Shrinking Wild Lands: Assessing Human Intrusion in the Highlands of Scotland, 1870 to 2004, Using Geographical Information Systems

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Abstract—Wild land in Scotland has been subject to steady attrition due to various types of development. This paper explores approaches that might be used to describe this attrition in Scotland, in order to promote more informed debate and assist policy development. Current digital map databases showing roads, bulldozed trails, plantation forest and hydropower schemes were backdated using historic maps, allowing these developments to be quantified in the Affric-Kintail-Knoydart area in the late 19th century, the 1950s and at the present time using Geographical Information Systems. Accessibility modeling and viewshed analysis are used to assess the influence of these developments on remoteness, and the extent of land free of such visible features, at these indicative time points. Land considered remote from roads or bulldozed trails has decreased over the last 100 years, although estimates are sensitive to the chosen analytical method. Land without visible trails, plantations and hydro schemes has also decreased by between 30 and 39 percent over this period. This provides quantitative support to the widespread perception that the Scottish wild land resource has experienced progressive incursion by hydro schemes, afforestation and road/track construction over the last 100 years.

Introduction

The uplands are highly valued hallmarks of Scotland, often combining spectacular landscapes with wildlife of high conservation importance, and providing a major focus for outdoor recreation. Against this general background, however, a number of areas are particularly remote and rugged, and have consequently experienced relatively little obvious human intervention. The distinctive aesthetic qualities of the Scottish hills are particularly strongly expressed in these areas, which are now widely referred to as 'wild land.'

The profile of wild land has gradually risen in recent decades because of several contributory factors. The total Scottish wild land resource has been subject to progressive attrition due to various types of development, including hydropower schemes, afforestation and the construction of bulldozed tracks. This trend has been paralleled by a steady growth in outdoor recreation and in turn, public awareness, with the emergence of active voluntary organizations that champion the importance of wild land.

Wild land is increasingly reflected in land use and planning policy in Scotland. National Planning Policy Guideline (NPPG) 14, published in 1999, highlights the value of wild land, indicating that local authority development plans should identify and protect such areas (Scottish Office 1999). In order to support this initiative, Scottish Natural Heritage (SNH) has recently produced a Policy Statement on Wildness in Scotland's Countryside (SNH 2002).

Similar trends have been recognized in other countries, and mapping generated by the Norwegian Directorate for Nature Management has demonstrated the decline in 'encroachment-free countryside' in Norway during the last century (Brun 1986). There is, however, a lack of quantitative data on historic changes in the Scottish wild land resource. This report describes a pilot study of the use of Geographical Information Systems (GIS) and historical map data to assess changes that are likely to have affected wild land in a selected area of the western Highlands over the last 100 years.

Wild land is widely thought to have experienced historic attrition associated with various types of development, including afforestation, water impoundment for hydropower generation and the construction of bulldozed tracks and ski facilities (Aitken and others 1992). Development trends have altered over time and while some of these influences have declined, others, such as the construction of telecommunications masts and wind farms, have recently risen to prominence. Wild land is likely to be very hard, and perhaps impossible, to re-create, and it is therefore important to consider the cumulative effect of these developments on this finite resource. The incremental nature of such changes also implies that their collective impact can only be assessed with a relatively long-term perspective.

A number of previous studies have sought to map wild areas at different spatial scales, both in Scotland and elsewhere in the world. Aitken (1977) used a number of techniques,

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including published maps and local knowledge, to identify wild and remote areas of the Scottish Highlands, while McCloskey and Spalding (1989) used basic GIS datasets on transportation and settlement derived from the Digital Chart of the World (DCW) to map wilderness areas at a global scale. Lesslie and Maslen (1995) used GIS to develop and map a wilderness continuum for Australia based on remoteness from settlement and mechanized access, absence of human artifacts and naturalness of the vegetation cover. The resulting maps have been used as the basis for the Australian Heritage Commission's (AHC) National Wilderness Inventory (NWI). Fritz and others (2000) used GIS-based multi-criteria evaluation (MCE) techniques and fuzzy-models to map public perception of wild land in Scotland at a local level within the Mar Lodge estate, and extended this methodology to a United Kingdom (UK) and European scale. Carver and others (2002) further developed the mapping of public perception of wild land by making GIS and relevant wild land datasets available on the web (see http://www.ccg.leeds.ac.uk/wild/). Finally, Sanderson and others (2002) have developed a 'global human footprint,' using recently available global datasets that map impacts on the natural environment from settlement, transport and agriculture. This analysis has been used to map the "last of the wild" where human influence is least pronounced.

Very few previous studies have attempted a quantitative assessment of historic trends in the extent of wild countryside. A notable exception is a study by the Norwegian Directorate for Nature Management (Brun 1986) that applied the simple methodology of tagging features on a GIS database according to their dates of origin, as a basis for retrospective mapping of 'encroachment-free countryside' at particular dates. Encroachment-free countryside was primarily defined on the basis of remoteness, as land more than 5 km (3 miles) from the nearest road, railway line or regulated water course. The total extent of such land in Norway is shown to have been greatly reduced over the past 100 years. In Scotland, Watson (1984) documented the expansion of bulldozed tracks in the Cairngorms area between 1960 and 1982. Within this study area, such developments collectively resulted in a 77 percent reduction in the extent of land more than 3.2 km (2 miles) from the nearest vehicular track or road.

The Scottish Natural Heritage commissioned this current study to explore approaches that might be used to assess the collective impacts of a wider range of developments on wild land throughout Scotland. This analysis was intended to stimulate more informed debate and assist policy development. The perception of wild land varies between individuals, reflecting a wide range of cultural and environmental factors, and is consequently very difficult to assess by hard quantitative measures. It is therefore important to note that this study merely investigates the cumulative effects of certain types of development on the extent of remote countryside, and on the visibility of features that are of obvious human origin. These attributes are commonly linked to the perception of wild land, but do not exclusively define such areas. These parameters are compared by similar methods at different time points, which should lead to valid estimates of their *relative* effect on the wild land resource before, during and after the 20th century.

Methods

The study was based on the subtraction of features from present-day GIS datasets by visual comparison with archived Ordnance Survey (OS) maps, to obtain directly comparable datasets corresponding to indicative dates of pre-1900 and the 1950s. These were used to compare the extent of remote areas, and land without visually obvious human developments, at these times and at the present day. The analysis focuses on roads and tracks, hydropower schemes (and associated overhead power lines) and plantation forestry. The effects of more recent developments such as telecommunication masts and wind farms have not been considered, owing to a lack of suitable datasets. All analyses were carried out using ArcGIS.

The pilot project was based on the Affric, Kintail and Knoydart area, which has been subject to a variety of land use and development during the 20th century. The study area was defined as the block of land bounded by the Kyle of Lochalsh–Loch Carron–Achnasheen–Muir of Ord–Cannich–Drumnadrochit–Fort William–Mallaig roads, with the mainland coast forming the western limit (fig. 1). The study area covers approximately 4,189 km^2 (1,617 square miles), including several large inland lochs (lakes).

A number of contemporary datasets provided the starting point for this analysis. Roads and tracks were derived from OS 1:50,000 vector data, OS 1:50,000 color raster data, and SNH data on private roads, which were also of OS origin.

a

Road
Railways
Track

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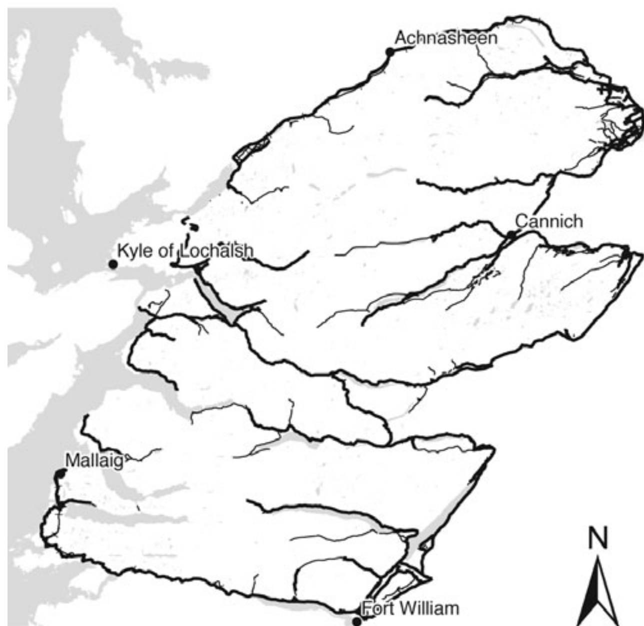


Figure 1—The study area: Affric, Kintail, and Knoydart areas, Scotland.

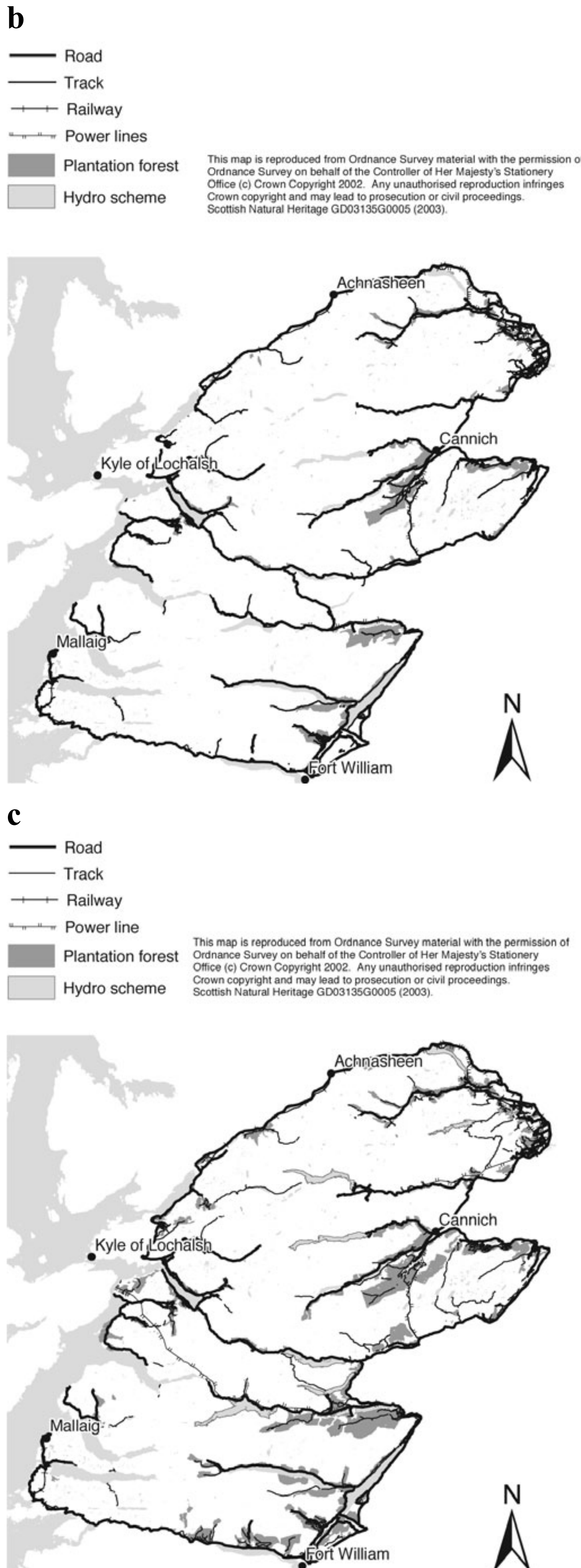


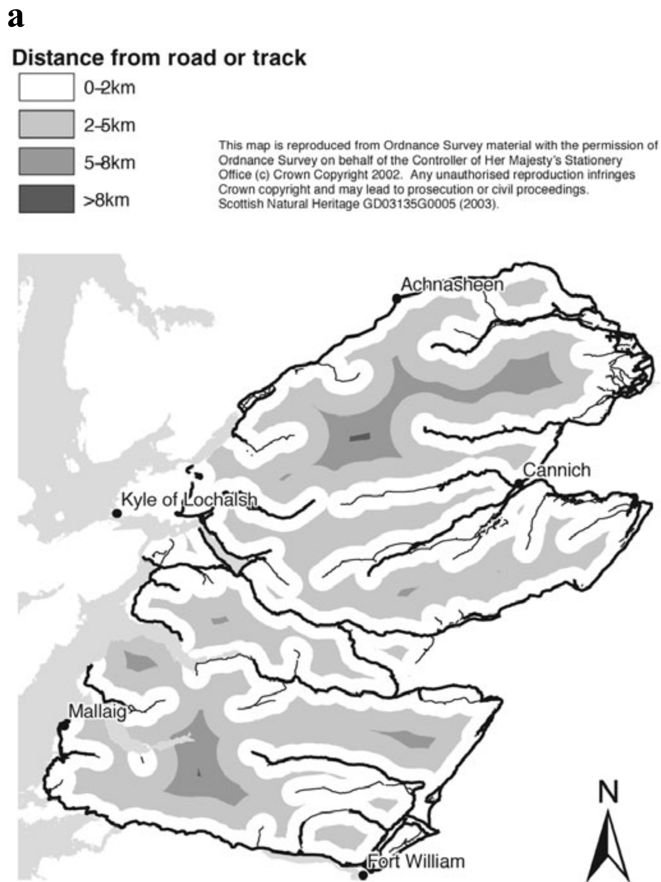
Figure 1—Continued.

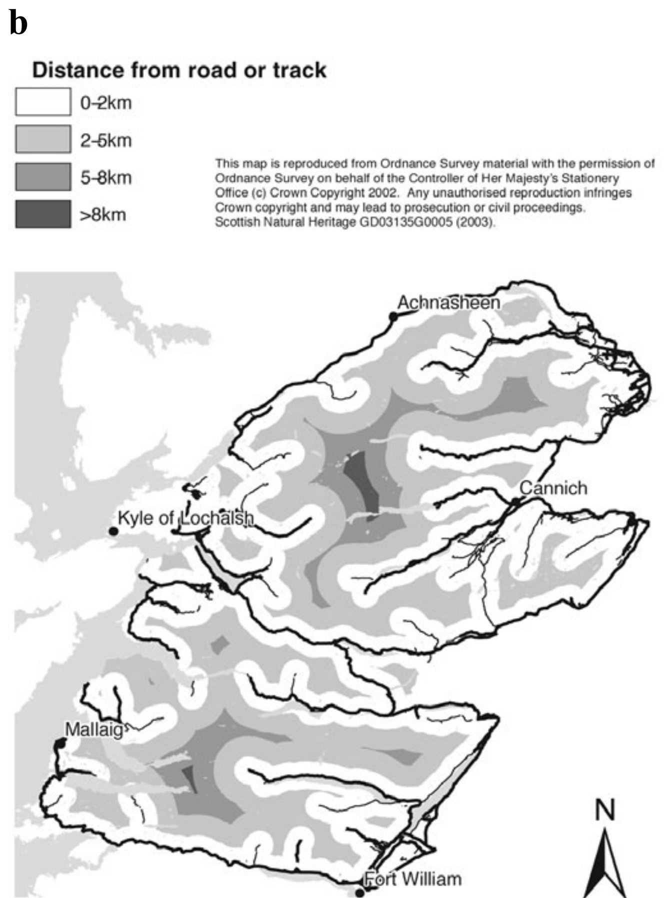
Lochs and conifer plantations were derived from SNH loch data of OS origin and the Caledonian Partnership Woodland Inventory (CPWI), respectively. The latter features were defined as the CPWI woodland categories with at least 80 percent planted trees. The indicative dates of pre-1900, 1950s and the present day were chosen to encompass a period of considerable social, economic and technological change in convenient 50-year intervals, and to reflect the availability of archived maps. Data corresponding to the pre-1900 and 1950s time points were derived from the above datasets by visual comparison with Victorian OS 1 inch to 1 mile (1:63,360 scale) maps dating from the 1870s to 1890s, and 1954 to 1955 OS 1 inch to 1 mile (1:63,360 scale) Seventh Series maps. The present day dataset was also refined by checking the original GIS data, where possible, against more recent maps, and some features known to exist as a result of very recent development were added by onscreen digitizing. Examples include the upgrading of some paths to bulldozed tracks where this was known to have occurred. There were no complete or readily available data for other types of development, but overhead power lines were readily identifiable from current mapping and were also therefore digitized and included in the analysis. Certain types of features sometimes disappeared from the map record over time, including roads or tracks that have fallen from use or that have been "drowned" by hydropower schemes. These features did not appear in the present-day GIS data and were therefore digitized onscreen, using the OS 1:50,000 color raster maps as a backdrop guide.

Individual features (line segments or polygons) in map layers corresponding to each type of development were individually tagged with a start and end date according to their occurrence at the three indicative time points. Maps showing the location of roads/tracks, railways, plantation forest, hydro schemes and overhead power lines at each of the three periods (pre-1900, 1950s and present-day) were then obtained by simple reselection from the date-tagged GIS data layers (fig. 1). These can be used to assess overall trends by simple visual comparison.

A key characteristic commonly associated with wild land is remoteness or inaccessibility (SNH 2002). Remoteness can be defined geographically as the distance from the nearest point of mechanized access and, more specifically, the time taken to walk into a roadless area (Carver and Fritz 1999). Three methods of mapping remoteness were used in conjunction with the date-tagged GIS data layers for roads and tracks, to assess the attrition of this key wild land value over the last 100 years and determine the feasibility of further analyses of this type. The methods used include simple buffer zones and a more complex accessibility model that may be described as 'anisotropic' (in other words, assuming variable direction and speed of movement). The simple buffering method assessed remoteness in terms of distance from the nearest point of mechanized access, and did not take terrain variables into account. The anisotropic accessibility model, by contrast, was based on an application of Naismith's Rule in conjunction with a detailed terrain model, to produce more realistic time/access surfaces that took account of barrier features, relative slope and typical walking speeds (Carver and Fritz 1999).

Simple linear buffer zones were drawn around the roads and tracks in the GIS database at 2-, 5-, and 8-km (1-, 3-, and 5-mile) distances for each of the three periods, using the





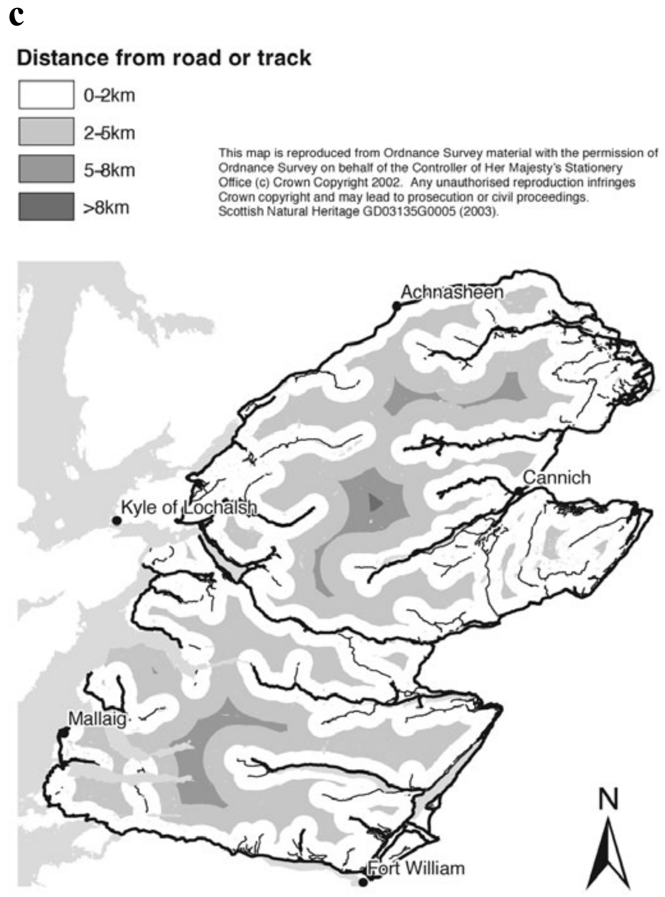


Figure 2—Study area buffer zones at 2, 5, and 8 km distances.

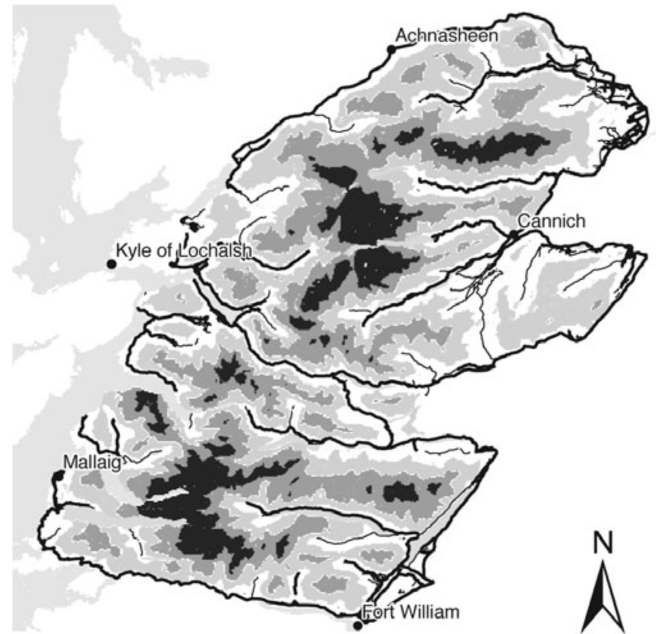
BUFFER command. The 2-, 5- and 8-km bands were chosen to mirror those used in the SNH Policy Statement on Wildness in Scotland's Countryside (2002). The simple buffering approach assumes equal ease of travel in all directions that is directly proportional to horizontal linear distance (fig. 2).

Anisotropic accessibility modeling was carried out using the PATHDISTANCE command to create a remoteness surface for each of the three periods that took impassable barriers (lochs and coastal waters) and terrain (relative slope and height gain) into account. The relative distance values generated by this procedure were expressed as time (seconds) to walk from the nearest point of mechanized access (road or track) (table 1; fig. 3). Unlike the buffer model, this method recognizes that the quickest route from one point to another is not usually a straight line, especially in areas of high relief and containing significant barrier features. The effect of terrain was modeled using Naismith's Walkers' Rule (1892) which is based on a walking speed of 5 $km.hr^{-1}$ (3 miles/hr) plus half an hour for every 300 m (984 ft) of ascent; and Langmuir's correction (1984), which subtracts 10 minutes for every 300 m descent for slopes between 5 and 12 degrees and adds 10 minutes for every 300 m descent for slopes greater than 12 degrees. These rules were incorporated into the PATHDISTANCE command using a 50-m (164-ft) resolution terrain model and the 'Table' option in the Vertical Relative Moving Angle (VRMA) field. The VRMA is the angle of slope (in degrees) between successive

Table 1—Naismith's Rule as expressed in the vertical relative moving angle (VRMA) field.

Vertical relative moving angle	Vertical factor
(degrees)	*(VF)*
–40	2.21
–30	1.83
–20	1.53
–12	0.69
–11	0.72
–10	0.75
–9	0.72
–8	0.8
–7	0.82
–6	0.85
–5	1.0
0	1.0
10	1.76
20	2.57
30	3.49
40	4.62

b



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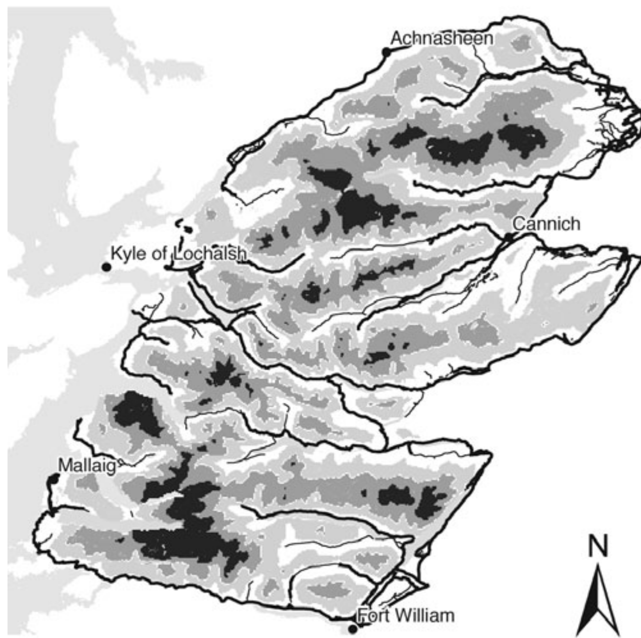

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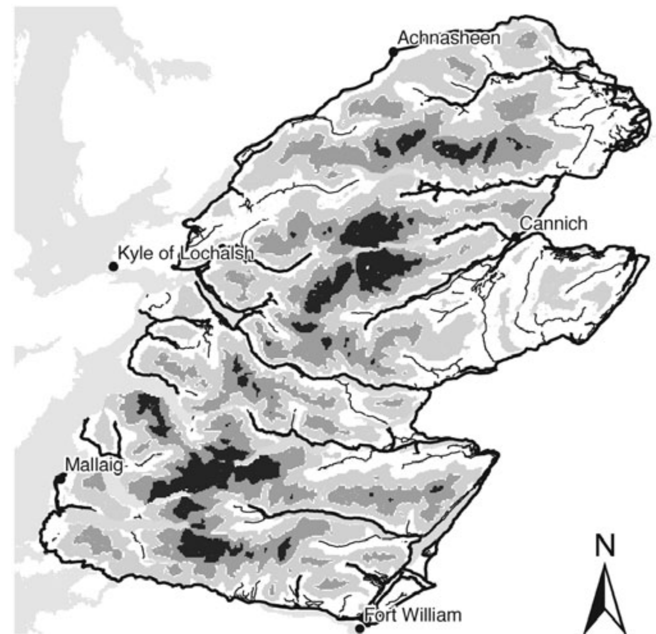
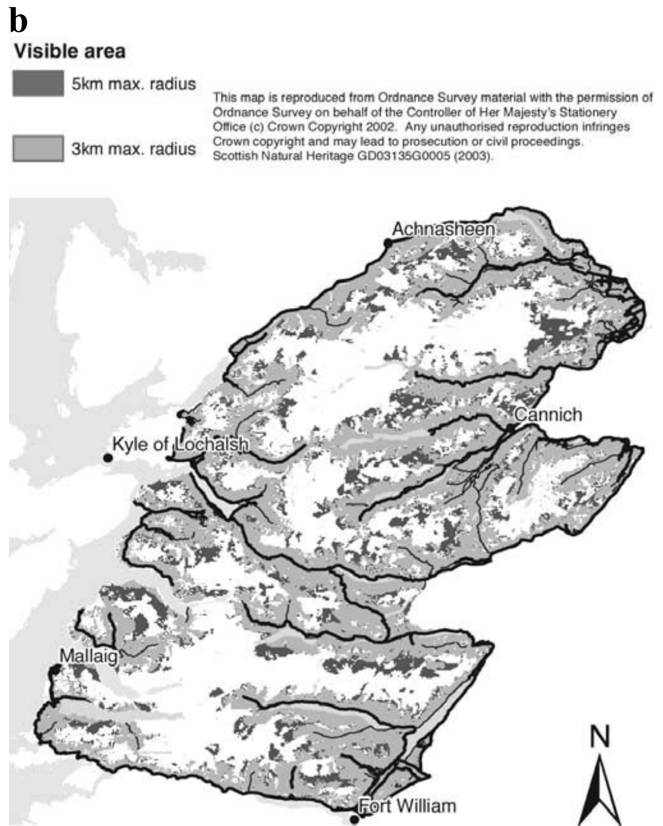
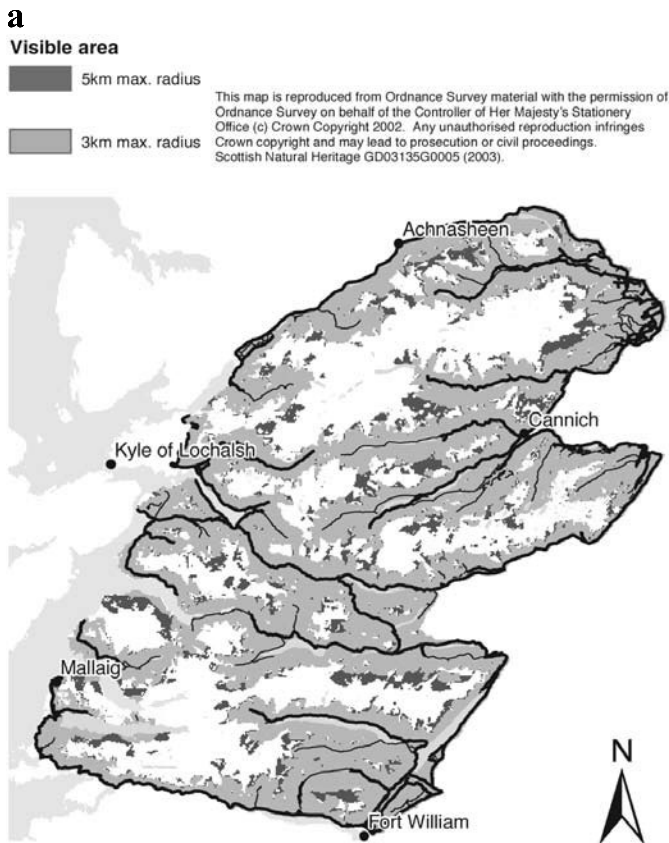


Figure 3—Anisotropic accessibility modeling.

points along a route and was translated into a correction factor (referred to as the 'vertical factor') to indicate relative walking time as shown in table 1. Barriers to travel on foot (coastal or inland waters and slopes in excess of 40 degrees) were included by incorporating these as 'no data' values in the cost surface (the GIS data layer which describes the relative walking time between different points), so that the time taken to negotiate such an obstacle is effectively based on walking around its edge. The surfaces generated were then reclassified into three bands similar to those used in the simple and advanced buffering methods, on the basis of the equivalent time taken to walk 2, 5 and 8 km on flat terrain (assuming 5 km.hr^{-1}).

The potential visibility of human developments can be estimated using a terrain model and the GIS to derive maps of the areas from which roads, tracks, railways, plantation forests, hydro schemes and associated overhead power lines can be seen (referred to as a "viewshed"). A variety of other features could also result in adverse visual impacts on wild landscapes, but the scope of this exercise was limited by the availability of suitable datasets, as noted above. The viewsheds of date-tagged features were calculated using the VISIBILITY command for each of the three periods (fig. 4). This model was applied using two alternative distance thresholds, assuming the maximum distance at which any feature has a noticeable impact to be either 3 or 5 km (2 or 3 miles). These values were chosen





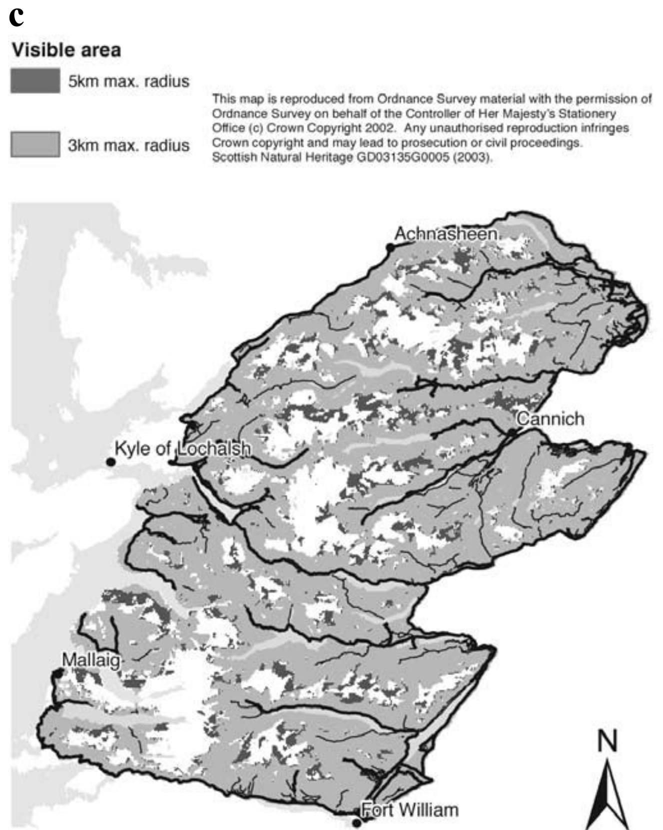


Figure 4—The viewsheds of two alternative distance thresholds.

for illustrative purposes and were judged to represent reasonably conservative, and hence robust, estimates of the distance from which such features would be visually prominent in the landscape of the study area. The 3-km threshold is roughly equivalent to the 2-mile buffer used by Watson (1984) to assess the visibility of bulldozed hill tracks in the Cairngorms. Input features were generalized to a 250 m (820 ft) resolution point dataset (each point representing the presence of a human feature every 250 m interval) and viewsheds were calculated using a 100 m (328 ft) resolution terrain model, assuming a viewing height (eye level) of 1.8 m (5.9 ft).

Changes in the visibility of these types of development can be assessed by comparing the output maps resulting from the above analyses (fig. 4). These changes were also quantified using map overlays to derive comparative statistics for successive time periods.

Results

Figure 1 indicates the extent and location of roads/tracks, hydro schemes and forestry plantations at the three indicative time points, based on the date-tagged GIS data. Comparison of the maps from each of the different periods suggests that a number of tracks which might have been present in the late 19th century have subsequently been lost through disuse, although this conclusion is complicated by the difficulty of interpreting the Victorian maps; this point is considered further below. This apparent trend has, however, been more than offset by increased construction of bulldozed tracks and, very locally, public roads, in the post-war period. Significant sections of new bulldozed track include the recent upgrading of 10 km (6 miles) of former path from Bendronaig Lodge, Attadale to Pait Lodge on Loch Monar, in the north of the study area. Many smaller sections of new track have been associated with plantation forestry in various parts of the area. New road developments between the 1950s and present-day periods include the A890 along the side of Lochcarron, at the northwestern edge of the area, and a new section of the A87 Fort William—Kyle of Lochalsh road, which was constructed to replace the old route after the development of the Loch Loyne dam and hydro scheme. Overall, the total length of roads in the study area (including the boundary roads) increased by only 3 km (2 miles) between pre-1900 and the 1950s, but by 28 km (17 miles) between the 1950s and the present-day, an overall increase of 31 km (19 miles) over the whole study period. For tracks, the total length increases by only 5 km (3 miles) between pre-1900 and the 1950s, and by 309 km (192 miles) between the 1950s and the present day, an overall increase of 314 km (195 miles) over the whole study period. These net figures mask the apparent losses due to disuse between pre-1900 and the 1950s.

A comparison of the 1950s and present-day data shows the expansion of plantation forest in the post-war period, particularly around Glen Garry and Loch Eil in the southeast of the study area. There is only limited evidence of scattered plantation forestry in the pre-1900 maps, and it was not possible to definitively distinguish semi-natural woodland from long established plantations on this basis. Plantations are therefore excluded from the pre-1900 map. The area of plantation forest in the 1950s was 156 km^2 (60 square miles) and this increased by 235 km^2 (91 square miles) between this date and the present-day, to a total of 391 km^2 (151 square miles).

A significant amount of hydro scheme development can be seen in the post-war period within the study area. Major developments at Loch Mullardoch and Loch Luichart, in the northern part of the area, are indicated on the 1950s maps. An additional six large hydro developments were completed in various parts of the area between the 1950s and the present day, at Lochs Quoich, Garry, Loyne, Cluanie and Monar and the Orrin Reservoir. One reservoir (Loch Beinn a'Mheadhoin) was excluded from this analysis as the level of this loch is maintained by transfer from other reservoirs and there is consequently no visible draw-down zone. In area terms, the 1950s water impoundments total 17 km^2 (7 square miles) and the further six schemes developed after the 1950s total 73 km^2 (28 square miles) an area increase of 56 km^2 (22 square miles). Some overhead power lines were also added to the distribution network in conjunction with these developments. The total length of these features in the 1950s maps is 108 km (67 miles), increasing to 167 km (104 miles) by the present day.

The analysis of remoteness indicators all suggest that the extent of remote land has generally decreased within the study area over the period from pre-1900 to the present day, due to a net increase in the extent of roads and tracks. This overall picture does however encompass much variation between individual methods, in different geographic areas and in different time periods. The results described below represent increasingly realistic estimates of remoteness as a result of applying more sophisticated models.

Table 2 provides a quantitative summary of historic trends using the simple buffering method, based on areas greater than 2, 5, and 8 km (1, 3, and 5 miles) from the nearest road or track (fig. 2). This analysis shows a net decrease in remoteness over the entire study period in the 2 to 5 and 5 to 8 km distance bands, although there is no net decrease in the >8 km category. These changes are reflected by a corresponding net increase in the extent of land that lies within 0 to 2 km of a road or track. Table 3 provides a quantitative summary of historic trends in the extent of remote land using the anisotropic distance measure (fig. 3). The accessibility surfaces and subsequent reclassification into walking-time equivalents of the 2, 5, and 8 km buffers used above demonstrate the strong effect of mountainous terrain on predicted remoteness. While the overall historic pattern is of reduced size of remote areas, this modeling approach results in the allocation of a greater proportion of the land area to the more remote distance bands, by comparison with simple buffering methods.

Results from the visibility analysis for all the features included in the date-tagged GIS data are shown in tables 4 and 5 and figure 4. The areas outside the viewsheds of one or more such features lack visible development of the types included in the study. The overall pattern is of increasing visibility of such features, with net change appearing relatively small between pre-1900 and the 1950s because of the apparent loss of 19th century tracks in some areas during this period. This apparent trend is considered further below.

Table 2—Areas greater than 2, 5, and 8 km from the nearest road/track based on simple buffering (km²). (Figures in brackets indicate percentage values with respect to the pre-1900 "baseline.")

	Pre-1900	1950s	Present-day	Change: pre-1900–1950s	Change: 1950s–present-day	Change: pre-1900–present-day
0–2km	2411 (100)	2361 (98)	2689 (112)	–50	+328	+278 (+12)
2–5km	1533 (100)	1505 (98)	1330 (87)	–28	–175	–203 (–13)
5–8km	242 (100)	297 (123)	168 (69)	+55	–129	–74 (–31)
>8km	3 (100)	26 (867)	3 (100)	+23	–23	0 (0)

Table 3—Equivalent walking-time areas greater than 2, 5, and 8 km equivalent on flat terrain from the nearest road/track based on anisotropic accessibility modeling (km²).

	Pre-1900	1950s	Present-day	Change: pre-1900–1950s	Change: 1950s–present-day	Change: pre-1900–present-day
0–2km	1314 (100)	1308 (100)	1573 (120)	–6	+265	+259 (+20)
2–5km	1443 (100)	1421 (98)	1362 (94)	–22	–54	–76 (–6)
5–8km	1015 (100)	968 (95)	840 (83)	–47	–128	–175 (–17)
>8km	293 (100)	357 (122)	237 (81)	+64	–120	–56 (–19)

Note: Figures in brackets indicate percentage values with respect to the pre-1900 "baseline." These area figures exclude lochs, which are included in the analysis as barrier features and therefore as "no data" values. The pre-1900, 1950s, and present day columns do not therefore add up to a consistent total area, as the overall loch area has increased due to impoundment.

Table 4—Trend in area with visible human features (km²).

Maximum view distance (km)	Pre-1900	1950s	Present-day	Change: pre-1900–1950s	Change: 1950s–present-day	Change: pre-1900–present-day
3	2069 (100)	2072 (100)	2705 (131)	+3	+633	+636 (+31)
5	2517 (100)	2529 (101)	3166 (126)	+12	+637	+649 (+26)

Table 5—Trend in area without visible human features (km²).

Maximum view distance (km)	Pre-1900	1950s	Present-day	Change: pre-1900–1950s	Change: 1950s–present-day	Change: pre-1900–present-day
3	2120 (100)	2117 (100)	1484 (70)	–3	–633	–636 (–30)
5	1672 (100)	1660 (99)	1023 (61)	–12	–637	–649 (–39)

Discussion

Subject to technical limitations, the maps of different classes of development at the three indicative time periods (fig. 1) have a clear, objective foundation. The maps of remoteness and visibility embody a number of assumptions that are more open to alternative interpretation. These assumptions have therefore been kept relatively simple in order to maximize the robustness and transparency of the analysis.

The simple buffering approach leads to contrasting estimates of the extent of remote land, which are most noticeable in the >8 km distance bands (table 1). These differences are primarily attributable to the inability of simple buffering to adequately represent the true remoteness, in practical terms, of much land in Morar and Knoydart, in the southeast of the study area. The coastline hereabouts is indented by long fjord-like sea lochs, and the effective remoteness of much land is greater than would be suggested by simple assessments based on linear distance from access points.

The second approach to the assessment of remoteness was, by contrast, based on modeling of walking times in conjunction with terrain, with reclassification of the resulting data into notional distance bands that reflected equivalent walking times on level ground. The benefits of this more sophisticated approach do not necessarily outweigh the simplicity and transparency of the advanced buffering method, although omission of the final reclassification step would perhaps make the output easier to interpret. This method was only applied to land beyond the extent of vehicular tracks, allowing a more direct comparison with the simple and advanced buffering approaches. This method could, however, be applied to all land beyond the roadside access points commonly used by hill walkers, thus including the effects of the tracks themselves on approach walks through the glens concerned. This type of analysis would reflect actual patterns of use,

and the impact of such tracks on remoteness as perceived by recreational users, and could strengthen the case for modeling approaches based on walking time rather than distance. It is perhaps worth noting that both the advanced and anisotropic approaches assumed that lochs present an impassable barrier. This assumption is not universally true, as kayaks or other boats are occasionally used to approach the more remote hills, but the number of recreational users involved is thought to be very small.

The analysis of the visibility of human features included plantation forestry and water impoundment in addition to vehicular tracks. This analysis did however exclude certain types of development and land management activities that can have significant visual effects on land of otherwise wild character. These include isolated buildings, telecommunications masts, deer fences, aquaculture, smaller scale hydro schemes and the effects of grazing, drainage and muirburn, all of which occur to varying extents within the study area. The resulting assessments are therefore likely to significantly underestimate the extent of visible human features at the present day.

The lower 3-km distance threshold adopted for this analysis is comparable to the 2-mile threshold used by Watson (1984) in his study of the impact of hill tracks in the Cairngorms. This value, and the higher 5-km (3-mile) threshold, are nonetheless relatively conservative with respect to certain types of development, and some features, such as strongly linear tracks, angular conifer plantations or reflective pipework associated with hydro schemes, can be highly visible from much greater distances. This consideration would also suggest that the increase in the visibility of human development is, if anything, underestimated by this analysis.

Conclusions

The results of this pilot study provide quantitative support to the widespread perception that the Scottish wild land resource has been eroded over the last 100 years due to incursion by hydro schemes, afforestation and road/track construction. With the exception of the unrepresentative analysis based on simple buffering, these results suggest that the extent of remote land within the study area has decreased over the last century, with an overall reduction of 30 percent in the area of land more than 5 km (3 miles) from a road or track, by the nearest practicable route. The extent of land without visible development of any of the above types has also decreased by between 636 km^2 (246 square miles) (30 percent) and 649 km^2 (251 square miles) (39 percent) over this period, depending on the distance thresholds applied. The scale of change has been much greater during the latter half of the 20th century.

The parameters included in this analysis do not define wild land when considered in isolation, and this quality also depends on a number of other physical attributes, such as terrain and vegetation, and perceptual responses, including a sense of solitude or physical challenge. There is, however, widespread agreement that these parameters are closely associated with wild land (Aitken and others 1992; NTS 2002; SNH 2002), and much land in Affric, Kintail and Knoydart is highlighted as a search area for wild land in the SNH Policy Statement of 2002. Numerous mountaineering guidebooks also highlight the presence of these qualities in this part of the western Highlands, and particularly in Knoydart and adjoining areas (for example, Bennet 1983; Murray 1987). The development trends considered in this report have therefore almost certainly influenced the extent and quality of important wild land areas.

Taken at face value, these results suggest that the overall increase in vehicular tracks could conceal complex local trends, and that some former tracks may have contracted or disappeared during the early 20th century. This may well be the case in some areas, where former tracks could have been linked to pre-Clearance settlements, reflecting the complex land use history and cultural heritage of many areas which are now valued for their wild character. In practice, however, some apparent Victorian tracks may be map interpretation artifacts resulting from the difficulties noted above.

The overall trends in development identified in this study area highlight certain differences with respect to other parts of the Scottish uplands. Some new tracks within this area have been associated with sporting estates, but most of these developments have been linked to new forestry schemes. This situation contrasts with the position in the Cairngorms, where a considerably greater increase in new tracks occurred during the 1960s, 70s and 80s alone (Watson 1984). The construction of new tracks in the latter area was much more strongly associated with stalking and grouse shooting, although a small proportion was linked to other built development, or to forestry. The historic increase in water impoundment within the present study area is, by contrast, likely to represent the upper end of the range of variation within Scotland, as few other upland areas have experienced such concentrated large scale hydro development during the 20th century. The extent of afforestation in this area is relatively modest by comparison with other parts of the Highlands, such as Argyll, and the Southern Uplands. In broad terms, the combined net impact of human developments within this area is therefore likely to reflect wider trends affecting wild land throughout Scotland.

The many large hydro schemes within this area represent a legacy of earlier development trends that have now almost ceased. A range of present day developments continues, however, to exert pressures on wild land. Most recent hydro development has been relatively small scale in nature, but such schemes can nonetheless result in significant detrimental effects on the wild qualities of such areas. The construction of vehicular tracks continues sporadically, and new tracks have recently appeared in the Monar-Pait area. Vehicle tracks are not always deliberately constructed, and have developed in some areas due to repeated use of all-terrain vehicles. The balance of new afforestation has shifted to new native woodland schemes across much of upland Scotland, but the associated deer fencing and ground preparation sometimes creates new and highly visible features on the short-medium term. Relatively recent innovations such as aquaculture development, telecommunications masts and wind farms could also contribute to the attrition of wild land if sited inappropriately. This study highlights the cumulative erosion of wild land over a long period of time, emphasizing the need to safeguard this resource from a wide range of incremental development.

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