al. established a meta-analysis function including 78 European studies. It is acknowledged that this introduces uncertainties as it is based on a coarse assessment of a several services. However, more precise methods on a service-by-service basis are lacking. For this reason, the same value transfer function has also been applied for the UK National Ecosystem Assessment:

“A review of recent meta-analyses of wetland valuation concludes that Brander et al. (2008) provide the most appropriate benefit transfer function for the UK case.”⁴⁹

The valuation techniques involved in the studies included by Brander et al. (2008) are hedonic pricing, the travel cost method, contingent valuation, choice experiments, market

⁴⁵ Hölzinger 2014b.

⁴⁶ Scott et al. 2014.

⁴⁷ HM Treasury 2003, 97.

⁴⁸ Hölzinger 2014b.

⁴⁹ Hulme and Siriwardena 2010, 7.

prices, net factor incomes, production functions, replacement costs as well as opportunity costs.⁵⁰

Geographic Information System (GIS) software was used to determine the number and extent of wetland sites. Within Godrevy to Portreath 9 wetland sites were identified with an average size of 1.8 ha. Another distinction has been made regarding the accessibility of sites. The underlying assumption is that ecosystem services such as recreation and aesthetic appreciation can only be experienced if the site is publicly accessible. Because non-use values are explicitly excluded in the meta-analysis provided by Brander et al. (2008)⁵¹, one has to infer that accessibility is necessary to benefit from the ecosystem service biodiversity as well. Therefore the Brander et al. (2008) biodiversity value has been added to the cultural services of recreation and aesthetic appreciation. The wetland layer was overlaid with a public access layer to determine accessibility. Wetlands were also assumed to be accessible if overlapping with Public Rights Of Way (PROW). In Godrevy to Portreath 4 out of 9 wetland sites were identified as being publicly accessible. This is a conservative estimate as other wetland sites may also be accessible for example by informal agreements with landowners.

The Brander et al. (2008) value transfer function allows taking different socio-economic variables and context-specific attributes into account. Table A.2 outlines how the Brander et al. (2008) benefit transfer function has been applied for wetlands in Godrevy to Portreath. The underlying assumptions and variables are also explained in the comments section of this table.

⁵⁰ EFTEC 2010, 125.

⁵¹ Brander et al. 2008, 33.

Table A.2 Wetland Value Function and Corresponding Assumptions

Variable	Coefficient value	Value of explanatory variable	Comment
Constant a	-3.078	1	
Wetland type: Inland marsh	0.114	1	
Wetland size:	-0.297	<i>ln</i> 0.3/ <i>ln</i> 3.0	Average size of wetland site with and without public access.
Flood risk reduction and storm buffering:	1.102	1	These services are occurring independently from accessibility of the site.
Water quality improvement:	0.893	1	
Biodiversity:	0.917	0/1	These services only occur if the wetland site is accessible. Therefore the variable has only been applied for accessible sites. Note that recreational fishing has a negative influence on the total value.
Recreational fishing:	-0.288	0/1	
Non-consumptive recreation:	0.340	0/1	
Amenity and aesthetic services:	0.452	0/1	
GDP per capita (2003 US\$):	0.468	<i>ln</i> 18,162	GDP is approximated from the Cornwall level with €15,874 (in 2003, real prices, NUTS 2 level, source: Eurostat). Converted to 2003 US\$ using OECD purchasing power parity (PPP) exchange rates. This resulted in US\$18,162.
Population density per km ²	0.579	<i>ln</i> 85	Simplifying the population density of Cornwall has been used.
Wetland area within 50 km:	-0.023	<i>ln</i> 3,000	Considering the marginal influence on the result it has conservatively been allowed a generous wetland area of 3,000 ha within 50 km radius of each wetland site.

Source: *Brander et al (2008) and author assumptions/calculations.*

In the next step, the value attributable to each ecosystem service was approximated. By setting every variable standing for an ecosystem service to zero and viewing the difference in the sum, an estimate has been made of the attributable value for each ecosystem service.⁵²

⁵² The negative influence of recreational fishing has been distributed equally to recreation, amenity and biodiversity.

For the sensitivity analysis, uncertainties regarding the estimates taken as well as the scientific evidence have been considered. For the ecosystem services of water quality regulation, recreation, aesthetic appreciation and biodiversity, a range of 50% has been applied. Uncertainties for flood regulation are generally higher because they are more context-specific. Taking this circumstance into account, a range of 70% has been applied for this ecosystem service. The findings for each assessed ecosystem service can be reviewed in the tables below.

Table A.3 Wetland Flood Regulation

	Annual Value (£m)			Capitalised Value (£m)			
	High	Central	Low	High	Central	HM Tr.	Low
Floodplain Grazing Marsh	£0.020	£0.012	£0.004	£1.011	£0.423	£0.291	£0.087
Other	£0.003	£0.002	£0.000	£0.128	£0.054	£0.037	£0.011
TOTAL Wetland	£0.023	£0.013	£0.004	£1.139	£0.476	£0.328	£0.098
Legend: Central Central estimate High Higher threshold of the sensitivity analysis (even if the real value could still exceed this threshold) HM Tr. Based on the higher discount rates recommended by HM Treasury (stated for comparability purposes) Low Lower threshold of the sensitivity analysis							

Source: *Author calculations based on Brander et al. 2008*

Table A.4 Wetland Water Quality Regulation

	Annual Value (£m)			Capitalised Value (£m)			
	High	Central	Low	High	Central	HM Tr.	Low
Floodplain Grazing Marsh	£0.014	£0.010	£0.005	£0.723	£0.342	£0.236	£0.118
Other	£0.002	£0.001	£0.001	£0.092	£0.043	£0.030	£0.015
TOTAL Wetland	£0.016	£0.011	£0.005	£0.815	£0.386	£0.266	£0.133
Legend: Central Central estimate High Higher threshold of the sensitivity analysis (even if the real value could still exceed this threshold) HM Tr. Based on the higher discount rates recommended by HM Treasury (stated for comparability purposes) Low Lower threshold of the sensitivity analysis							

Source: *Author calculations based on Brander et al. 2008*

Table A.5 Wetland Recreation & Aesthetic Appreciation (incl. Biodiversity)

	Annual Value (£m)			Capitalised Value (£m)			
	High	Central	Low	High	Central	HM Tr.	Low
Floodplain Grazing Marsh	£0.009	£0.006	£0.003	£0.431	£0.204	£0.141	£0.070
Other	£0.001	£0.001	£0.000	£0.055	£0.026	£0.018	£0.009
TOTAL Wetland	£0.010	£0.006	£0.003	£0.485	£0.230	£0.158	£0.079
Legend: Central Central estimate High Higher threshold of the sensitivity analysis (even if the real value could still exceed this threshold) HM Tr. Based on the higher discount rates recommended by HM Treasury (stated for comparability purposes) Low Lower threshold of the sensitivity analysis							

Source: *Author calculations based on Brander et al. 2008*

2. Methods & Calculations: Woodland Wild Species Diversity

To value the ecosystem service ‘wild species diversity’ for woodland habitats, findings from Hanley et al. (2002) were used for a benefit transfer. Hanley et al. (2002) valued the non-use benefits of UK woodland as habitat for species. The Willingness-To-Pay (WTP) method was used to elucidate values for woodland habitats with different attributes, expressed by focus groups.⁵³ This study is considered appropriate as a source for benefit transfer, even though the sample size was comparatively small and not representative of the whole population in the United Kingdom.⁵⁴

The mean WTP to create an area of 12,000 ha of lowland broadleaved woodland was expressed with £0.84 per household (2002 prices).⁵⁵ This equates to £1.13 per household in 2015 prices. Because this is a non-use value, the benefits are theoretically not restricted to local residents.

“There is no reason within standard economic theory why non-use values would also decrease with distance.”⁵⁶

However, non-use values are controversial and may contain use value elements as well which are distance related. It is not clear at which level aggregation should stop.⁵⁷ Here, a conservative approach has been taken by assuming that only residents in the South West Region benefit from woodland in Godrevy to Portreath as ‘habitat for species’. Multiplying the WTP by the number of households in the South West (2.3m) and breaking the result down to the regional area of lowland broadleaved woodland, an annual value of £29,000 for

⁵³ Hanley et al. 2002.

⁵⁴ Willis et al. 2003, 15.

⁵⁵ Hanley et al. 2002, 18.

⁵⁶ Brander et al. 2008, 18.

⁵⁷ Saraev 2012, 25.

134.8 ha of woodland has been calculated. For the upper threshold of the sensitivity analysis, all UK households have been taken into account.

In the original valuation study the focus group participants were asked explicitly for their WTP for an increase of woodland.⁵⁸ This means that the WTP may not be applicable for existing woodland. However, there are confounding factors including: (1) woodland creation would entail loss of other habitat(s) set aside for tree planting, (2) if the amount of woodland and therefore the habitat for species declines, the marginal value increases, and (3) average species diversity in established woodlands is generally higher than in more recently planted woodlands. Following these arguments, the valuation of existing woodland applying the values for an increase of woodland seems to be justifiable and rather underestimating the true value.

Table A.6 Woodland Wild Species Diversity Benefits

	Annual Value (£m)			Capitalised Value (£m)			
	<i>High</i>	Central	<i>Low</i>	<i>High</i>	Central	<i>HM Tr.</i>	<i>Low</i>
Low land Broadleaved Woodland & Scrub	£0.501	£0.029	£0.015	£25.069	£1.035	£0.713	£0.357
Low land Coniferous Woodland	£0.021	£0.001	£0.001	£1.032	£0.043	£0.029	£0.015
TOTAL	£0.522	£0.030	£0.015	£26.101	£1.077	£0.743	£0.371
Legend: Central Central Estimate <i>High</i> Higher threshold of the sensitivity analysis (even if the real value could still exceed this threshold) <i>HM Tr.</i> Based on the higher discount rates recommended by HM Treasury (stated for comparability purposes) <i>Low</i> Lower threshold of the sensitivity analysis							

Source: *Author calculations based on Hanley et al. 2002*

⁵⁸ Hanley et al. 2002.

4. Methods & Calculations: Global Climate Regulation

To estimate the carbon stock in Woodland in Godrevy to Portreath findings from Read et al. (2009) were used. The estimated total carbon stock in UK forests and corresponding soils in 2007 was approximately 790Mt (million tonnes), equivalent to 2,897 Mt CO₂e (carbon dioxide equivalent).⁵⁹ At that time, the estimated woodland area in the UK was 2.84 million hectares⁶⁰ which results in an average carbon stock in UK woodlands and corresponding soils of 278 t per ha.

The estimated carbon stock in Godrevy to Portreath has been approximated by multiplying the average UK carbon stock per ha by the area of woodland in Godrevy to Portreath of 149 ha. This is a rather crude estimate because it does not for example account for species selection and soil types, but it gives us a 'ballpark figure'. Applying the approach described above, the carbon stock in Godrevy to Portreath woodlands and corresponding soils was estimated to be in the region of 41,400 t which equals 151,900 t CO₂e. Multiplied by the actual price (2015 level) per tonne of CO₂e of £62.42, recommended by the UK Department of Energy & Climate Change⁶¹, the value of carbon stored in Godrevy to Portreath woodland and woodland soils is in the region of £9.5 million.

Globally, wetlands have one of the highest carbon stocks per ha. The Intergovernmental Panel on Climate Change (IPCC) estimates an average carbon stock in wetlands globally at more than 750 tonnes per ha.⁶² When applied to the area of wetlands in Godrevy to Portreath, this results in a carbon stock of 12.1 t equivalent to 44.2 t CO₂e and valued at £2.8 million.

⁵⁹ Read et al. 2009, 7.

⁶⁰ Forestry Commission 2008.

⁶¹ DECC 2009.

⁶² Gorte 2009, 5.

The value of carbon stored in heathland and grassland habitats has been estimated using the findings of a review undertaken by Alonso et al. (2012). They estimated that the average carbon stock in UK heathlands and corresponding soils is 90 tC per ha whilst the stock in neutral grassland habitats has been estimated with 61 tC per ha.⁶³ Applying these estimates for 51 ha of heathland in Godrevy to Portreath results in a carbon stock of 4,626 t valued at £1.06 million. For 11 ha of neutral grassland a carbon stock of 675 t valued at £154,500 has been calculated.

Aggregating the findings a total carbon stock in assessed habitats and corresponding soils of 58,770 t was calculated. This results in a total carbon stock value of £13.45 million. It should be noted that this is a stock value; not to be confused with the (capitalised) flow value of ecosystem services. Because the main framework of this exercise is based on calculating the annual and capitalised flow of ecosystem services, the value of £13.45m has not been added to the main table (see Section 2.2) of the monetary valuation within scope of this study as it does not match the conceptual framework.

To get a better understanding of the value of carbon captured and stored in trees in Godrevy to Portreath or the CAONB area as a whole an i-Tree Eco assessment could be undertaken.⁶⁴ The i-Tree tool has been developed in the United States and allows, for example, to estimate the carbon stock and sequestration by trees within a specific geographical area. A sample of the woodland, but also for example single trees, would be measured and the species structure would be recorded. This would allow calculating more robust figures for carbon stock and actual carbon sequestration.

⁶³ Alonso et al. 2012.

⁶⁴ <http://www.itreetools.org/>

5. Methods & Calculations: Other Ecosystem Services

The findings of the study *“The Economic Valuation of the Ecosystem Service Benefits delivered by the UK Biodiversity Action Plan”*⁶⁵ have been recalculated to estimate the value of the following ecosystem services:

- Woodland: flood risk regulation
- Wetland: wild species diversity
- Heathland: recreation & aesthetic values, flood risk regulation, wild species diversity
- Unimproved grassland: recreation & aesthetic values, flood risk regulation, wild species diversity

The aim of that primary valuation study was to estimate the value of changes in biodiversity and associated ecosystem services which result directly from the delivery of the UK Biodiversity Action Plan (UK BAP). Specific objectives were to assess the marginal value of ecosystem services per habitat associated with the UK BAP and the marginal value of conservation activities associated with different scenarios.

In the original primary valuation study values were calculated in two steps. The first step entailed a choice experiment to determine the values people place on ecosystem services delivered by UK BAP habitats. Choice experiments are surveys that present people with different policy scenarios, where scenarios are described in terms of different environmental characteristics and different ‘prices’. Analysis of people’s choices for these scenarios reveals values associated with the different preferences or choices. The second step entailed a weighting matrix evaluating the proportion of ecosystem service provision related to habitat

⁶⁵ Christie et al. 2011.

and ecosystem service (group). Experts were asked to identify the relative levels of ecosystems services delivered by the habitats with which they were most familiar. These results were then pooled. Experts were also asked to identify the proportion of ecosystem service values that were directly attributed to UK BAP conservation activities. The primary outcome was the marginal change of ecosystem services provided by different UK BAP priority habitats in relation to different scenarios.⁶⁶

Although the data warrants some caveats, it has been judged sufficiently robust to inform this investigation. The study results have been applied in cases where no other robust primary valuation data was available. For the purpose of this investigation the total ecosystem services value rather than the value of management/conversation interventions was needed. Therefore the values for a marginal change in conservation activities needed to be recalculated. Fortunately the available data allowed this step.

The values for ecosystem services provided by habitats in Godrevy to Portreath have been derived from average UK values in Christie et al. (2011) rather than the values derived specifically for the South West Region. Crucial for this decision was the bigger sample size for the choice experiment as well as the higher degree of accuracy of habitat data used in the original study. However, just applying average per-hectare values is not always the best solution. Therefore additional assumptions have been made. Calculations and main assumptions are summarised below for each assessed ecosystem service.

Cultural Services

In Christie et al. (2011) the category 'sense of place' captures all cultural services such as aesthetic, spiritual, educational and recreational benefits. Wild species diversity which can also be categorised as 'cultural service' is not included. Here assuming a direct relation between area of habitat and value would bias outcomes because especially cultural values are strongly related to the number of people who can locally benefit from such services.⁶⁷ To take this factor into account the average value per hectare has been adjusted by population density.

⁶⁶ Ibid., 11.

⁶⁷ See also Church et al. 2011.

In absence of alternatives the average value per hectare has been divided by the average Census 2011 based population density per km² in the UK (253/km²) and then multiplied by the average population density in Cornwall (150/km²).⁶⁸ However, this approach has only been applied for the value 'within own region'. For the WTP stated for 'outside own region' it can be estimated that this value is more related to non-use values and therefore not related to population density. Therefore the average value per hectare has been applied for the latter.

A range of 50% has been applied for the sensitivity analysis to account for uncertainties related to the applied assumptions, potential transfer errors, etc. The findings are outlined below.

Table A.7 Cultural services provided by Grassland and Heathland

	Annual Value (£m)			Capitalised Value (£m)			
	High	Central	Low	High	Central	HM Tr.	Low
Low land Calcareous Grassland	£0.001	£0.000	£0.000	£0.028	£0.013	£0.009	£0.005
Other Neutral Grassland	£0.003	£0.002	£0.001	£0.135	£0.064	£0.044	£0.022
Low land Heathland	£0.017	£0.011	£0.006	£0.845	£0.400	£0.276	£0.138
TOTAL	£0.020	£0.013	£0.007	£1.007	£0.477	£0.329	£0.164
Legend:							
Central Central estimate							
High Higher threshold of the sensitivity analysis (even if the real value could still exceed this threshold)							
HM Tr. Based on the higher discount rates recommended by HM Treasury (stated for comparability purposes)							
Low Lower threshold of the sensitivity analysis							

Source: Author calculations based on Christie et al. 2011

Wild Species Diversity

The quantification of services flowing from wild species diversity is often inadequate due to limited data and scientific evidence.⁶⁹ Furthermore some valuation approaches are considered controversial.⁷⁰ Nevertheless, some authors calculate values for 'wild species diversity' and often refer to 'biodiversity' or 'habitat for species'. When they do so, they often refer to the occurrence of charismatic species. This usually reflects a non-use value of preferences for the pure existence of a species without using (watching/experiencing) them. This approach may require true altruism and its quantification is therefore considered

⁶⁸ Cornwall has been used as a proxy. It would also have been possible to estimate the population density in and around Godrevy to Portreath, for example at the Output Area level, but considering that many beneficiaries are visitors/tourists this would likely lead to an underestimate.

⁶⁹ Norris et al. 2011, 65.

⁷⁰ UK NEA 2011b, 1186.

controversial; assigning absolute values also raises theoretical problems. Additionally, overlaps with use-values can occur.⁷¹ However, human preferences for the pure existence and survival of species can also be explained by option-use values⁷² or bequest values⁷³. Some authors calculate values explicitly for 'biodiversity' or 'wild species diversity'. Therefore, we adopt this category but findings should be treated with care. Within this exercise we tried to rule out overlaps with services like recreation and aesthetic appreciation as far as possible.

Christie et al. (2011) made a distinction between 'charismatic species' and 'non-charismatic species'. The former include terrestrial mammals, birds, amphibians, reptiles, butterflies, and moths. The latter incorporates vascular plants, non-vascular plants, terrestrial invertebrates (excluding butterflies and moths), and fungi (including lichens).⁷⁴ Not surprisingly the average WTP for charismatic species is significant higher than for non-charismatic species. To ensure consistency within this investigation the two categories have been combined as 'wild species diversity'. In absence of alternatives the assumption has been made that this ecosystem service directly relates to the area of habitat. The findings for each assessment area are summarised below. Unfortunately quantification was only possible for coastal and floodplain grazing marsh.

Table A.8 Wetland Wild Species Diversity Benefits

	Annual Value (£m)			Capitalised Value (£m)			
	High	Central	Low	High	Central	HM Tr.	Low
Coastal and floodplain Grazing Marsh	£0.013	£0.008	£0.002	£0.650	£0.272	£0.187	£0.056
Legend:							
Central Central estimate							
High	Higher threshold of the sensitivity analysis (even if the real value could still exceed this threshold)						
HM Tr.	Based on the higher discount rates recommended by HM Treasury (stated for comparability purposes)						
Low	Lower threshold of the sensitivity analysis						

Source: *Author calculations based on Christie et al. 2011.*

These values refer to the non-use values based on the findings of Christie et al. (2011). Not included are the use-values for biodiversity based on the findings of Brander et al. (2008)

⁷¹ Ibid.

⁷² You might never see a whale in nature, but you can benefit from the ability to see whales in the future.

⁷³ You might never see a whale in nature, but you can benefit from the ability of coming generations to see whales in the future.

⁷⁴ Christie et al. 2011, 131.

(see above). Because such use-values are dependent on site-visits and physical interaction with the ecosystem, the latter values have been included in cultural services. Because non-use values were explicitly excluded by Brander et al. (2008), it can be assumed that no overlaps between these two value domains exist.

For heathland and grassland, also the findings provided by Christie et al. (2011) were used applying similar assumptions as for wetland wild species diversity above. Together, the wild species diversity value of these habitats has been valued at £36,000 annually. The findings are summarised below.

Table A.9 Grassland and Heathland Wild Species Diversity

	Annual Value (£m)			Capitalised Value (£m)			
	High	Central	Low	High	Central	HM Tr.	Low
Low land Calcareous Grassland	£0.001	£0.000	£0.000	£0.027	£0.011	£0.008	£0.002
Other Neutral Grassland	£0.003	£0.002	£0.001	£0.167	£0.070	£0.048	£0.014
Low land Heathland	£0.057	£0.034	£0.010	£2.865	£1.197	£0.826	£0.248
TOTAL	£0.061	£0.036	£0.011	£3.059	£1.278	£0.881	£0.264
Legend:							
Central Central estimate							
High	Higher threshold of the sensitivity analysis (even if the real value could still exceed this threshold)						
HM Tr.	Based on the higher discount rates recommended by HM Treasury (stated for comparability purposes)						
Low	Lower threshold of the sensitivity analysis						

Source: *Author calculations based on Christie et al. 2011*

It should be noted that because these are non-use values, people often have problems in expressing their own preferences.⁷⁵ Such values are abstract and sometimes hard to grasp for non-specialists. Also, the WTP for this form of ecosystem service is a very small fraction of income which often leads to a comparatively wide variation of expressed values. Furthermore, the form of moderation of focus groups and the information provided about the habitats can have a strong influence on the expressed WTP. The comparatively small sample size and other caveats discussed above makes the application of a wide range of 70% reasonable for the sensitivity analysis.

⁷⁵ See also Saraev 2012.

Flood regulation

As for wild species diversity a direct link between the area of habitat and the provision of flood risk regulation services has been assumed in Christie et al. (2011). Within the Christie et al. (2011) study ‘water regulation’ stands for the ecosystem service ‘flood regulation’ as defined in this exercise.

For the purpose of this calculation the WTP ‘within own region’ and ‘outside own region’ has been applied as also remote areas could benefit for example when water levels of upstream rivers are reduced. Flood risk regulation values were available for woodland, unimproved grassland and heathland. It should be noted that the value for lowland meadows has been applied to other neutral grassland habitats as these are likely to perform similarly in terms of flood risk regulation benefits. Below you can find a detailed break-down of findings.

Table A.10 Flood Risk Regulation Services of Woodland, Grassland and Heathland

	Annual Value (£m)			Capitalised Value (£m)			
	High	Central	Low	High	Central	HM Tr.	Low
Low land Broadleaved Woodland & Scrub	£0.122	£0.072	£0.022	£6.105	£2.551	£1.759	£0.528
Neutral Grassland	£0.004	£0.002	£0.001	£0.185	£0.077	£0.053	£0.016
Low land Heathland	£0.031	£0.018	£0.006	£1.562	£0.653	£0.450	£0.135
TOTAL	£0.157	£0.092	£0.028	£7.853	£3.282	£2.263	£0.679
Legend:							
Central Central estimate							
High Higher threshold of the sensitivity analysis (even if the real value could still exceed this threshold)							
HM Tr. Based on the higher discount rates recommended by HM Treasury (stated for comparability purposes)							
Low Lower threshold of the sensitivity analysis							

Source: *Author calculations based on Christie et al. 2011*