Assessment of Landscape Sensitivity to Wind Turbine Development in Highland

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Summary Report

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1 INTRODUCTION

1.1 OBJECTIVES

1.1.1 This study was commissioned by The Highland Council (THC), Scottish Natural Heritage (SNH) and the Cairngorms National Park Authority (CNPA), which also comprised the Steering Group. The work was carried out by the Macaulay Land Use Research Institute (MLURI) and the Edinburgh College of Art (ECA), comprising the project team.

1.1.2 The aim was to inform decision-making to:

1. Provide a basis for developing Highland-wide and Local Plan policies and supplementary planning guidance, informed by evolving advice relating to SPP6, in discussion with Scottish Government consultants.
2. Examine 'Areas of search' for commercial wind turbine developments.
3. Advise on issues of cumulative effects of multiple commercial wind turbine proposals in inter-visible locations.

1.1.3 The study was carried out for use at a strategic level and not for the assessment of individual windfarm sites, either existing or prospective. The outputs do not take into account other natural heritage issues (e.g. wildland, habitat sensitivity), or technical considerations such as wind speed and connections to the electricity grid. These are issues for consideration by the planning authority, as set out in SPP6. Such issues can be considered by the overlay of relevant factors in a wider process of mapping areas of availability and suitability (i.e. a criteria-based assessment as identified in Planning Advice Note 45 Annex 2: Spatial frameworks and Supplementary Planning Guidance for Wind Farms (Scottish Government, 2008).

1.1.4 The outputs are:

1. Datasets for use in a Geographic Information System (GIS), and associated maps of an assessment of the sensitivity of landscape character to large scale wind turbine developments
2. Maps of theoretical visual sensitivity from viewing locations such as settlements, roads, mountain peaks (i.e. selected visual receptors).
3. Data on the number and extent of intervisibility of existing windfarms from routeways.

1.1.5 The derivation of these datasets was with professional landscape architecture theory and practice, backed up by calibration through field observations viewpoints, computer analysis of the areas visible from these points (i.e. referred to as the 'viewsheds'), and calculations of the viewsheds for visual receptors. The selection of viewpoints, visual receptors and basis of the calculations were through discussion and selection by the Steering Group and project team.

1.1.6 The study was carried out for an area of eastern and northern Highland, from the southern end of the Cairngorms National Park to Caithness in the north-east, and Ullapool in the north-west. The two parts of the area form the core areas of study (referred to in this report as 'north' and 'south'), with the area in between as a secondary priority. Results for this latter area would be considered if time permitted for conducting all of the appropriate field observations.

1.1.7 The south area extends along the Moray Firth coast, from Burghead to Inverness, and south-west to include the west of Loch Ness. The north area is that of the Scottish Natural Heritage 'Northern Area', including the southern area of Loch Broom, and generally follows the line of watersheds, intersecting the east coast on the south side of the Dornoch Firth. The area of the Cairngorms National Park is excluded from the reporting of the study but is shown in the majority of the output maps. However, to aid in the interpretation of landscapes, viewpoints were selected in the secondary priority area, and within that of the Cairngorms National Park.

1.1.8 The boundary used for the analysis and in the output maps was derived by adding a buffer of 35 km around the study area (consistent with the outer viewing distance required in Environmental Statements), thus including windfarms which may contribute to the landscape within the study area. The inclusion of the area of Moray and Orkney bordering Highland allows for consideration of windfarms which might impact on the visual impact of wind turbines within the Highland area. The final boundary was as agreed with the Steering Group and project team, and in consultation with the Scottish Government consultants on Supplementary Planning Guidance, Enviros Ltd. and MacRoberts.

1.1.9 The maps and datasets were uploaded to THC computer facilities, and installed at the CNPA.

1.1.10 This report is an abridged version of the full report and materials submitted to the Steering Group, which contains greater detail of the datasets and methods used, and range of outputs.

1.2 DEFINITION OF KEY TERMS

1.2.1 Many of the terms used in this report have been defined or employed elsewhere in a variety of ways. The terminology used here was based, as far as possible, on the "Guidelines for Landscape and Visual Impact Assessment" (GLVIA) (Institute of Environmental Management and Assessment and The Landscape Institute, 2002). The exceptions are terms that do not appear in the glossary to the GLVIA, in which case definitions were taken from "Elements of Visual Design in the Landscape" (Bell 1991) and the "Guidelines on Environmental Impacts of Wind Turbines and Small Hydroelectric Schemes" (Scottish Natural Heritage, 2001). Some differences between these publications had to be resolved. The definitions of the main terms used throughout the report are as follows:

Landscape character sensitivity

1.2.2 Landscape character sensitivity is the degree of anticipated change in landscape character in response to a given type/magnitude of wind turbine development, derived in this study from analysis of landform complexity, landform scale, land cover complexity and land cover naturalness. The assessment carried out is related to the Landscape Character Assessment (LCA) types produced by SNH, rather than being an independent assessment. This enables the strategic evaluation to be aligned with already existing datasets and policy work, and follows a key source of information identified in PAN 45 Annex 2 (Scottish Government, 2008).

1.2.3 An area of high landscape character sensitivity will show a greater change in landscape character to a given wind turbine development than one of low landscape character sensitivity, and vice versa. Landscape character sensitivity is independent of landscape value. Hence, an area may be of high landscape character sensitivity and low landscape value, and vice versa.

Landscape Visual sensitivity

1.2.4 Visual sensitivity is a measure of the anticipated visual effect[1] in response to a given type/magnitude of wind turbine development, as derived from analysis of specific visibility, and viewer criteria.

1.2.5 An area of high visual sensitivity will experience a greater change in appearance and visual amenity and/or affect a larger number of people as a result of the introduction of differently-sized wind turbine developments, than one of low visual sensitivity, and vice versa. Visual sensitivity includes an element of landscape value.

[1] Visual effect as defined in GLVIA, Institute of Environmental Assessment and The Landscape Institute, 2002. "Visual effects relate to the appearance (of these changes) and the resulting effect on visual amenity". (GLVIA Summary page – no page number)

1.3 LIMITATIONS

1.3.1 Over the course of the study there have been certain limitations with respect to data collection, analysis and interpretation which are summarised here. Some are expanded upon in discussion through the report.

Strategic study

1.3.2 The study is carried out at a strategic level. The approach, data used, analysis and interpretation are not intended for use at a site-specific level. It is also a study relating to landscape aspects of windfarm development and does not provide a measure of absolute or inherent sensitivity of landscape and visual character in the Highland area. Any reference to 'character sensitivity' or 'visual sensitivity' should be interpreted in that context.

Viewpoints

1.3.3 The selection of viewpoints was from discussion between the Steering Group and project team. These were to calibrate the interpretation of Landscape Character Types within the LCA with respect to sensitivity to wind turbine development. The distribution reflects that of the LCA polygons, with points selected to provide views across some LCA types, and cover recognised differences within LCA types (e.g. Monadhliath Mountains).

Survey routes

1.3.4 During field visits routes were chosen to ensure that all selected points were visited, and to provide scope for reconnaissance leading to the addition of further points, and a field interpretation of the landscape character throughout the area. All Trunk, A and B roads in the area were driven. It would have been desirable to have included some additional minor roads, such as that from Altnaharra to the north coast, west of Ben Hope, south-west from Ardgay to Gleann Mor and Gleann Beag. However, this was not possible in the time, with good visibility. All areas specifically identified by the project and Steering Group teams were included.

Datasets

Wildland

1.3.5 Data representing 'wildland' were not included in the final analysis. Its inclusion would have contributed to the interpretation of landscape character sensitivity to wind turbine development. 'Naturalness' was one of the elements considered in both the fieldwork and spatial modelling. The topic was extensively discussed with the Steering Group and options considered included use of a dataset from SNH on wildland search, and an extension of the modelling undertaken for the CNPA by the University of Leeds. The former was eventually deemed unavailable for wide use and was being revised, and the latter would have required considerable new analysis for the entire study area which was agreed to be beyond the scope of this study.

Landscape Character Assessment

1.3.6 The LCA for Scotland is reviewed in detail by Tyldesley (1999). It was a basis for assessing landscape character sensitivity to wind turbine developments. Amongst some limitations of this dataset are inconsistencies in the scale and level of detail of landscape units mapped in different parts of Scotland, of which differences between the mapping in Caithness and Sutherland compared with the Cairngorms are notable. Other issues include positional errors in matching the boundaries of the digital data in different parts of the study area (e.g. in south-west Moray). Such issues led to modification of the LCA as a part of the study, with generalisation by removal of small features to enable effective use at a strategic level.

Visual receptors

1.3.7 The choice of visual receptors was intended to include the most significant places and types of viewing experience. These data are subject to a number of limitations, including the date of compilation of the spatial database, and the assumptions about theoretical viewing distances. They are not intended to provide site-specific assessments of visual sensitivity, but they do consider the types of visual receptors which would be included within a LVIA.

Mapping

1.3.8 Some of the input data to the mapping of visual sensitivity and landscape character sensitivity will change through time as new roads, footpaths or houses are built. The brief descriptions and interpretations of the maps are to highlight overall patterns across the study area or in sub-areas.

2 METHODOLOGY

2.1 BACKGROUND

2.1.1 A study was carried out into landscape potential for wind turbines in areas of Highland and Moray in 2002. That was undertaken by the Macaulay Land Use Research Institute (MLURI) and the Edinburgh College of Art (ECA), with representatives from Scottish Natural Heritage (SNH), MLURI, ECA, the Moray Council and the Highland Council (Scottish Natural Heritage, 2003). The study was at a strategic level, to inform THC of the sensitivity of the landscape character, and visual sensitivity to development of wind turbines.

2.1.2 The approach used Geographic Information System (GIS) tools, calibrated and used by professional landscape architecture theory and practice from the research and steering group teams, backed up by fieldwork. The methodology is based on an approach developed for SNH, THC and Moray Council in 2003, informed by a critique by SNH, and revised in discussion with the Steering Group. It exploits the Landscape Character Assessment (LCA) for Scotland, as a basis for developing targeted planning guidance on wind turbine development, and potential interpretation of areas of search.

2.1.3 In order to assess the potential of the landscape character to accommodate large-scale wind turbine developments, this strategic approach seeks to integrate:

1. the sensitivity of landscape character to wind turbine development at viewpoints;

2. observer sensitivity to wind turbine development in any given landscape, with respect to different visual receptors.

2.1.4 The approach was to produce two sets of outputs, one relating to a network of viewpoints, with field observations, designed as a sample of the Landscape Character Types found in the study area, and the second was maps of visual sensitivity, based upon visual receptors such as roads, settlements and viewpoints. These two sets of maps can be overlaid to show overall sensitivity to wind turbine development. The maps in this summary report relate to large scale developments of over 25 turbines, but do not take account of factors such as layout.

2.1.5 An overview of the approach is shown in

2.1.6 Figure 2.1.

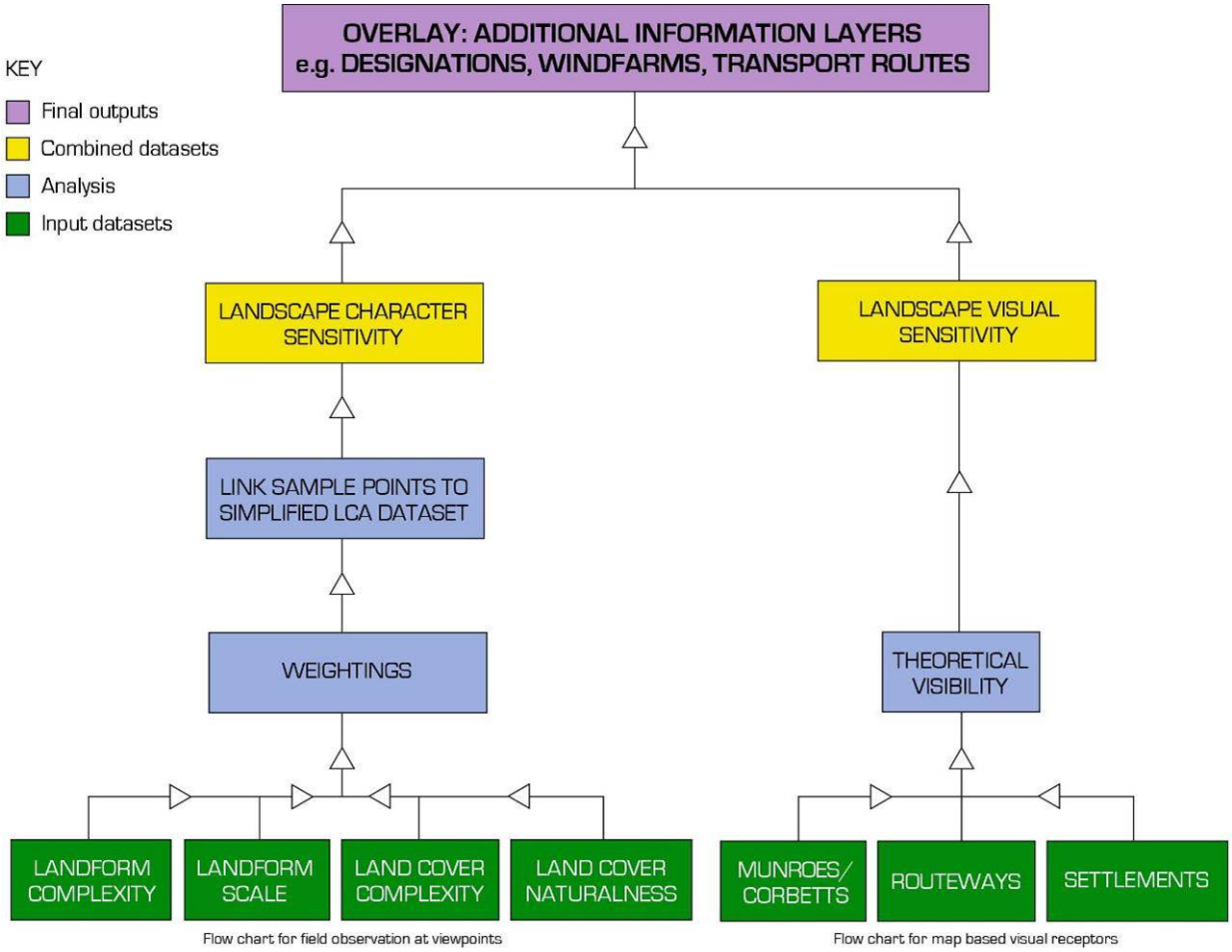

Figure 2.1 Flowchart of methodology for the sensitivity of landscape to wind turbine development for viewpoints and viewsheds.

2.2 LANDSCAPE CHARACTER ASSESSMENT

2.2.1 Landscape character is 'the distinct, recognisable and consistent pattern of elements in the landscape that makes one landscape different from another' (Martin and Swanwick, 2003). The factors that influence interpretation of landscape quality include physical features, usually mappable, but also those such as landscape experience, and are inherent within the Landscape Character Assessment for Scotland (LCA) (Scottish Natural Heritage and The Landscape Agency, 2002). This is a largely objective assessment of character, and LCA reports are accepted as baseline assessment and used regularly by landscape and planning professionals nationwide. The map units represent biophysical and experiential aspects of landscapes and are regularly used by the principal stakeholders of this study.

2.2.2 The LCA dataset has been used to link descriptions of the landscape and interpretation of the potential landscape impacts of wind turbine development. This provides a means of developing spatial planning guidance which can be consistent across the study area, or sub-areas. In this study, viewpoints were visited in the field and scored. Analysis of the data from the field was then used in a GIS, together with derived data, including viewsheds and databases of landscape character, and maps of landscape designations. This enabled the calibration of LCA Types with respect to their sensitivity to wind turbine developments, with the direct use of field observations and the geographic footprint of the view within which the assessment was made.

2.3 LANDSCAPE CHARACTER SENSITIVITY

2.3.1 Four main factors were used to derive the classification of the sensitivity of landscape character to wind turbine development for the study area:

- landform complexity
- landform scale
- land cover complexity
- land cover naturalness

2.3.2 Each factor was subdivided into three classes and weighted to reflect different levels of contribution to landscape character sensitivity. This weighting was devised by an expert panel of landscape architects from the initial study, taking account of different degrees of influence of each factor.

2.3.3 The approach is different from early uses of scoring which somewhat crudely applied scores to compare different things in assessments of landscape value, for example the so-called 'Fines System' or 'Manchester Method' (Fines, 1968). However, the numerical scales are used for largely subjective measures, with limited means of calibration. In this study, the scores relate to sections on continuous scales of variability which can be split into discrete steps. This provides a practical and repeatable tool for dividing data into different classes that can be assessed with respect to their likely sensitivity to the locating of wind turbines.

2.3.4 Each factor was assessed in the field, at each viewpoint. The outputs from these field observations were input to the derivation of datasets of landscape character sensitivity, which can be combined with other datasets (e.g. visual sensitivity from selected receptors, or landscape designations).

2.3.5 Although a continuum can be sub-divided into classes there is a limit to how many can be determined on the ground (i.e. visually) and, practically, how many are useful in the final data analysis. Too few classes may be too crude a representation of the data, and risks losing subtlety at the boundaries between factors, with scope for large degrees of transition open to debate. For this study, three classes were adopted for each factor, as used in the equivalent study in 2003 (Scottish Natural Heritage, 2003). The choice was an adaptation of experience gained from successfully applying similar assessment methods (Bell, 2000; Forestry Commission, 2000).

2.3.6 The field observations were entered into a spreadsheet and the weightings applied for the derivation of scores for landscape character sensitivity. The output is the field assessment of landscape character sensitivity, at the viewpoints. The viewing cone shows the direction and field of view from each point, and the size of circle indicates the assessment of the level of character sensitivity at that point. The viewshed from each viewpoint was also calculated and the field assessments for landscape character sensitivity allocated for the respective viewpoints. Note that the assessment of landscape character sensitivity was for the field of view shown, and not for 360 degrees.

2.3.7 A high score equals a high landscape character sensitivity. For example, a score of three for landform complexity indicates that very complex landforms and moderately complex landforms are highly sensitive to large scale wind turbine developments. A simple landform has a low sensitivity and has a score of one. The approach is presented in more detail in Scottish Natural Heritage (2003).

2.3.8 The findings have been reported to the Steering Group and are currently being verified by THC and SNH.

2.4 LANDSCAPE VISUAL SENSITIVITY

2.4.1 A critique of the previous study noted the importance of considering viewing distance in calculations of visual sensitivity; that is, the reduced capability to identify and recognise features the greater the distance from the viewer. This is also known as 'distance decay'. For receptors of Munros and Corbetts (mountains between 2500 and 2999 ft), viewing distances of 7 km, 14 km and 35 km were used, enabling greater weight to be attached to closer features.

2.4.2 As an example of the difference in the area from which wind turbines may be theoretically visible for the view to the tip of blade at 120 m rather than eye-level (1.8 m), the calculation was run for two viewing distances from the Munros and Corbetts. The difference between the outputs in Figure 2.2 and Figure 2.3 illustrates the geographic extent of the difference in the calculation.

2.4.3 The final sets of individually weighted data are presented separately to represent the visual sensitivity of the landscape to the observer under different circumstances: (i) Observer at a point looking down on the landscape (i.e. assumed to be from Munros and Corbetts); (ii) Observer looking from areas of residence, workplace or holiday accommodation (e.g. settlements); and, (iii) Observer looking from transport routes (i.e. roads, railways and long distance footpaths). For details of the source data and analysis please see materials provided to the Steering Group.

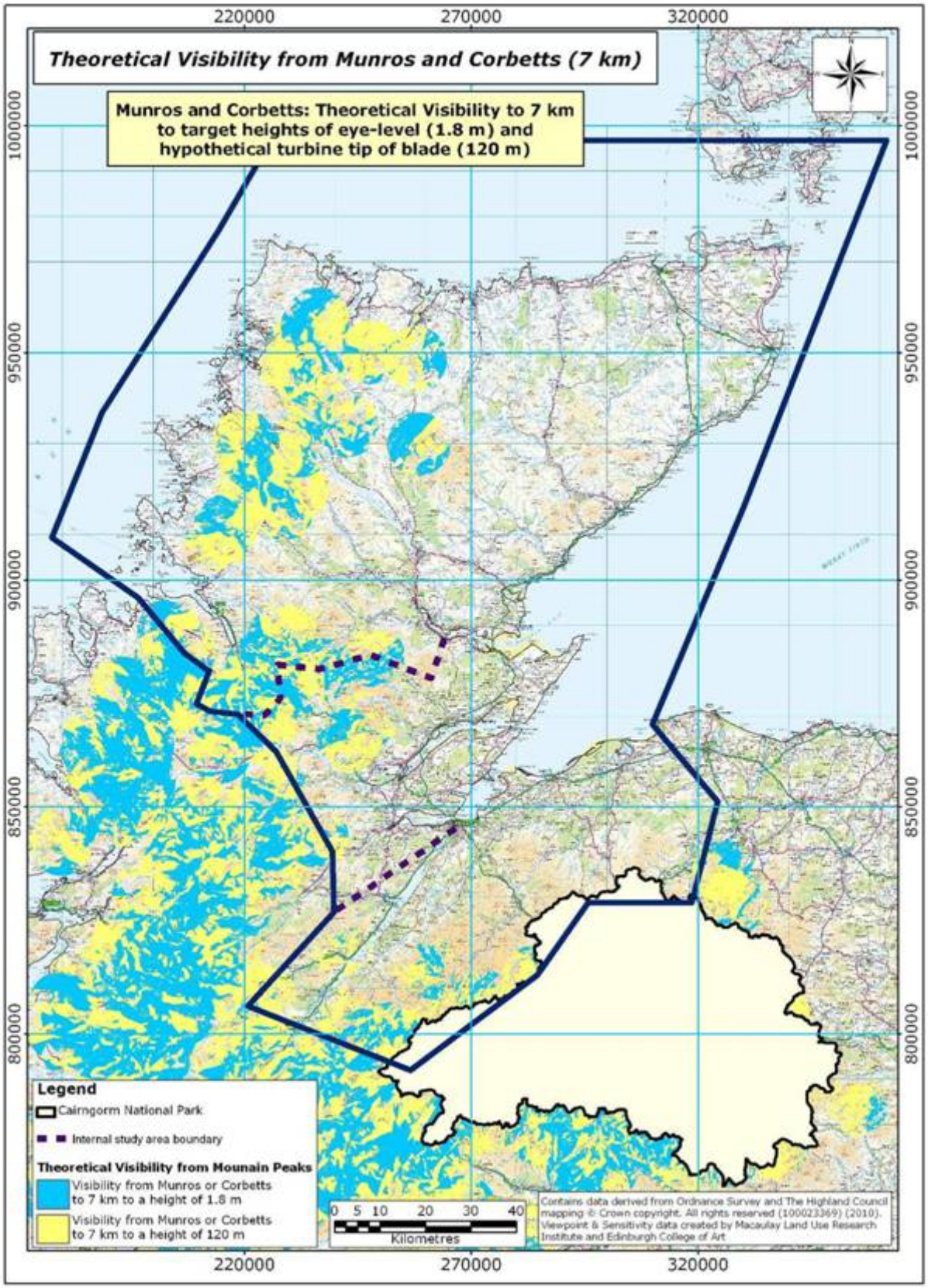

Figure 2.2 Example of theoretical visibility from Munros and Corbetts, at 1.8 m, to viewing targets 1.8 m and 120 m above ground, to a viewing distance of 7 km.
(Inputs: OS 1:50,000 DTM; peaks of all Munros and Corbetts; Analysis: visibility to 7 km radius, to target heights of 1.8 m and 120 m)

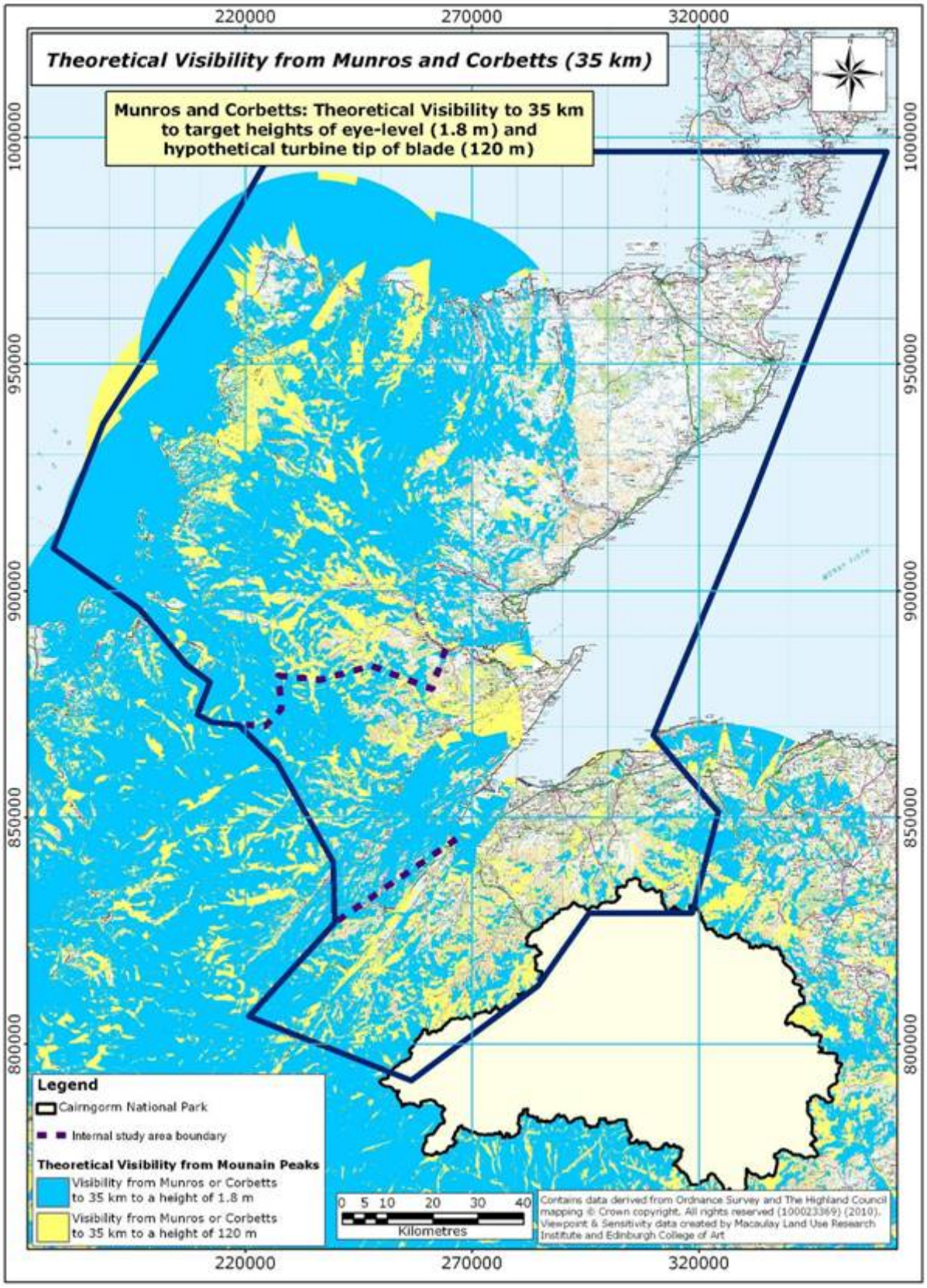

Figure 2.3 Example of theoretical visibility from Munros and Corbetts, at 1.8 m, to viewing targets of 1.8 m and 120 m above ground, to a viewing distance of 35 km.
(Inputs: OS 1:50,000 DTM; peaks of all Munros and Corbetts; Analysis: visibility to 35 km radius, to target heights of 1.8 m and 120 m).

3 Landscape Character Assessment

3.1.1 An overview of the landscape character assessment for Scotland is provided by Tyldesley (1999). A recognised weakness of the mapping is that there are inconsistencies in spatial resolution between some areas of the country. The compilation of the LCA was undertaken by several contractors, of which five cover the area of the study; therefore, the level 1 classification was used for the preliminary work in the south area.

3.1.2 For this study, following the field visits and discussion with the Steering Group, it was agreed that the mapping of the landscape character would require modifications in both the north and south areas. For this, the relevant LCA reports for the study area were consulted to obtain more detailed descriptions of the LCA units, their forces for change, and any discussion which related to the phrases used in the keys (e.g. in terms of experience). These reports were Ferguson McIlveen (1999) (Ross and Cromarty), Fletcher (1998) (Inner Moray Firth), Land Use Consultants (1999) (Tayside), Richards (1999) (Inverness District), Stanton (1998) (Caithness and Sutherland), and Turnbull Jeffrey Partnership (1998a, b) (Moray and Nairn; Cairngorms).

3.1.3 The LCA in the north area is at a finer spatial resolution than that required. It includes individual forests, lochs and some other units which are geographically small, largely surrounded by more extensive character units, often including some of the same features. These landscape character types include small areas interpreted as crofting, surrounded by landscapes described as largely agricultural, or adjacent straths, the descriptions of which include reference to farming activities.

3.1.4 Inconsistencies were resolved by:

1. Where surrounded by a single class, the *Coniferous Forest LCT* classes and smaller lochs in the north area were recoded to such a surrounding class.
2. Small units representing crofting, adjacent to, or surrounded by, straths or classes of farming were amalgamated with such classes.
3. The *Coniferous Forestry LCT* was reallocated to adjacent classes, using topographic maps and the 1:250,000 mapping of soils (i.e. biophysical landscape units) as guides.

3.1.5 For parts of the south area the LCA is at too coarse a spatial resolution (e.g. too few units in the Monadhliath Mountains), despite having sub-areas for which the character could be interpreted as being distinct. Therefore, the Strath Dearn area was delimited, with a new Upland Valley class introduced, which is a variation on the existing classes of upland valleys.

3.1.6 Figure 3.1 shows the revised LCA map which was used in the subsequent analysis.

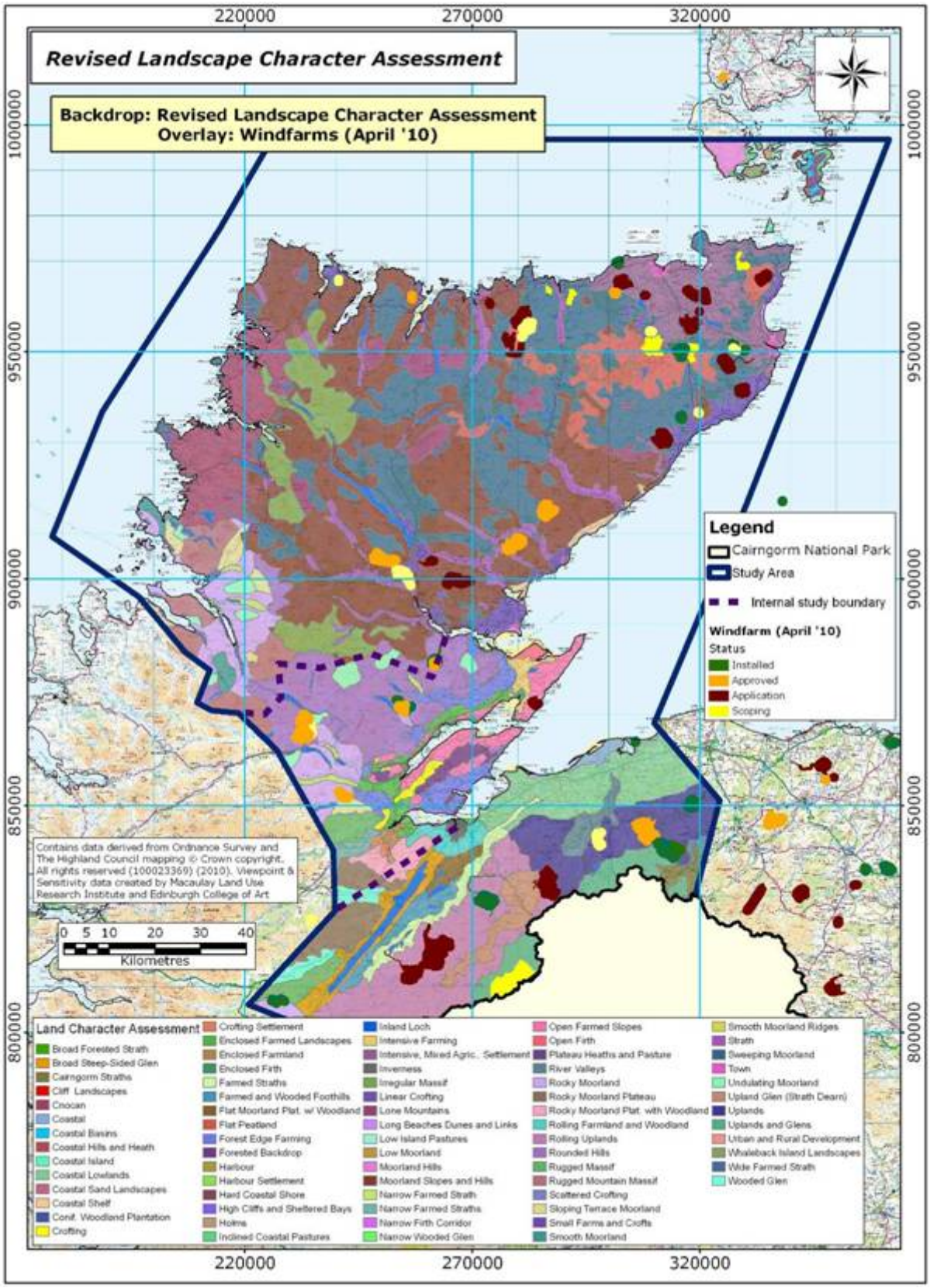

Figure 3.1 Landscape Character Assessment – revised dataset following generalisation of the small polygons and splitting of a large polygon in the Monadhliath Mountains.

4 LANDSCAPE CHARACTER AND SENSITIVITY TO WIND TURBINES

4.1 VIEWPOINT SELECTION AND OBSERVATIONS

4.1.1 A database of viewpoints was compiled from different studies carried out in the area over recent years, with additions suggested by the Steering Group. The sources of data were: (i) the previous study into landscape potential for wind turbine development (Scottish Natural Heritage, 2003); (ii) viewpoints from a study of landscape and development indicators (Miller et al., 2007); (iii) viewpoints used in visual impact assessments of proposed wind turbine developments (e.g. Lairg); (iv) additional points added by the Steering Group.

4.1.2 A subset of viewpoints was selected based on level 3 of the classification of the LCA. These were to assess the potential landscape character sensitivity to wind turbine development, with consideration of: (i) the strategic nature of the study; (ii) coverage of the range of LCA Types within the core areas of the study, and that between the two areas; (iii) accessibility of the points for field observation during winter, and in the time available.

4.1.3 At each point, a principal viewing direction was identified in accordance with the Guidelines on Landscape and Visual Impact Assessment (Institute of Environmental Management and Assessment and The Landscape Institute, 2002), and the field of view for the observations. The field observations, coordinates of the viewpoints, and reference numbers were entered into a spreadsheet, and transferred to a GIS. Figure 4.1 shows the viewpoints at which the field observations of landscape character sensitivity and visual sensitivity were made.

4.1.4 As noted above, currently The Highland Council is undertaking a process of verification of results and conclusions of the analysis of field observations and derivations of landscape character and visual sensitivity to wind turbine development.

4.1.5 The provisional findings are that the assessments of landscape character sensitivity are higher for areas designated for landscape reasons (e.g. NSAs than AGLVs). However, there are also high sensitivity areas outwith designated areas and some low sensitivity areas within AGLVs. The provisional findings suggest that locations of turbine developments constructed, approved or in planning are mainly in LCA types of low sensitivity, implying that the location criteria being applied by developers and through the EIA and planning process generally seem to be working from the point of view of landscape character sensitivity.

4.1.6 Figure 4.2 shows the distribution of windfarms in and around the study area, as of April 2010, overlaid on the LCA. Those which are either installed or approved have been buffered to 25 km to give an impression of the areas within which there are clusters of developments, most noticeably in Caithness, south Sutherland and Easter Ross, and Moray. (Note that a viewing distance of 35 km is recommended in PAN 45 (Scottish Government 2008), which is used in the later analysis of visibility).

4.1.7 Figure 4.3 shows the same dataset of wind turbines and area within 25 km, but in relation to landscape designations. Most of the designations to the west and north-west are beyond a 25 km distance of installed or approved windfarms. However, there are almost no areas beyond 25 km of an installed or approved windfarm between Helmsdale and Moray on the east coast, south-east Highland, and Fort Augustus in the south-west. Current applications would appear to increase the density in areas around the Monadhliath Mountains, and the northern boundary of the Cairngorms National Park, and extend the footprint along the north coast to include most of the NSA of the Kyle of Tongue.

4.1.8 The theoretical visibility of installed or approved windfarms to a viewing distance of 35 km, as of April 2010, is shown in Figure 4.4, and the locations of other windfarms which are currently at the stage of a formal application for planning permission or scoping. The footprint of visibility shows that most of east and southern Highland and Moray are within the theoretical visibility of at least one windfarm. The most extensive cover is that around the Moray Firth, Easter Ross, southern Sutherland and Caithness. Most of the west coast and much of the north coast, including areas around Strathnaver and Altnaharra have few such theoretical views.

4.1.9 Figure 4.5 shows the same footprint of visibility with landscape designations superimposed. This shows that there are several areas designated for their landscape significance, at international (i.e. National Park), national (i.e. NSAs) and local (i.e. AGLVs) levels, from which wind turbines are theoretically visible, some in close proximity to the designated area (e.g. north-west of the CNP, and in south-east Caithness). It is also apparent that extensive areas of Caithness and south Sutherland and Easter Ross have potential views of wind turbines, as measured up to distances of 35 km. However, NSAs of Assynt, north-west Sutherland and Kyle of Tongue currently have only limited views of installed or approved wind turbines.

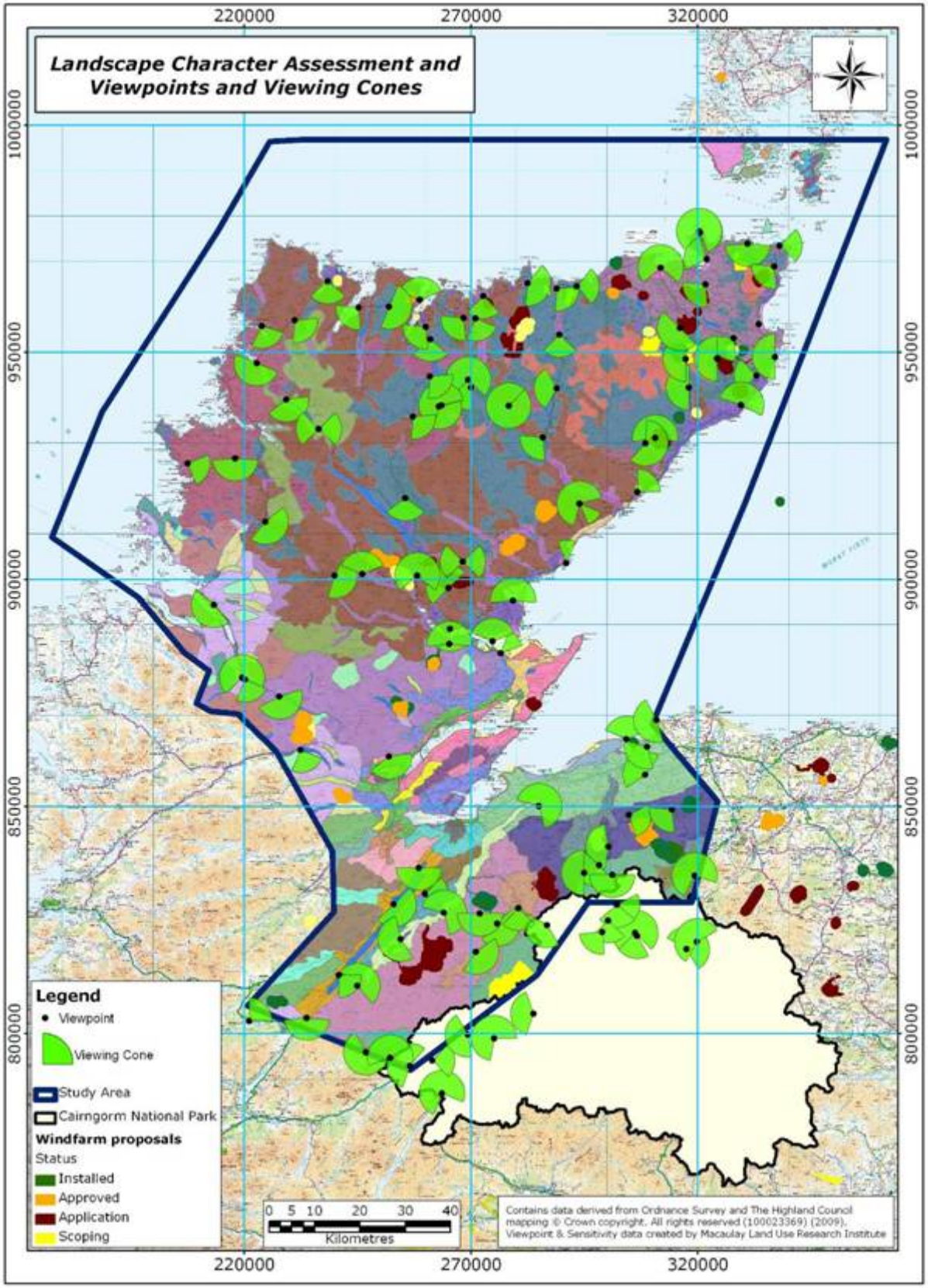

Figure 4.1 Landscape Character Assessment and viewpoints. (See Revised Landscape Character Assessment Areas for LCA legend).
(Inputs: Revised Landscape Character Assessment; viewpoints for field observations).

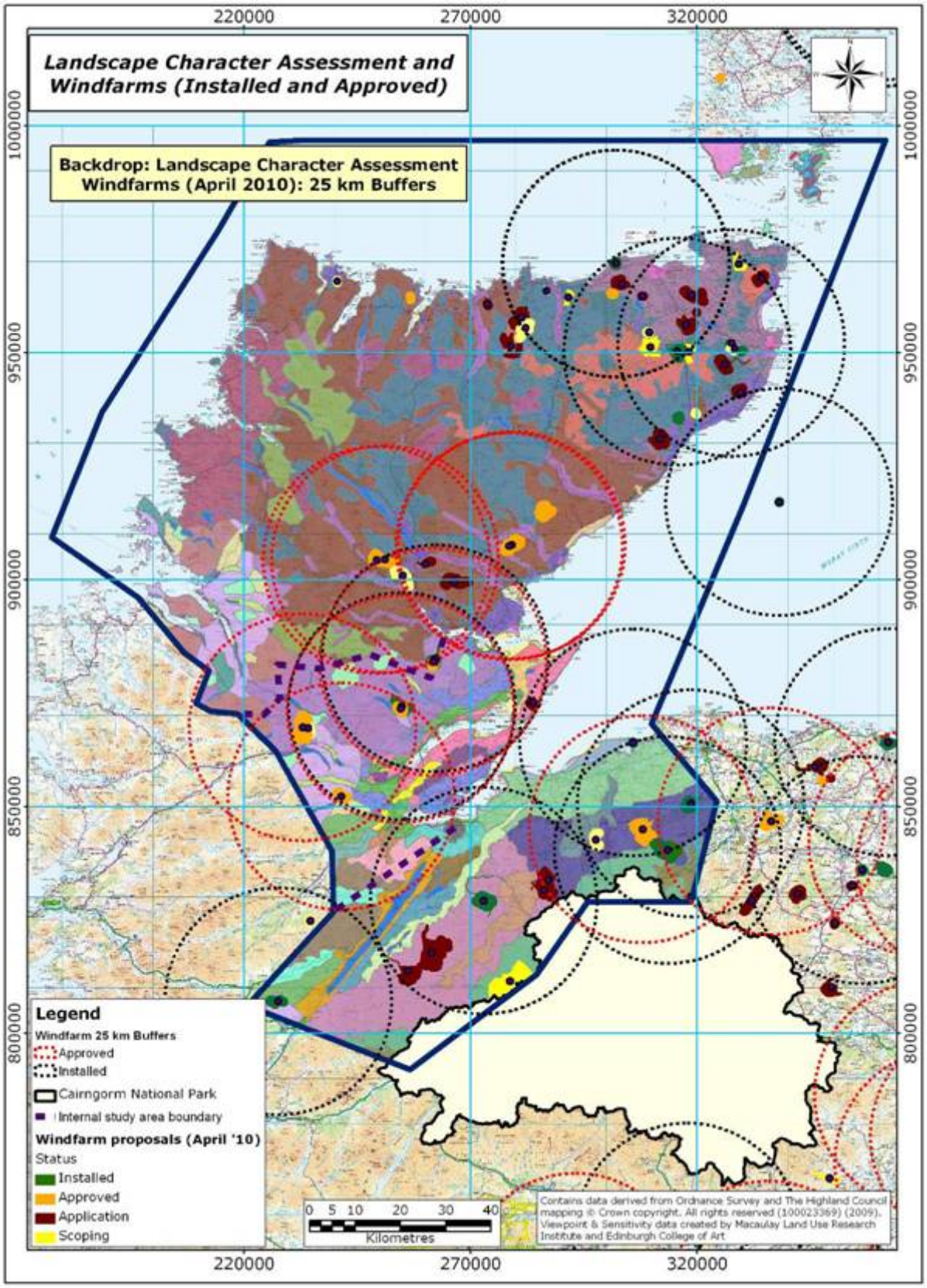

Figure 4.2 Revised Landscape Character Assessment and installed and approved windfarms buffered to 25 km (See Revised Landscape Character Assessment Areas for LCA legend).
(Inputs: Revised Landscape Character Assessment; windfarms as of April 2010, with 25 km buffers around those installed or approved).

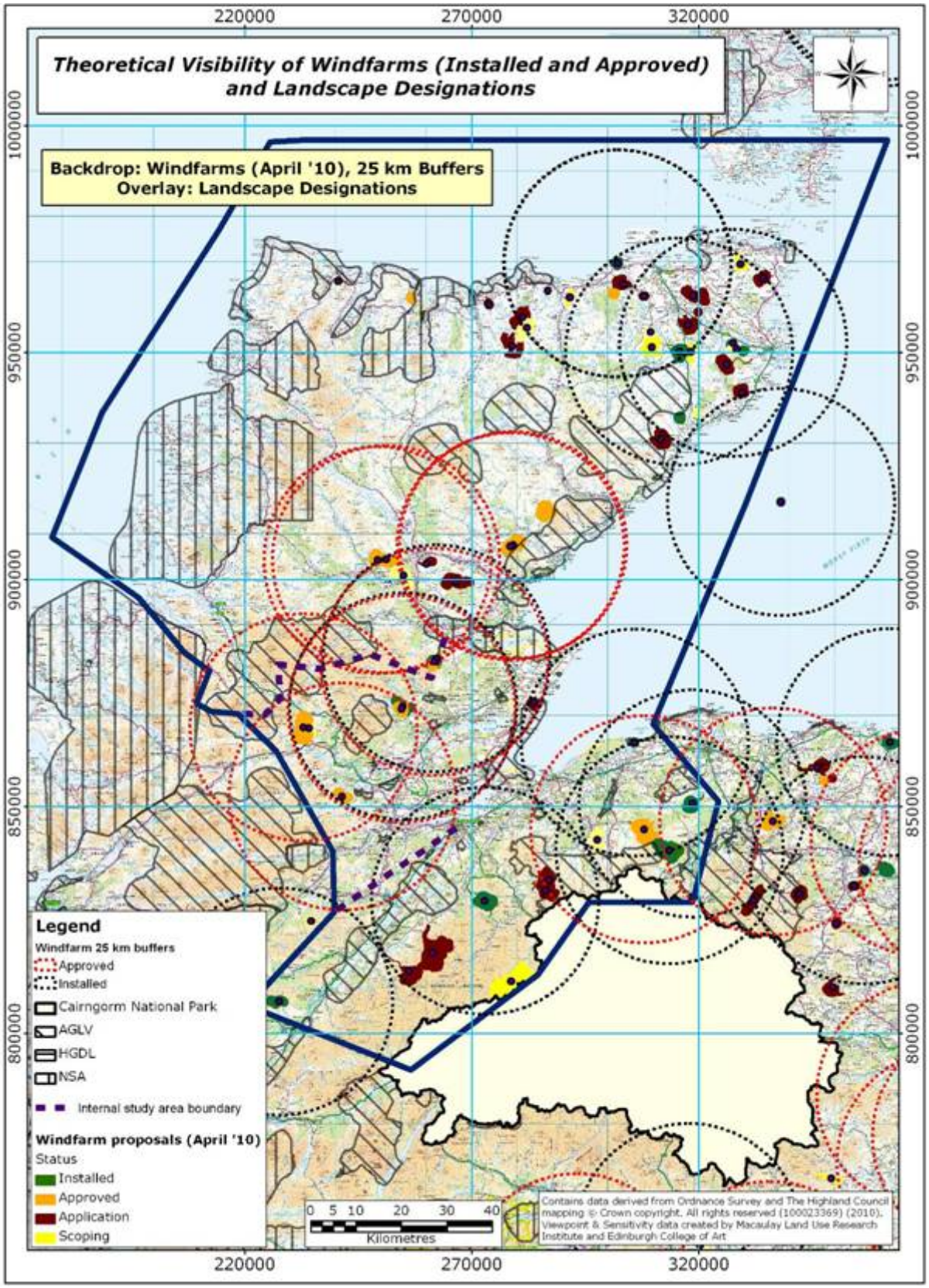

Figure 4.3 Landscape designations and installed and approved windfarms buffered to 25 km). (Inputs: Windfarms as of April 2010, with 25 km buffers around those installed or approved; landscape designations from SNH and THC).

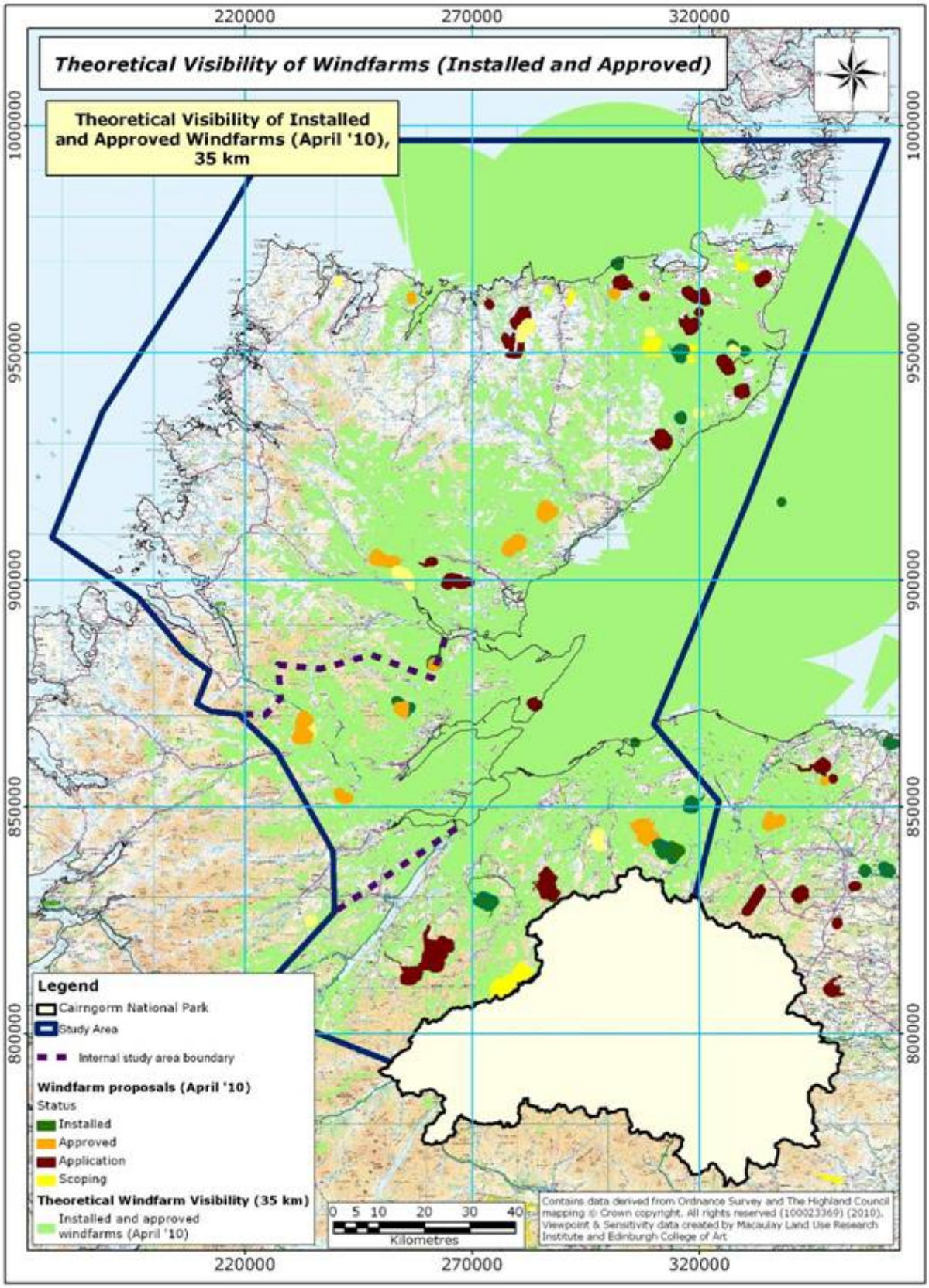

Figure 4.4 Theoretical visibility of installed or approved windfarms (as of April 2010).
(Inputs: Calculated theoretical visibility of installed and approved windfarms, and location of those in applications process or scoping; visibility calculation using documented turbine height to tip of rotor blade, or 120 m).

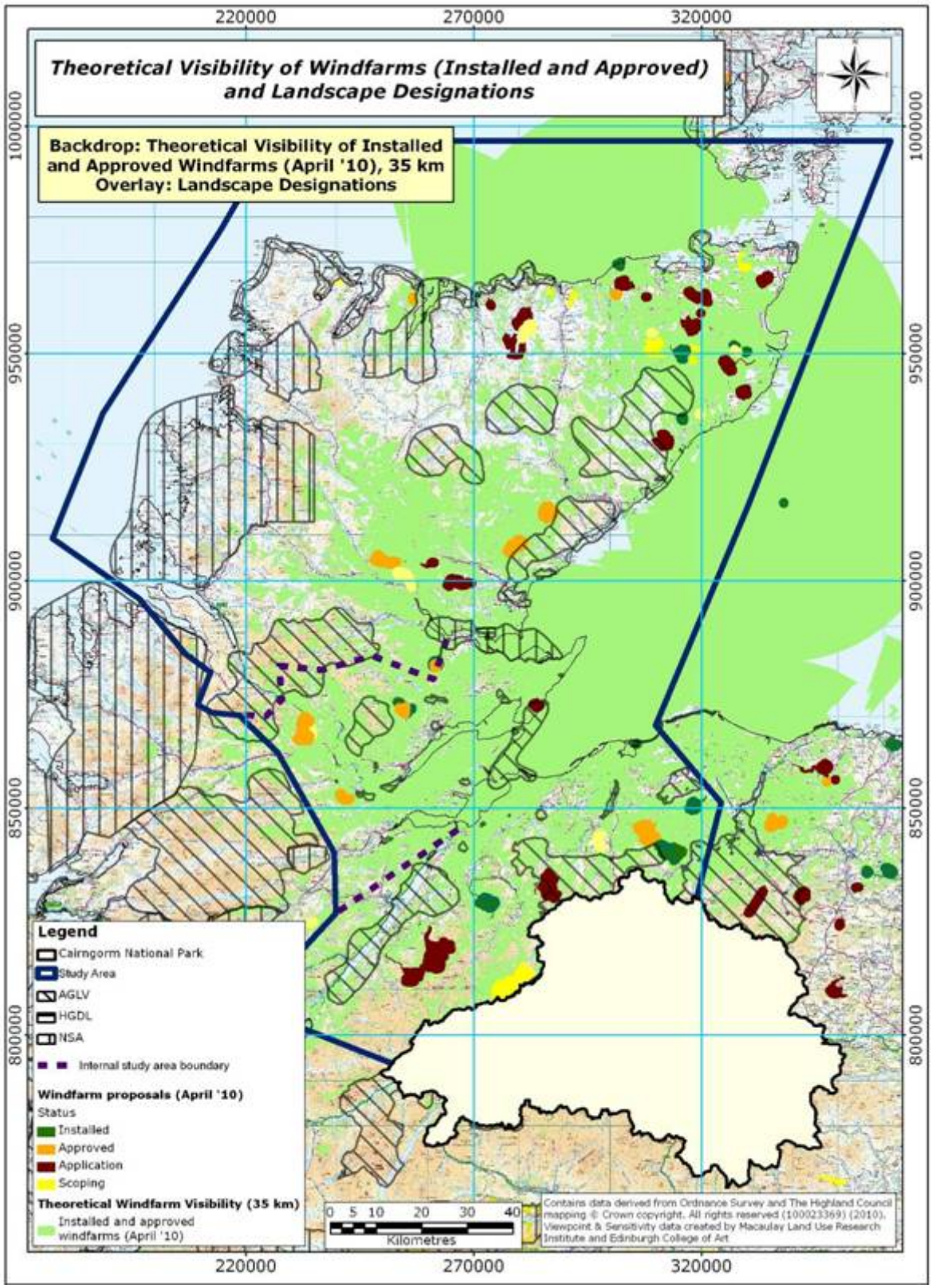

Figure 4.5 Theoretical visibility of installed or approved windfarms (as of April 2010) and landscape designations.

(Inputs: Calculated theoretical visibility of installed and approved windfarms, and location of those in applications process or scoping; visibility calculation using documented turbine height to tip of rotor blade, or 120 m; Superimposed: landscape designations).

4.2 LANDSCAPE CHARACTER SENSITIVITY

4.2.1 The proportions of the landscape character types within the views of the viewpoints was used to rank the LCA types with respect to landscape character sensitivity, and then split into High, Medium or Low sensitivity classes. The descriptions and keywords of the character types were then considered by a landscape architect in the project team to make a final judgement on allocating character types between classes.

4.2.2 The output is a regional map of landscape character sensitivity to wind turbine development for use as one input to the development of the overall strategy for wind turbines in Highland. The datasets and findings have been reported to the Steering Group and are currently being verified by THC and SNH.

5 LANDSCAPE VISUAL SENSITIVITY

5.1 VISUAL RECEPTORS

5.1.1 An assessment was made of the areas in which wind turbine development may have the greatest affects on landscape views. This is based upon assumptions about the types of places people visit, their movement through the landscape and where they stay. Geographic data were obtained for features identified as being of relevance, either from previous studies (e.g. Scottish Natural Heritage, 2003), or in discussion with the Steering Group.

5.1.2 In the same way as for landscape character, field observations were made of landscape visual sensitivity, which is also represented as scores for the viewsheds. More detail of which is provided in the reporting materials provided to the Steering Group and these results are not presented in this abridged version. The use of field observations on landscape visual sensitivity also allows a comparison to be made between the areas designated for landscape reasons and the visual sensitivity recorded at viewpoints by overlaying maps of such landscape designations (e.g. NSA, AGLV).

5.1.3 For regional assessments of visual landscape sensitivity to wind turbine development a spatial database of visual receptors has been compiled from a range of input data which represent locations from which people would have views of the landscape, such as mountain peaks, settlements, and routeways. The data were compiled from a range of sources including The Highland Council, Scottish Natural Heritage, Cairngorms National Park Authority, Moray Council and Ordnance Survey. The analysis of visibility of landscape was undertaken using a raster format (i.e. calculations based on cells 50 m x 50 m in size) with the Ordnance Survey Panorama Digital Terrain Model (DTM) (Ordnance Survey, 2008a).

5.1.4 A database of selected features was compiled which represent locations of visitor interest (e.g. Munros, which are mountains over 3000 ft), have a high frequency of people passing (e.g. main roads), or with large numbers of residents (e.g. Inverness). These are referred to as ‘visual receptors’; the visibility from such was calculated, and the outputs combined to represent the areas in which wind turbines would be considered to impact on the view. These are complemented by the set of viewpoints at which field observations were made.

5.1.5 The results of the field observations show that the areas in the south which are of highest visual sensitivity are around the Cairngorms, not all in the study area, but some with views towards the area, the uplands in Moray, and along the coast. In the north area, the viewpoints with the highest sensitivity are located in areas of mountainous or coastal backdrops, or LCA types which are very diverse in the nature of the observer’s experience. The area of typically

medium landscape sensitivity along the north Sutherland coast relates to the balance in factors associated with the increasing landscape quality, and reducing population numbers, as one moves from the east to the west.

5.1.6 Field observations showed the highest visual sensitivity for views which are fully inside an NSA, such as Assynt, the Dornoch Firth, the Kyle of Tongue, and those with views towards NSAs (e.g. North-West Sutherland), but medium or low from those points with views outwards from NSAs (e.g. west of the Cairngorms NSA). A similar pattern was observed for AGLVs, but with more views of medium scores (e.g. Loch Naver, north-west of Helmsdale, Durness, and east of Loch Ness). Those with low landscape visual sensitivity are generally restricted to valley bottoms, and areas with limited viewing distances or across extensive areas of land with few distinguishing features.

5.2 MUNROS AND CORBETTS

5.2.1 Figure 5.1 shows the pattern of visual sensitivity from Munros and Corbetts, based on the theoretical visibility from these points. The map illustrates the predominance of the higher visual sensitivity to the west and south of the area, but that there are no views into Caithness from Munros or Corbetts, for a viewing distance of 35 km. However, it is recognised that there are distant views of mountains from Caithness, when looking towards the west.

5.2.2 The results show the expected concentration of higher visual sensitivity in the west and south of the area, particularly in the NSAs of Assynt, the Cairngorm Mountains and the Torridon NSA. From some Munros and Corbetts, the extent of the views appear understated. This is largely due to the shape of the mountain and that the views closest to some peaks are hidden, although the viewshed often extends to the maximum calculated of 35 km. Therefore, the proportion of the Kyle of Tongue NSA with a high visual sensitivity is limited despite the presence of Ben Loyal. The viewshed of Ben Kilbreck also reflects the shape of its highest peak and the lack of overlooking Munros or Corbetts on its south-eastern slopes.

5.2.3 Areas of high visual sensitivity from the peaks of Munros and Corbetts exist outwith the CNP, NSAs and AGLVs, but are limited to north-west of the study area, north of Ben Wyvis, and the south-eastern area of the Monadhliath Mountains. There are areas of medium or low visibility within some areas designated for their landscapes. However, the basis of the designation should be considered when interpreting the data. The area designated encompasses an area within which there will be variation in its character, and the extent and nature of the views. Therefore, one would also expect internal variation in the range of visual, or landscape character, sensitivities as derived in this study.

5.2.4 There are extensive areas of medium visual sensitivity where the views from several peaks overlap in the distance zone 7 km to 14 km, interspersed by areas of high sensitivity, in particular, the area south of Loch Loyal, stretching east to Syre, and west to Achfary and Ben Stack, and south of Altnaharra. Therefore, development within such an area would be visible from several peaks, looking from different directions, and thus illumination conditions would not limit the potential to identify a development from each and every location at any given time.

5.2.5 Within the study area, similar extensive areas of contiguous high and medium visual sensitivity lie within a triangle between Loch Luichart, Ullapool and the Wyvis Forest, and through the CNP. Outwith the area, the extent of such high and medium sensitive land is considerable to the west and south.

5.2.6 Several existing windfarms have been built within areas of low visual sensitivity from Munros and Corbetts (e.g. Novar, Beinn Tharsuinn, Farr, and Uish). Others would fall within areas of medium or high sensitivity from this set of visual receptors (e.g. Dunmaglass, Beinn Dearg), although some are in areas of low visual sensitivity (e.g. Berry Burn in Moray).

5.2.7 There are other significant peaks which do not qualify as either Munros or Corbetts which could merit consideration but were not included in the analysis. Similarly, people move through the landscape to reach a viewpoint, whereas the analysis of viewsheds from Munros and Corbetts ignores the routes required to reach the peaks. However, to consider fully all such aspects of the potential visual sensitivity would require data which are not available.

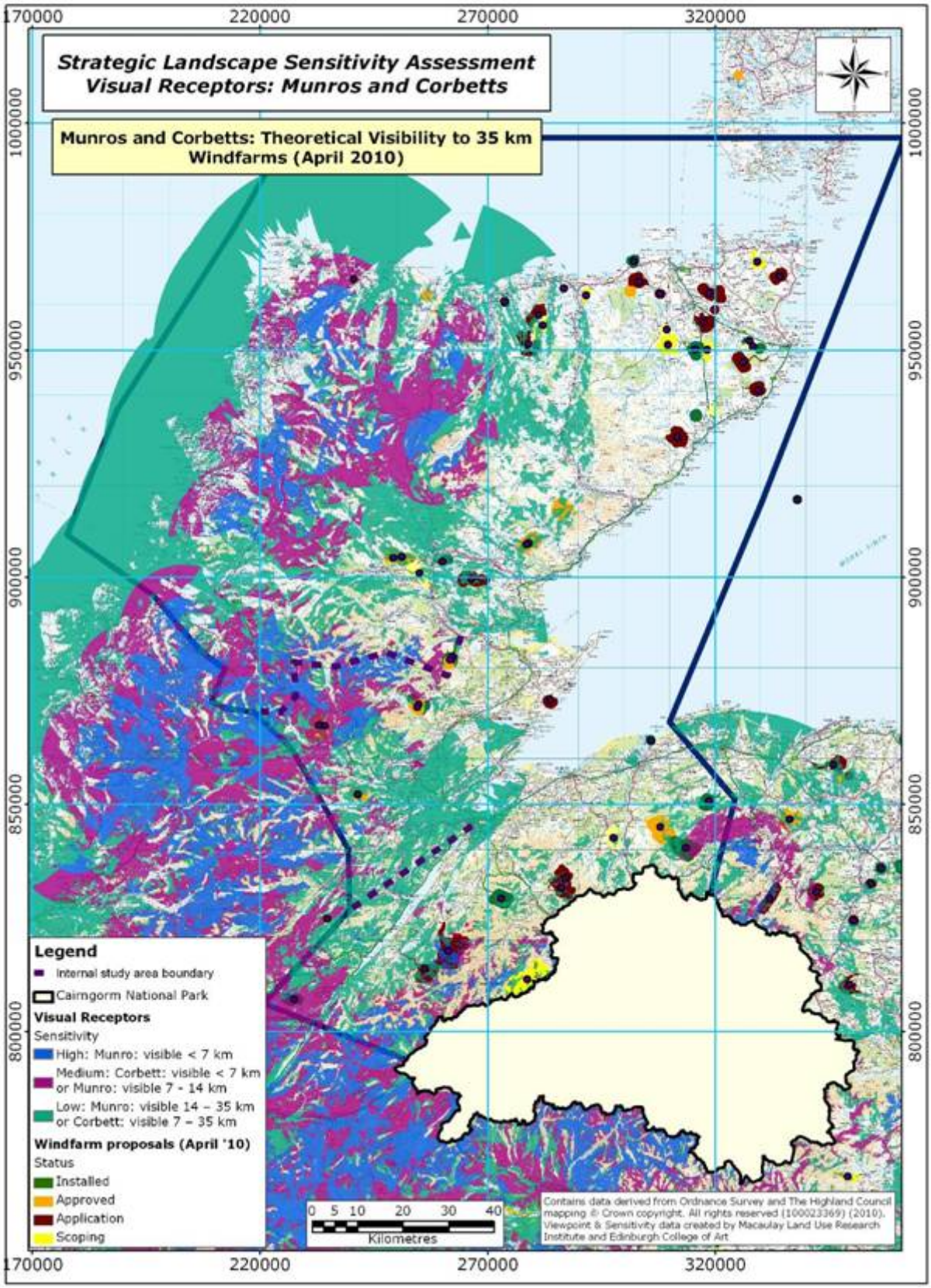

Figure 5.1 Visual sensitivity of landscape from mountains (Munros and Corbetts).
(Inputs: OS 1:50,000 DTM; peaks of all Munros and Corbetts; Analysis: theoretical visibility to 35 km radius, to eye-level target height)

5.3 ROUTEWAYS

5.3.1 The visibility of the landscape from transport routes was taken into account, using data from roads and railways. For the roads, the Ordnance Survey MasterMap (Ordnance Survey, 2008b) and OSCAR (Ordnance Survey, 2008c) datasets were used, with road segments extracted and analysed according to their level of vehicle use, or likely visitor interest.

5.3.2 The pattern of visibility from this type of visual receptor is shown in Figure 5.2. The distribution of land with a higher visual sensitivity is skewed towards the east and south of the study area, reflecting the distribution of major roads, and the railways, and the contribution of the long distance footpaths along the Spey Valley and the Great Glen. However, due to the shape of the topography, the viewsheds of some routeways are restricted. For example, the views inland from the A9 between Golspie and Helmsdale are mainly limited to the hillslopes and not the uplands. This is also apparent along the A835 from Garve to Ullapool. By comparison, much of central, west and north Sutherland have more open views across the Flat Peatland LCT, Sweeping Moorland LCT, and Moorland Slopes and Hills LCT resulting in more geographically extensive coverage of views from the route network through these areas.

5.3.3 The largest area of low visual sensitivity, but still visible from routeways, is in the vicinity of Syre, from the eastern end of Loch Naver to Badanloch Lodge towards Kinbrace, and north to Strathnaver. Combining this area with those not visible from routeways provides an extensive, contiguous, area of central Sutherland from Golspie north to near Strathy. This is one area (albeit probably better considered as separated into north and south), within which several wind turbine developments are consented or proposed. Other smaller areas of low visual sensitivity from routeways are located in Caithness, Assynt and Dava moor, north of the CNP.

5.3.4 Areas designated for landscape reasons are predominantly in areas with few transport links and a lower level of visual sensitivity from this visual receptor. The exception is the CNP which has a very few views into its core area.

5.3.5 In some areas there is a high frequency of interspersed views of low to high visual sensitivity, which reflects (i) the mix of routes from which there are views from different angles across the same area, and (ii) variability in the terrain. The area exhibiting this pattern most noticeably is the east side of Loch Ness.

5.3.6 The issue of intermittent and sequential views of wind turbine developments was described in the previous study (Scottish Natural Heritage, 2003) in which areas in Caithness and Moray were chosen to illustrate the potential reporting of the addition of windfarms in different orders of development with respect to one form of visual receptor, that of the routeway. Further information on these examples is available to the Steering Group to show cumulative effects of the addition of wind turbines in different orders with respect to the total length of A, B and C class roads.

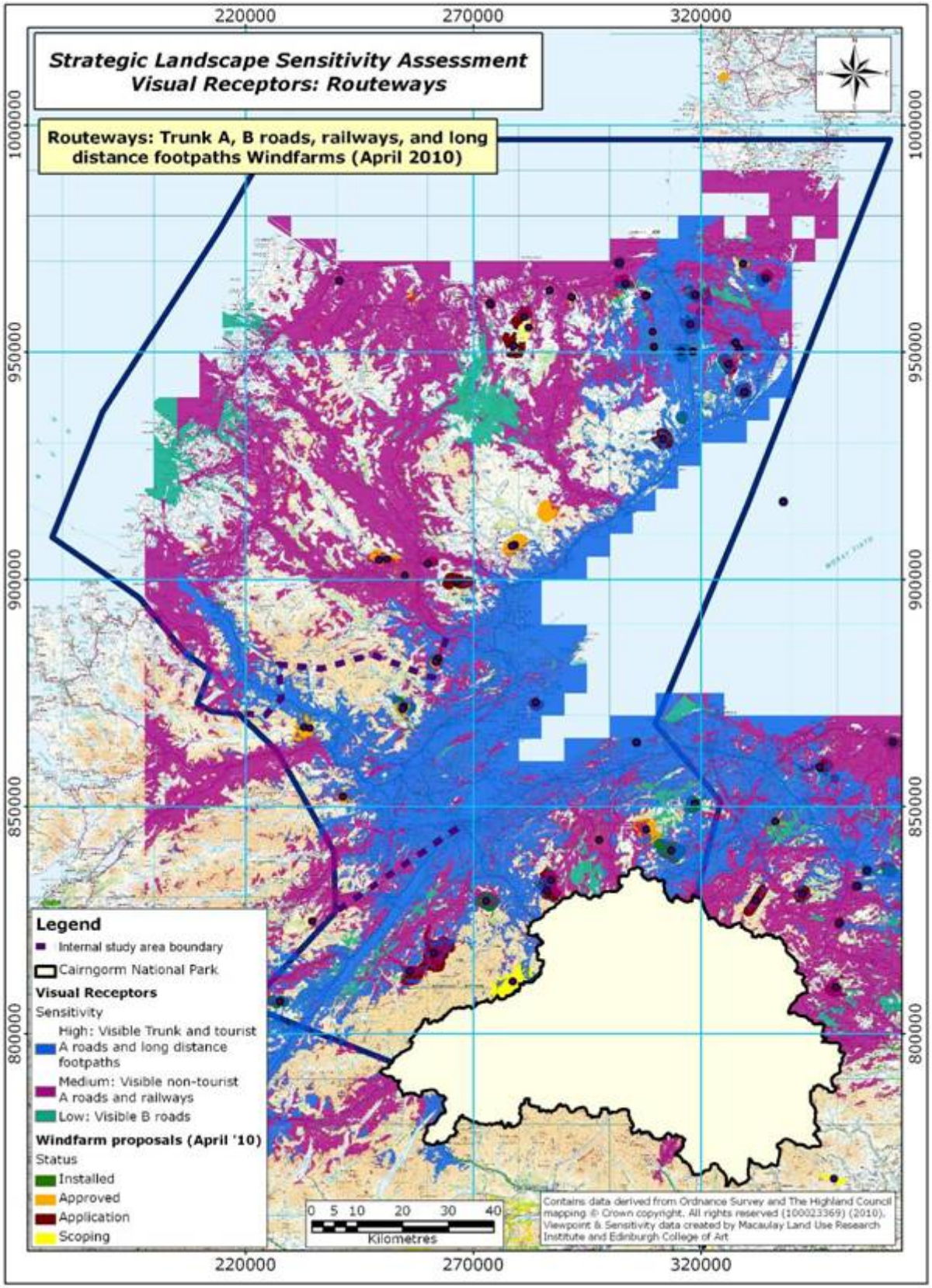

Figure 5.2 Visual sensitivity of landscape from transport routes.
(Inputs: OS 1:50,000 DTM; theoretical visibility from Trunk, A and B roads, and long distance footpaths).

5.4 SETTLEMENTS

5.4.1 In accordance with Guidelines for Landscape and Visual Impact Assessment (GLVIA), settlement (population) size has been used as a proxy in order to ascertain where larger numbers of visual receptors will be impacted by views to windfarms. Settlements were coded to reflect population size. Using data from the population census for 2001, the largest settlements (Inverness and Elgin) were separated and the viewsheds calculated for those towns. Elgin was included with Inverness because it is more than twice the size of any other settlements within the Highland and Moray area.

5.4.2 All other identifiable settlements as listed by the General Register Office for Scotland (General Register Office for Scotland, 2009) were grouped together, plus other clusters of houses which could be considered as a single settlement, in which there may also be facilities such as a school, shop or Post Office. To include all other dwelling, a 500 m radius buffer was centred on every property as mapped on the Ordnance Survey Address Point dataset (Ordnance Survey, 2008d). No viewshed calculation was undertaken for these buffered areas. At a strategic level of assessment, the variation in extent of area represented will be minor and assessments of potential impacts would be the role of a LVIA for a specific windfarm proposal.

5.4.3 Figure 5.3 shows the pattern of visibility from the settlements and properties. As for routeway visual receptors, the pattern reflects the predominance of the population living in the east or coastal parts of the study area. The viewshed of Elgin only extends into the eastern most part of the study area but does include views of Uish and the AGLV near Dallas. Inverness, by comparison, includes views which extend from the Monadhliath Mountains in the south, to Novar windfarm in the north.

5.4.4 Of the areas visible from settlements, there is almost a contiguous area of high visual sensitivity from the coastal lowlands of Moray in the east, through the Black Isle, the hinterland of Inverness, Easter Ross and Cromarty, the Dornoch Firth, and north to Helmsdale. There is a gap between there and a cluster of areas visible from Wick and Thurso. Other distinct and comparatively sizeable clusters are in the vicinity of Tongue, Kinlochbervie, Ullapool and Loch Broom, Lairg, Fort Augustus and parts of the Spey Valley.

5.4.5 In the north part of the study area, areas of a low density of properties are also identifiable in some of the straths, particularly in Strath Fleet, between Dornoch and Lairg, Lochinver and along the coast to its north side, Strath Oykel, and throughout parts of Caithness. Most of these are crofting areas. In the south part of the study area, a low density of properties are located through Strath Nairn, west of Loch Ness, in the transition area between the coastal lowlands and uplands of Moray, and in the Spey Valley.

5.4.6 Most existing or consented windfarm developments are in areas for which there is visual sensitivity from this receptor, with Novar, Uish, Fairburn and Watten as the most notable exceptions. This may reflect the design of the individual developments which have been through the environmental assessment and planning process. However, several proposed developments are within the medium class of visual sensitivity, including Spittal and Durran Mains in Caithness, and south-west of Lairg, with the area of Dunmaglass spread between high sensitivity and not visible.

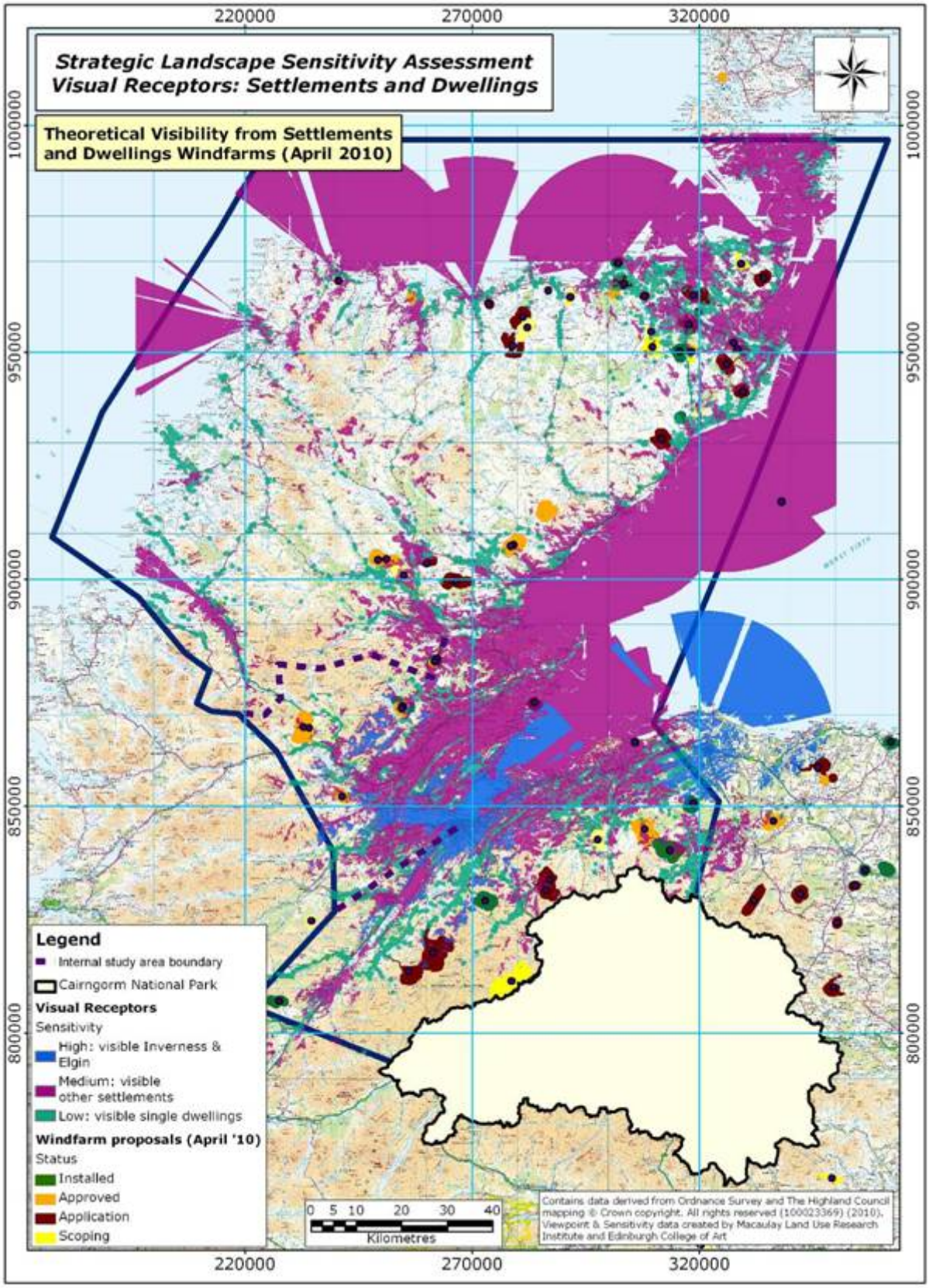

Figure 5.3 Visual sensitivity of landscape from settlements and properties.
(Inputs: OS 1:50,000 DTM; theoretical visibility from large settlements, and other discrete settlements, and 500 m buffer around isolated buildings).

5.5 COMBINED VISUAL RECEPTORS

5.5.1 The visual receptors were combined into a single dataset, allocating the output as the highest level of visual sensitivity at any point from any of the three visual receptors. However, it is the individual visual receptors which are proposed for use along with the landscape character sensitivity rather than the combined dataset. The outputs are shown in Figure 5.4.

5.5.2 The map shows a concentration of land with high visual sensitivity in the south-east of the study area, particularly around the Moray Firth, the Dornoch Firth, and Loch Ness. There are some smaller areas of high sensitivity in Caithness, and in some parts of the north and west (e.g. in the vicinity of Durness, Tongue, and south-east of Ullapool). Most of the upland areas are low visual sensitivity or have no overviewing visual receptor. This includes much of the areas designated as NSAs and AGLVs along the west coast and through Sutherland.

5.5.3 Only the three turbines at Watten, in Caithness, comprise an existing or consented windfarm which fall within areas classified as having a high visual sensitivity, although Fairburn Estate includes areas of high and low visual sensitivity. Some other sites are located in areas of medium visual sensitivity but most are predominantly in areas of low scores (e.g. Farr).

5.5.4 Of the sites at proposal stage or in scoping, the area within which Dunmaglass would lie occupies medium and low scores for visual sensitivity, Cairn Duhie (north-east of Dava Moor) occupies medium and high scores, as does that south-west of Lairg, and most in the Caithness area. However, the proposals south of Strathy Forest lie in areas with either low or no scores, as does that near Loch Buidhe, between Dornoch and Lairg and Allt Duine.

5.5.5 The sections of the map which are identified as ‘no visibility’ are those which are not visible from any the visual receptors. It could be argued that these are therefore of low sensitivity but in fact the sensitivity analysis is only of visible areas. This does not mean that either: a) there are no views within these areas currently excluded from a visual receptor, or b) that there may not be view in future as a road is opened, a long distance path established, or a house built which creates a new viewpoint and affects sensitivity.

5.5.6 Retaining separate sensitivity maps may be of more utility as planning guides as it may be valuable to know what factors are contributing to sensitivity in a given situation – in the west it may be landscape quality or views from peaks of Munros, whilst in the east it may be settlements, transport corridors and Corbetts. This recognises that (as recommended in PAN45, Scottish Government, 2008) the significance of views, and the sensitivity of visual receptors be considered with respect to identifying areas of broad search, and cumulative visual impacts.

5.5.7 Given the extent of the area of Highland Council, and the considerable variations in the landscapes from west to east, and north to south, the visual receptors may be attributed different significance relative to each other in different parts of the region. Therefore, the sensitivity of landscape to wind turbine development may be assessed as different in each area from a planning point of view. For example, in the settlement areas, more public consultation may be needed, the LVIAs undertaken will need a specific set of viewpoints, and the cumulative visual impacts along roads may be more significant than in remoter places where higher elevation views may enable mitigation by changing turbine colour to play a more important role or where micro-positioning to effect the most screening may be possible.

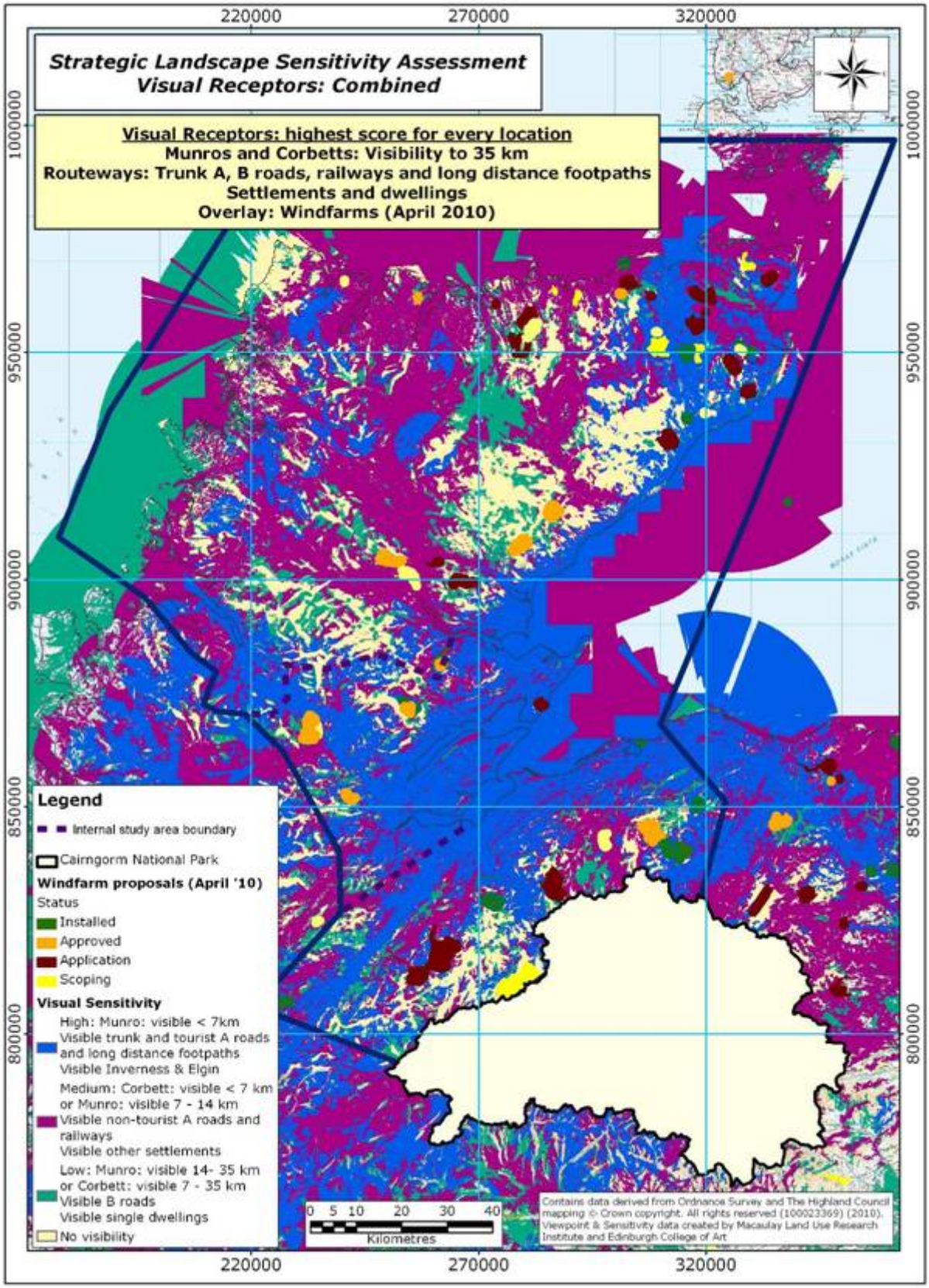

Figure 5.4 Combined visual receptors.
(Inputs: Visual receptors from Munros and Corbetts, Settlements, Routeways with the output the highest score from any one of the receptors).

6 CONCLUDING OBSERVATIONS

6.1 FINDINGS

6.1.1 The mapping of each of the types of visual receptor separately has provided a basis for interpreting visual sensitivity at a regional level, and to group sub-areas according to broad similarities. Importantly, the visual receptors show that some areas of low landscape character sensitivity have a high visual sensitivity. The interpretation of differences between areas with respect to visual and landscape character sensitivity enables areas to be identified for which specific planning guidance can be prepared. Such guidance should reflect factors of local significance, such as details of landscapes not captured within the LCA, the concentration or proximity of designations, and views from settlements, routeways or hotels.

6.1.2 Following from verification of the assessment of landscape character sensitivity the results can be combined with those for the visual sensitivity. Combining these two outputs will provide a basis for identifying the combined sensitivity of the landscape to windfarm development at a strategic level. Overlaying such outputs with other datasets (e.g. landscape designations, routeways, settlements) enables the identification of areas of search for wind turbine developments. However, the use of such overlays will not describe the effects which such developments may have on the setting of a designated area (e.g. the CNP, or an NSA).

6.1.3 The use of different visual receptors allows consideration of different scenarios of population and visitor activity, and the different types of landscape experiences they would have. Considering the distribution of existing or proposed wind turbines with respect to individual viewpoints, types of viewpoints, or in sequence along routeways, can support a regional interpretation of the potential cumulative impacts of wind turbines on landscapes.

6.1.4 The network of visual receptors can be refined further to link analysis of landscape character with cumulative visual impacts of wind turbine developments from the road network (i.e. what types of landscape character are visible from the stretches of road from which one or more windfarms are theoretically visible?).

6.1.5 Regional (i.e. across the study area) and specific route-based analysis (e.g. Durness to John O' Groats; routes through south-east Highland and Moray) have been overlaid on data of landscape character. This enables interpretation of the location and length of repeat views of a windfarm development, sequential views of windfarms with respect to landscape character and character sensitivity to windfarm development. Such analysis can be run for any specified route within the area and used to test the potential effects of scenarios of additional windfarms in an area. The findings can be expanded upon once THC and SNH complete verification of the findings of the baseline data on landscape character sensitivity to wind turbine development.

6.1.6 This study only considers visual landscape-related issues and sensitivity to wind turbine development. It was designed to provide a means of developing landscape-related guidance for inclusion in Supplementary Planning Guidance in compliance with SPP6, and now Consolidated Scottish Planning Policy (2010). The datasets developed can be compared with other strategic documents, such as the Scottish Natural Heritage locational guidance for wind turbines for broader interpretation of the relative importance of different factors of relevance to the planning of wind energy.

6.2 NEXT STEPS

6.2.1 As noted above, The Highland Council is undertaking a process of verification of results and conclusions of the analysis of field observations and derivations of landscape character and

visual sensitivity to wind turbine development. This is being done with Scottish Natural Heritage as part of the Council's development of its supplementary guidance, and the relevant materials will then be published for reference.

6.2.2 The database of observations will provide a baseline which can be used to further test the analysis, and updated as part of an exercise in monitoring impacts on landscapes. The network of field viewpoints could be expanded to include more points in the central area. Infilling the coverage would complete the interpretation of the LCA within that area and a more detailed assessment of landscape character and special qualities, previously considered by the CNPA.

6.2.3 The coverage could also be extended to include those areas outwith the study area, to the west and south-west of Highland, allowing the extension of the analysis of landscape character sensitivity and visual sensitivity across the entire area of THC. The analysis of some of the visual receptors (e.g. mountain summits and settlements) has been completed for the entire area by MLURI, therefore extension of the area could directly exploit the existing datasets and analysis undertaken.

6.2.4 The sets of visual receptors could also be expanded to cover a wider range of options (e.g. lower mountain peaks, receptors from offshore, such as ferry routes, cruise ship berths (e.g. Invergordon), and harbours, and views from inshore waters (e.g. Great Glen cruiser boats). Analysis of scenarios of additional windfarms could then also be included.

6.2.5 As noted in the Introduction, the subject of wildland could be revisited by: (i) using the wildland study undertaken by University of Leeds for the CNP, and the associated assessment of landscape qualities, (ii) use of the dataset being compiled by SNH for Scotland, or (iii) implementing the wildland mapping from the CNP across Highland, which would require considerable processing, but for which the data are largely already available.

6.2.6 Other factors identified in discussion with the Steering Group workshops included issues of recognition as well as visibility of wind turbines, including the colours and patterns of backdrops to views, illumination conditions and colour of turbines, and the extent to which turbines might be considered dominant, co-dominant or sub-dominant in the view. Combining the themes of scale, colour, backdrop and illumination, a more comprehensive set of guidelines could be developed for particular locations, areas or landscape character types. At this stage, the level of detail becomes one of site specific interest and no longer of overall strategic relevance.

6.2.7 Use of the observations and findings in this abridged report are for The Highland Council to determine how to take forward the findings presented in this abridged report, and in the background materials presented in the reporting materials provided to the Steering Group.

7 Report Status

7.1.1 Please note that the views expressed in this report are those of the project team and not necessarily those of the Steering Group partners of The Highland Council, Scottish Natural Heritage or the Cairngorms National Park Authority. The datasets, maps and findings have been reported to the Steering Group and are currently being verified by THC and SNH.

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APPENDICES

A.I List of Abbreviations Used

AGLV Areas of Great Landscape Value
CNP Cairngorms National Park
CNPA Cairngorms National Park Authority
DTM Digital Terrain Model
DSS Decision Support System
DST Decision Support Tool
ECA Edinburgh College of Art
EIA Environmental Impact Assessment
GIS Geographic Information System
GLVIA Guidelines for Landscape and Visual Impact Assessment
GPS Global Positioning System
HGDL Historic Gardens and Designed Landscapes
LCA Landscape Character Assessment
LCT Land Cover Type
LVIA Landscape and Visual Impact Assessment
MLURI Macaulay Land Use Research Institute
NSA National Scenic Area
PAN Planning Advice Note
SNH Scottish Natural Heritage
SPP Scottish Planning Policy
THC The Highland Council
VLT Virtual Landscape Theatre
ZTV Zone of Theoretical Visibility

A.II Glossary of Selected Terms

A.II.1 **Landform scale**
The relative magnitude and visible extent of landform, as measured by range in elevation, and viewshed area, derived from a digital terrain model.

A.II.2 **Landform complexity**
A measure of the degree of variability of topographic shape, derived from a combination of field observations and digital terrain data.

A.II.3 **Land cover complexity**
A measure of the degree of variation in land cover derived from analysis of the number of different land cover classes[2] visible at any given location.

A.II.4 **Landscape character sensitivity to wind turbine developments**

[2] (as defined in the Land Cover of Scotland 1988 dataset)

The degree of anticipated change in landscape character in response to a given type/magnitude of wind turbine developments, as derived from analysis of specific landform, land cover and other criteria[3]. (An area of high landscape character sensitivity will show a greater change in landscape character to a wind turbine development than one of low landscape character sensitivity, and vice versa. Landscape character sensitivity is independent of landscape value, hence an area may be of high landscape character sensitivity and low landscape value, and vice versa).

A.II.5 **Visual sensitivity to wind turbine developments**

A measure of the anticipated visual effect[4] in response to a given type/magnitude of wind turbine developments, as derived from analysis of specific visibility and viewer criteria. (An area of high visual sensitivity will show a greater change in appearance and visual amenity to a given wind turbine developments than one of low visual sensitivity, and vice versa. Visual sensitivity is independent of landscape value, hence an area may be of high visual sensitivity and low landscape value, and vice versa).

[3] The criteria used in this study are landform complexity, landform scale, land cover complexity, land cover naturalness

[4] Visual effect as defined in GLVIA. "Visual effects relate to the appearance (of these changes) and the resulting effect on visual amenity". (GLVIA Summary page – no page number)