THE FINDHORN DUNES

LICHEN SURVEY

June 2008

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Report for the Findhorn Dunes Trust

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LICHEN SURVEY

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The photo on the front cover shows a species-rich and luxuriant development of lichens in Plot 11: the slender, soft mouse-grey podetia (stalks) are *Cladonia subulata*; the more gingery-brown podetia are *Cladonia gracilis*.

The Findhorn Dunes

VC 95 Morayshire

LICHEN SURVEY

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1. Introduction

1.1 The survey

The lichen survey was initiated and promoted by Davina Thomas on behalf of the Findhorn Dunes Trust, and was part funded by Scottish Natural Heritage and the Moray Firth Partnership (www.morayfirth-partnership.org). A visit of three days (1st, 2nd and 4th June, 2008) was made by Brian and Sandy Coppins to look at the lichens on the Findhorn Dunes. Local lichenologist Heather Paul joined us on 2nd June, and Chris Ellis and Rebecca Yahr (two lichenologists from the Royal Botanic Garden, Edinburgh) and their baby son, Simon, joined us on 4th June.

1.2 Results

The Findhorn Dunes Trust land is a very special place. It is now firmly established as a site of **National Importance for lichens**. The total taxa recorded is 145, of which 130 are lichens, and 15 lichenicolous fungi (fungi that are parasitic or commensalistic on lichens). There are 38 lichens recorded from pebbles (plus 2 on cinders), and 62 recorded as growing directly on sandy soils. Thirty-seven lichens were recorded from *Calluna* (heather) and/or pines. There are 5 Nationally rare and 18 Nationally scarce lichens (this includes 1 species listed as Endangered, 1 species listed as Vulnerable, 1 species listed as Near Threatened, and 2 species listed as Data Deficient, as per Woods & Coppins, 2003). See **Table 1 for details of notable species**.

The sum of the lichen data includes that which was gathered over the three days (June 2008), plus records made from a brief visit made by Brian and Sandy Coppins in August 2006, lichens recorded from the northern and western edges by Bryan Edwards and Joe Hope from a brief visit in May 2004

1.3 Background

Davina Thomas (a local resident, familiar with the Findhorn Dunes and involved in the Findhorn Dunes Trust), collected some lichens, and sent them to Dr Brian Coppins at the Royal Botanic Garden, Edinburgh. One of the lichens was *Arctoparmelia incurva*, a lichen not previously recorded from shingle pebbles, more often associated with siliceous rocks in upland Britain. This prompted a visit to Findhorn by both Brian and Sandy Coppins in 2006, and we were amazed at the extent and unspoilt nature of the site, and the extraordinary richness and diversity of the lichen communities. It was on the strength of this 2006 visit that Davina set in motion the possibility of commissioning a more detailed lichen survey.

Arctoparmelia incurva on a pebble at Plot 6. The delicate, pale creamy-yellow lobes are slightly incurved (as the name suggests), and hug the stone surface like tiny fingers. This lichen is very local at the Findhorn Dunes, and is known from upland Britain and Europe.

1.4 Findhorn, a "Cinderella" site?

On the west side of Findhorn Bay, the lichen importance of the Culbin Sands, Culbin Forest and Findhorn Bay SSSI is well known, with lichens included as a notified feature of the SSSI (Edwards, 2004). Culbin has received many visits by lichenologists, and is well recorded. It was assessed by British Lichen Society in a review of terricolous lichen sites (Fletcher *et al*, 1984) and is listed as Grade 1, of International Importance. By contrast, on the east side of Findhorn Bay, the area of the Findhorn Dunes appears to have escaped all forms of recognition. It is overlooked as being an integral part of the evolving coastal geomorphology along the north Moray coast (e.g. not mentioned in Sneddon & Randall, 1993 review *Coastal vegetated structures of Great Britain*, JNCC). This is remarkable, as unlike Culbin or the Kingston Shingle (Spey Bay SSSI), Findhorn has mostly escaped afforestation so retains features of dynamic coastal dune and shingle processes. Gilbert (2000) in his New Naturalist *Lichens*, has a nice section on lichens of coastal habitats, and cites two examples for Scotland: Culbin and Cuthill Links (by the Dornoch Firth). Lambley & Hodgetts (2001) in their overview of lichens and bryophytes of British coastal shingle, report on the lichens of the Kingston Shingle near Speymouth, then skip Findhorn and devote some detail on Culbin (drawing extensively on Fryday *et al*. 1996), before briefly discussing Cuthill Links and Ferry Links.

1.5 Should Findhorn be declared a SSSI?

The lichen survey in 2008 has filled in the picture and Findhorn can now be seen to be a nationally important site for the lichen assemblages. The site certainly "qualifies" to be considered as a SSSI under the guidelines set out in Hodgetts 1992: *Guidelines for selection of biological SSSIs: non-vascular plants* (JNCC). In Scotland, the threshold for a site to be considered as qualifying as a SSSI on the strength of the lichens present is to achieve a score of 300. Any Nationally rare (NR) species scores 50 points; any Nationally scarce (NS) species scores 30 points. At Findhorn, there are 5 NR species (5 × 50 = 250) and 18 NS species (18 × 30 = 540). Therefore, the total score for Findhorn is 790. Other criteria lend weight to supporting the need to consider a site as qualifying as a SSSI, such as "All Red Data Book species' localities should be regarded as candidate sites." The Red Data Book (RDB) species at Findhorn that fall into this category are *Cladonia uncialis* subsp. *uncialis* (RDB Vulnerable) and *Peltigera malacea* (RDB Endangered). There are significant populations of both these species at Findhorn, but there are also significant populations at Culbin. As Culbin is within SNH's 'Area of Search', and is already a SSSI where similar lichen habitats, communities and species are a notified feature, then it is unlikely that the presence of *C. uncialis* subsp. *uncialis* and *P. malacea* would add greatly to the strength of the case to promote SSSI status at Findhorn.

However, if a good case could be made to notify Findhorn on geomorphological grounds, then the lichen communities would add weight as an additional supporting feature demonstrating the biological importance of the site to the Scottish nation. SNH are now aware of the significant lichen interest at Findhorn, and have the data to back up this assessment. If Findhorn Dunes came under threat – say from application to develop the site for housing, golf course, or some such – then the fact that it was not a SSSI would weaken the case to oppose development applications. However, as the Dunes are in sympathetic ownership (The Findhorn Dunes Trust), development that would cause loss of habitat would seem to be unlikely – but not impossible. So, seeking to have the mantle of SSSI protection is always advisable and desirable.

Peltigera malacea, damp green lobes nestling in amongst mosses.

Table 1: Notable lichen species recorded from Findhorn Dunes

T = terricolous (growing on sand); Pe = pebbles; P = Pines; Cl = *Calluna*; NR = Nationally rare; NS = Nationally scarce; Cons. Eval. = Conservation evaluation (Woods & Coppins 2003); DD = Data Deficient; NT = Near Threatened; VU = Vulnerable; EN = Endangered.

Species name	**2006 etc.**	**2008**	**T/Pe/ P/Cl**	**frequency at the site**	**NR/NS**	**Cons. Eval.**
Alectoria sarmentosa subsp. *vexillifera*	2006	2008	T	locally occasional	NS	
Buellia jugorum	2006	–	Pe	rare	NR	DD
Caloplaca asserigena	2006	2008	thin twigs	local	NS	
Catillaria atomarioides		2008	Pe	occasional	NS	
Cladonia macrophylla		2008	T	rare	NS	
Cladonia mitis	2006	2008	T	occasional/ frequent	NR	NT
Cladonia uncialis subsp. *uncialis*	2006	2008	T	rare/ occasional	NS	VU
Cladonia zopfii	2004 2006	2008	T	locally abundant	NS	
Lecanora farinaria		2008	P	rare	NS	
Lecidea auriculata	2006	2008	Pe	rare	NS	
Lecidea brachyspora		2008	Pe	rare	NS	
Lecidea diducens		2008	Pe	rare	NS	
Lecidea plana	2006	2008	Pe	rare/occasional	NS	
Lepraria elobata		2008	T	rare	NS	
Leptogium palmatum		2008	T	rare	NS	
Ochrolechia frigida f. *lapuensis*		2008	T	rare	NR	
Peltigera malacea	2004 2006	2008	T	occasional/locally frequent	NR	EN
Protothelenella corrosa		2008	Pe	rare/occasional	NS	
Psoroma hypnorum	1970 2004	2008	T	rare, local	NS	
Rhizocarpon cinereovirens	2006	–	Pe	rare	NR	DD
Stereocaulon condensatum	2004 2006	2008	T	occasional/ frequent	NS	
Stereocaulon leucophaeopsis		2008	cinders	rare	NS	
Epilichen scabrosus (on *Baeomyces rufus*)		2008	lichen-icolous	rare	NS	

2. The Findhorn Dunes as a lichen habitat

2.1 The biological soil crust

The main area of dunes, shingle ridges and flats (about 100 ha) is in the care of the Findhorn Dunes Trust. In many respects the dunes present an exposed, extreme habitat, and may appear bleak and inhospitable, especially on well-used paths and tracks, where dry sand and loose pebbles seem totally devoid of life. But, aside from the paths, the surface of the sand amongst the pebbles usually has a slight 'skin,' a biological crust invisible to the naked eye, except sometimes you can detect a greyish hue present on untrampled areas, contrasting with the stark whitish-yellow of the disturbed, loose sand. This crust is sometimes detectable if you press your finger onto the sand surface, and feel a slight 'crunch' as your finger breaks through the crust and makes an indentation on the surface, and you can see that some sand grains actually hold together. This biological crust is composed of microscopic filaments and cells of algae, cyanobacteria ('blue-green' algae), moss protonema, fungal hyphae, fungal spores (some of which may develop into lichens) and they act to bind the loose sand grains together. The presence of mosses and lichens growing directly on sand is just a further development stage of the soil crust (see Habitat 2), and at Findhorn there are remarkable lichen communities on both sand and shingle.

Cladonia diversa, sometimes called Lipstick lichen because it produces these bright red fruiting bodies around the rim of the cup. These were photographed at Plot 11.

2.2 Disturbance or stability?
However, it is obvious from looking at the tracks and paths through the dunes that with regular disturbance, the fragile soil crust is broken, and sand becomes mobile, and there is a loss of the special biological communities associated with undisturbed areas.

And yet, the story is not so simple, because without some forms of disturbance the dune habitat would evolve into grassland or scrub and eventually, woodland. It is the degree and nature of the disturbance that ensures that the special lichen communities associated with dune and shingle habitats are able to persist and flourish. In 'natural' conditions, dune systems are dynamic, with various stages in the succession present, with interruptions in the succession by occasional major storm events, which sets the system back to start again. As the Danish lichen ecologist Steen Christensen says "lichens are indicators of the stability of the instability" (Christensen 1997).

2.2.1 Shingle
Lichens require some stability of habitat in order to colonise sand and shingle. For lichens to colonize a pebble, the pebble must be lying undisturbed for some time – how long is not known, but may be several years. A lichen propagule landing on the smooth surface of the pebble has to remain there for sufficient time in order to get a 'fix', so if it lands in windy weather, it might get blown away, and in rain it will get washed away. If conditions are dry, but with bright, baking sunshine, then the propagule may die. There are tiny invertebrates which browse on lichens, so the propagule may just get eaten. So, the 'window of opportunity' can be limited. For common species, there will be many propagules available, but for rare species, the opportunities are a lot more chancy. This is why when rare species are present, it is interpreted that the habitat has been stable and undisturbed for a long while, and is a mature or even ancient habitat.

Once the lichen has established and started to grow, all would be well, except if the pebble is disturbed by someone walking over the shingle. If the pebble gets turned over, then the underside of the pebble becomes the upper side, devoid of lichens, a fresh surface awaiting the chancy lichen propagule to land. The already-established lichen (now on the underside of the pebble), may linger on for a while in the dark conditions, but will eventually die out. So, seeing the well developed lichens encrusting the shingle at some parts of the Findhorn Dunes, you know that that area has remained undisturbed for many years.

At Findhorn there are other reasons why shingle stones may appear bare; at Plot 7 (Habitat 6), some parts of the stony shingle fields are encrusted with a 'carpet' of foliose (leafy-lobed) lichens. Foliose lichens tend to fracture and crack, and bits break off and blow away, leaving a bare surface behind. So, looking at Fig. 6.4, the grey carpet of *Parmelia saxatilis* can be clearly seen, but also there are several mostly white quartzite pebbles lying around, with no lichen cover, not even the usual grey crustose patches seen in other areas. It is believed that these pebbles have recently lost their foliose lichen cover. Perhaps in a year or two, they will have been re-colonized, and in the meantime, older bits of lichen on other pebbles will have disintegrated and left different pebbles exposed.

Lichens are often quoted as being very slow-growing organisms, and this can be true of lichens which grow on stones or rocks (saxicolous species), especially lichens that form crusts which adhere close to the rock surface, sometimes appearing no more than just coloured stains on the rock surface. The average growth rate has been given as between 0.5–2.5 mm yr^{-1} for crustose lichens (Hale, 1983). So, if you found a pebble, with a circular crustose lichen that measured 2.0 cm diameter, then (depending on the species) you could calculate the age of the lichen, by taking the radius measurement (1.0 cm), and making the following calculation: 1.0 ÷ 0.05 (20 years) or 1.0 ÷ 0.25 = (4 years) old.

Porpidia cinereoatra gradually spreading over the surface of this pebble. This lichen forms a crust or skin over the stone; this is the main part of the lichen, or the 'thallus' and here it is composed of grey-white areoles like minute crazy-paving. The black dots are the fruiting bodies, called apothecia. This lichen is one of the slow growing species, so this pebble must have sat here, undisturbed on the sand for many years.

2.2.2 Rabbits and localised disturbance value

The presence of rabbits is generally seen as beneficial to the health of the dune and shingle habitat, as rabbits browse down palatable plants, so reduce the rate that the plants spread and establish. Lichens are poor competitors, so lose out to more robust plants by being shaded out, so rabbits reduce competition from plants and thereby give lichens a greater opportunity to thrive. Rabbits also make little scrapes in the sand, sometimes also scuffing up clumps of lichens. It is known that some lichens such as the shrubby 'reindeer' lichens of *Cladonia arbuscula* and *C. portentosa*, reproduce by fragmentation, so the small scale disturbance caused by rabbits actually helps lichens. The scrapes expose small pockets of bare sand; these areas then slowly

begin to develop the rudiments of a biological crust, then early colonising lichens become established, sometimes followed by later-stage lichens. Sometimes, small scrapes act as seed beds for plants such as gorse, *Calluna*, grasses or other flowering plants. Depending on palatability and degree of rabbit population, these seedling plants may thrive and get established, or they may by nibbled off, leaving the way clear for rudimentary lichen development. In nearly every photograph of lichens for this report (especially lichens growing directly on sand or in amongst heather), rabbit droppings can be seen somewhere in the picture, giving an indication of the influence and importance of rabbits to the habitat functioning. Ants also play a part in minor disturbances, making holes with little sand 'volcanoes', so creating new surfaces ready for the process of biological crust-forming to start again.

An example of evidence of rabbits in the habitat – rabbit droppings scattered over the surface, amongst heathers and the lichens *Cladonia furcata* (brownish-pink spiky clump) and *Cladonia mitis* (loose, floppy whitish-branched clump).

2.2.3 Major disturbance events

Other forms of disturbance such as major storms which shift sand around so that it covers up vegetated areas, tend to occur only once in a while, and everything is set back to the beginning. As long as there is sufficient period of stability after the disturbance event, then slowly biological crusts will form, and the whole sequence of development will start again. There are examples of where shingle and dunes were heavily disturbed, such as Braunton Burrows in North Devon, which was used extensively as a training ground for the Allied forces in preparation for the D-Day landings. Subsequently, this site became a nature reserve, and was notable for the development of the lichen heaths. But these heaths gradually began disappearing as

scrub invaded – the answer to the wonderful development of heathland recovering after the devastation of a major military training ground with thousands of troops and vehicles was seen as preserving these habitats from disturbance. So now, management is considering using disturbance, but how much? What sort? Which parts of the site? It is one thing to have disturbance imposed on a site from an outside influence, but if you are responsible for site management and preserving features of value, to decide which bits should be disturbed is a brave and difficult decision.

2.3 The situation at Findhorn

We are not aware of the recent history (i.e. last 50–80 years) of the Findhorn Dunes, so speculation about the age of the habitats is difficult. Were there periods when the area was under degrees of disturbance, such as was experienced at Braunton Burrows, with military activity during the period of the Second World War? Are what we are seeing today at Findhorn, a stage of development of recovery dating from fragmentation and disturbance that occurred 60 years ago? Or are these lichen assemblages really older? Undoubtedly, the lichen communities colonising on sand and shingle contain species normally found in extreme habitats, such as bleak, mountain tops, exposed windswept ridges and cliffs, or arid dunes at sea-level. So, they would have been present in early Holocene at the retreat of the ice, with exposed gravels, scoured bedrock and moraines, and these lichens at Findhorn today are descendents of that ancient habitat.

2.3.1 The Culbin example

We know from the evidence at Culbin, that in the 1930s, major afforestation took place in order to "stabilize" the dune system, but in some areas, due to failure or very stunted growth of pines, there are now luxuriant developments of lichens. There is no record of what lichens were present at Culbin before afforestation, or at what stage the present communities started to develop to the extent that they first attracted attention. It is assumed that there were lichen communities present before afforestation, and that at that time, parts of Culbin resembled Findhorn. Since the 'disturbance' of the planting period, these communities have taken advantage of the 'stability' to expand and develop. From the Site Condition Monitoring report (Edwards 2004) for lichens at Culbin, there is some evidence that a slight but gradual increase in the pine growth may be adversely affecting the lichen abundance and diversity. However, Forestry Commission have initiated experimental management at four plots at Culbin, to test the effects on the lichens of different silvicultural thinning, i.e. different forms of disturbance.

2.3.2 Attempting to assess the future at Findhorn Dunes

From the results of the 3-day lichen survey at Findhorn, we have identified a number of habitats on the shingles and dunes where lichen assemblages are present, and sometimes dominant. Some of these habitats are associated with windswept, open and exposed areas, but usually there is a component of *Calluna* within the association. Other habitats have a degree of shelter from gorse, clumps of pine as well as *Calluna*. The question to ask is 'what will these habitats look like in 50 years time?' Will gorse have continued to expand across the site, gradually eliminating lichen-rich open areas? Will pines have increased to the extent that they have engulfed the classic open shingle and dune habitats? Will the *Calluna* still be present? Will the rabbit population have declined, or will there have been population explosions? And

trampling and disturbance from people visiting the site – will there be such an increase in levels of visitor disturbance that all the biological crusts will be wiped out?

Dunes and shingle ridges tend to inhibit colonisation by plants because there is very little nutrient available, and water tends to drain away rapidly, creating an arid habitat. However, as discussed above, without disturbance there is a slow but gradual natural succession towards build up of humus from accumulating plant fragments, and plants get established and increase. As we have discovered at Findhorn, gorse does have a role to play in providing additional habitats for lichens to take advantage of (see Habitats 3A & 3B). A small stand of self-seeded pine also provides an additional sheltered habitat niche that supported slightly different lichen assemblages than were found elsewhere (although all species were present at other habitats, but not quite in the same concentrated quantities) (see Habitat 5). *Calluna* (heather) is a fairly constant presence throughout, although it occurs in varying stand densities and growth forms. It therefore plays an important role at the site for the interactions with lichens.

2.3.3 Calluna *(heather)*

The presence of *Calluna* (heather) in places adds to the overall diversity, although rarely is *Calluna* well-developed; it achieves a robust dwarf form (often browsed by rabbits), but most frequently it is found as scattered, isolated low shrubs, of a low, mound form, resulting from a combination of wind, scouring sand and rabbit browsing. In extreme cases, *Calluna* is reduced to a prostrate, stretched form, hugging the ground over exposed shingle flats, the habitat resembling montane fell-fields (see Habitat 7). Some lichens take advantage of shelter, shade and enhanced humidity offered by the *Calluna*. The woody stems and exposed woody roots of *Calluna* also offer surfaces for some lichens, and 30 species are recorded from *Calluna*. Given the continuing presence of rabbits, plus on-shore exposure to severe winds, including salt-laden winds, it is unlikely that *Calluna* will become dominant overall. To lose significant amounts of *Calluna* (for example, by infestation of Heather beetle) would cause a set-back and decline for the lichen communities that appear to be well-developed in association with this sub-shrub. However, as and when *Calluna* re-established, this should lead to a re-establishment of the lichen communities.

2.3.4 Gorse

Gorse is particularly good at invading dunes, and produces a high percentage of leaf litter which builds up to form a thick layer under the bushes, effectively smothering all other forms of vegetation. Gorse also produces masses of seeds. At Findhorn there is a significant gorse presence, especially at the southern part of the site, but there are also clumps throughout the site, especially on old sand dunes. Where gorse has expanded and become widespread dense thickets, this has the effect of eliminating all other ground vegetation including any lichens. Attempting to remove gorse is an expensive project, as the leaf litter will have left a significant humus layer which provides a ready seed bed for the masses of gorse seeds. The only effective way to remove it is to scarify the soil, and leave a new area of exposed sand and/or shingle.

However, where gorse is in discrete clumps and patches, or forms sheltering hedges, then this creates little mini-habitats and niches which provide opportunity for some species to establish, and other species to grow more luxuriantly than they would in more exposed situations (see Habitats 3A & 3B). The occasional gorse hedges also

have value in discouraging access to some areas, and directing walkers to use established paths, so reducing trampling impact on some areas (e.g. Habitat 1). Gorse does not support many lichens on the woody stems, mainly because of the dense shady foliage and rather acidic and fibrous nature of the bark. One major threat associated with gorse is fire, but whether fires would spread out onto the parts of the dunes with *Calluna* (and so affect many of the lichen-rich areas) will probably depend on wind direction.

2.3.5 Pines

The pine plantation at the south of the site (adjacent to Plot 13) is well-established, and supports only rudimentary lichen assemblages within the floor of the stand. This is because of the reduction of light reaching the ground, plus the build up of pine needle litter. The little stands of self-seeded pines that occur occasionally throughout the site have very localized areas where dense needle litter has accumulated to the extent it inhibits lichen development. At present, the pines contribute small zones of localized protection and shelter (Habitat 5). However, in 50 years time, if left unchecked, then pine could well become a locally negative influence. The total elimination of pines is not seen as a priority, but gradual checking of pine expansion and removal of occasional pines would be a useful on-going management exercise. The disturbance caused by pine removal is seen as part of the cyclical disturbance-stability cycle.

2.4 Comparison with other sites

Comparison with other similar habitats in the British Isles is difficult, as there is nothing quite the same as the Findhorn Dunes. This report is not the place to provide detailed comparisons of the lichen interest of all the coastal dune and shingle sites in Scotland, as that would entail a study and report in its own right. However, it would be an interesting exercise to undertake, and a useful reference to raise awareness of the biodiversity value of lichens found on coastal shingle and dune sites. In European terms, Britain and perhaps Denmark to a lesser degree, have some of the most diverse and richest lichen assemblages associated with shingle and dunes. In 1984 (over 20 years ago), the British Lichen Society carried out a preliminary and partial survey and assessment of lowland heathland lichen habitats (Fletcher *et al*. 1984). Findhorn appears as a Grade 5 site (County Importance) with 22 lichens recorded (now 145 taxa recorded, and a revised grade to Grade 2, National Importance). Culbin is listed in Fletcher *et al*., 1984 as Grade 1 (International Importance), but at that time with only 50 species recorded (latest information we have is that 178 taxa are now known from Culbin). Cuthill Links (Dornoch Firth, Sutherland) is perhaps nearest in approaching a similar site to Findhorn; in the 1984 report, it is listed as Grade 2 (National Importance) with 111 lichen taxa recorded. Much of the lichen data for sites for coastal heath, dunes and shingles in Scotland is incomplete, and needs to be updated, including Tentsmuir SSSI, Kinnaber Links SSSI, Barry Links SSSI, Whiteness Head SSSI.

Xanthoparmelia mougeotii, growing on a white quartz pebble (close-up detail, below). This lichen is not uncommon on pebbles at Findhorn, but only in undisturbed areas. the finely-branched, silvery-green lobes are all edged in black, making it quite distinctive. It does not have fruiting bodies (apothecia), but special powdery structures (soredia), seen as small, pale green clumps. Bits of soredia break off, get moved around by the wind, and land on another pebble, and, if conditions are right, proceed to grow into a new baby lichen.

3. Management Recommendations

There are a few key issues concerning the habitats and lichen interest on the Findhorn Dunes. **Trampling** and **development** are perhaps the major concerns, but gorse and pine also deserve some consideration.

3.1 Raise awareness to reduce or limit trampling

- There is scope for increasing general public awareness of this special habitat. Local people as individual walkers, runners and cyclists regularly use the dunes, and at present, although the usage increases during holiday periods from the adjacent caravan and camping site, numbers seem moderate, and the impact they have at the site is sustainable. Nevertheless, it would be beneficial for local people, regular users of the dunes, and holiday-makers and visitors to take an interest in and be aware of the lichen habitat, as it is something special to this locality.
- There are well-established paths and trails running through the site, including the Moray Firth Trail (part of The North Sea Trail). Most people appear to stay on these paths and trails, although there is evidence of bikers' tracks going across fragile lichen-rich areas. Although some degree of disturbance can be tolerated (and for some habitats may indeed be beneficial), for more fragile habitats there has to be a corresponding period of recovery and non-disturbance.

Generally, once people are aware that fragile lichens are present on the dunes, and that these may be relics from an ancient time when the dunes were first settled, most people will respect this knowledge, and take care not to leave the paths.

- Encourage walkers, bicyclists and horse-riders not to stray off the paths and trails
- Discouraging all scrambling bikes, motor bikes, ATVs (All Terrain Vehicles)
- Orienteering events – somewhat more problematic, as participants do not necessarily follow paths, but take the best direct routes between check-points. Although recreational activities and enjoyment of the Findhorn Dunes should be open to all, conflict could arise with the biodiversity interest if orienteering events were held regularly and attracted over 100 participants at each event. The Findhorn Dunes Trust would have to carefully consider any applications to hold orienteering events, and judge how often and to perhaps limit the number of participants at each event.

How would awareness-raising be achieved?

Information Boards

- Permanent Information Boards now can be of a very high standard, and very durable. In East Lothian, the local Council have responsibility for some stretches of coastline, and have produced excellent information boards at strategic places (by Car Parks, or at places where coastal trails emerge onto a particularly popular or interesting area). When they first appeared, local people stood and read them, often commenting appreciatively, especially about facts about the local wildlife.

Visitors certainly stop and read the boards – most people like to know a bit about the place they are visiting, but do not necessarily want to read a lot of text.

- The Skibo Estate (which borders on part of the Dornoch Firth SSSI where the lichen-rich shingle and dunes of Cuthill Links occurs) have erected awareness-raising notice boards where lichen heath borders onto the edge of the golf course, advising golfers to avoid trampling on the lichens.
- The more widely the message and awareness of lichens as an integral part of the dune and shingle habitat is spread, the greater the understanding and appreciation by members of the public. There is a overall lack of awareness of lichens amongst the Scottish public, for all habitats. This is a pity, as Scotland generally has lichen communities that are better developed than many places elsewhere in Europe, and lichens are something Scottish people can feel justifiably proud of.

Where would the Information Boards be placed?
Perhaps at a strategic point at the edge of the Car Park to the north of the village, and also at the end of the track that leads out from the caravan park and on to the dunes? Also, at the eastern end of the Moray Firth Trail (the RAF Kinloss end). The Findhorn Dunes Trust will be better placed to decide the most effective and strategic points to place Information Boards.

3.2 Development

The relatively small caravan site at the edge of Findhorn village at the western edge is the only developments intruding onto the fringes of this habitat. The RAF base at the eastern end presumably was originally built on existing dune, but today has little or no impact onto the remaining intact dune area.

- There are plans to build some houses in the southern part of the site, largely in an area that is presently gorse dominated, although there is a small linear open area with several thalli of the Nationally rare ***Peltigera malacea***, Red Data Book category Endangered. Planning approval has already been given.

Possible mitigation action to redress the destruction of the habitat and populations of *Peltigera malacea*, Red Data listed as Endangered

In discussion with Heather Paul it was suggested that she might attempt to make some lichen translocations of *Peltigera malacea*. She would take material from the site where development is to destroy the habitat, and find suitable locations elsewhere in the Dunes to re-locate the lichen. This will be a useful exercise, for as far as we are aware, it has never been attempted before. So, it would be important for the translocation exercise to be carefully recorded, with follow-up visits (monitoring) to check on success or failure. Some monitoring of examples of *P. malacea in situ* should also be made as a 'control'. [See also **4. Potential Schools' Project**].

- However, the erection of houses at the fringes of the dunes (even in a predominantly gorse-dominated area) has set a precedent. It will be difficult to object to future applications for building (or for example, extension of the caravan park) that entail expanding into the existing Findhorn Dunes.
- Any incursions into the Findhorn Dunes area will impact on the habitats, by extending the zone of immediate impact (i.e. zone adjacent to the village and caravan park, where most people walk, so the zone of heaviest trampling impact) further into the zone of lesser impact (i.e. what are at present the remoter areas).
- Additional building of homes or expansion of the caravan park will mean a net increase in people going out onto the dunes. There are enormous pressures on holiday destinations to provide additional facilities for tourism. Fortunately, the appeal of Findhorn lies in its charm as a small, relatively unspoilt fishing village, so major development such as expanding a yachting marina, developing an international golf course or major hotel complex can be resisted.
- To protect and conserve the dunes and the associated special lichen communities will no doubt lead to careful planning to avoid future conflict. Dune habitats throughout Scotland are under severe pressure, and many habitats have been lost, mainly through a rapid increase in the number of golf courses. Obtaining a SSSI status would lend weight to resisting development, and securing a future for these special habitats and lichens.

3.3 Gorse and pine

The relative issues for and against gorse and pine have been discussed previously in Sections 2.3.4 and 2.3.5. So below is just a summary of the main points:

3.3.1 Gorse

Where gorse forms dense thickets, this eliminates all other ground vegetation including any lichens. Attempting to remove gorse is an expensive project, as the leaf litter produces a significant humus layer, a ready seed bed for the masses of gorse seeds. The only effective way to remove it is to scarify the soil, and leave a new area of exposed sand and/or shingle, perfect for colonization by biological crusts, precursors to lichens and bryophytes. However, on the positive side, where gorse is in discrete clumps and patches, or forms sheltering hedges, then this creates little mini-habitats and niches which provide opportunity for some species to establish, and other species to grow more luxuriantly than they would in more exposed situations. The occasional gorse hedges also have value in discouraging access to some areas, and directing walkers to use established paths, so reducing trampling impact on some areas. A watching brief to monitor gorse expansion should be set up, with action taken to restrict invasion if it is felt that habitats are becoming lost.

3.3.2 Pine

If left unchecked, in 50 years time pine could well become a locally negative influence. The total elimination of pines is not seen as a priority, but gradual checking of pine expansion and removal of occasional pines would be a useful on-going management exercise. The disturbance caused by pine removal is seen as part of the cyclical disturbance-stability cycle.

4 Potential School Project

Monitoring *Peltigera malacea* (the malachite green-felt lichen)

- Plots of *Peltigera malacea* could be set up (using GPS and photographs);
- date of visit;
- comments as to habitat, micro-habitat;
- measurement of the thallus (as length x breadth);
- comments on health of the thallus (neat-looking, ragged old lobes present, lots new lobes, etc);
- rabbit droppings present.

This could be expanded as necessary or required, depending on circumstances.

Repeat visits: ideally, four visits a year (one each season) would produce useful information. Growth-rates of *Peltigera* species vary according to species. The average growth-rate is perhaps 1–6 mm yr^{-1} for foliose species and although *P. malacea* may well fall within this range, no data currently exists for this rare species. Therefore, any work that is carefully carried out to record growth-rates of *P. malacea* would be well received.

The results could be presented as a small report published in the British Lichen Society *Bulletin*.

Skills utilized:
Observational skills; identification of the organism;
Using a map, compass and/or GPS.
Descriptive recording (ability to write clearly, concisely and accurately)
Measurement skills, recording data; presenting data, graphs, etc.
Photography, presentation of results.

5 The Lichen Survey

The following survey report is presented as a series of eight main habitats:

Habitat 1

Habitat description: flat, open areas (at least about the size of a football pitch), with small to medium pebbles in a sandy matrix; low-lying, spreading *Calluna* (very browsed) clumps present, perhaps 50% cover and occasional bird's foot trefoil. Dense hedges of gorse at the periphery; ant activity often present, and rabbit droppings indicating local rabbit activity. Lichen cover 70–90%. Comparing Figs. 1.1 (Plot 1) and 1.4 (Plot 10), there is very little overall difference.

Examples:

(date of visit**: 1.6.08)**	**Plot 1**	**NJ 04515.64430**
(date of visit**: 2.6.08)**	**Plot 10**	**NJ 04493.64473**

Habitat 2

Small sand 'cliffs' or banks (sand faces), with vertical or near-vertical sides and often over-topped by vegetation mats (such as *Calluna*, gorse or marram grass). In some instances, *Calluna* roots dangle free where the sand has eroded away beneath the plant. These roots often support quite interesting lichen assemblages, mostly lichens associated with trees and twigs (epiphytes).

Examples:

(date of visit**: 1.6.08)**	**Plot 2**	**NJ 04852.64311; NJ 04854.64309**
	Plot 9	**NJ 05208.64490**
(date of visit**: 4.6.08)**	**Plot 14**	**NJ 04934.64710**
	Plot 15	**NJ 05053.64705; NJ 05071.64622**

Habitat 3

Habitat 3 broadly encompasses lichen assemblages found in conjunction with stands of gorse, and paths or tracks at the edges of gorse. **3A** considers large or small gaps or mosaics of open ground between Gorse, and **3B** deals with vegetated fringes at the edge of gorse stands, particularly low-growing cover of *Calluna* and *Erica*. (There may be some overlap of habitat and community between Habitat 1 and Habitat 3B). Habitat **3C** is really a catch-all, mopping up a small habitat that doesn't quite fit elsewhere.

Habitat 3A

Small or large gaps or mosaics of open ground between dense gorse (*Ulex*), Heather (*Calluna*) and Bell heather (*Erica*).

Examples:

(date of visit**: 1.6.08)**	**Plot 3**	**NJ 04915.64243**
(date of visit**: 2.6.08)**	**Plot 11**	**NJ 04765.63895**
	Plot 12	**(Lyell's Grave) NJ 05077.63987**

Habitat 3B
Vegetated fringes at the edge of Gorse stands, particularly low-growing cover of *Calluna* and *Erica*.

Examples:
(date of visit**: 1.6.08)** **Plot 3** **NJ 04915.64243**

Habitat 3C
Disturbed and now recovering habitat, associated with edges of dusty tracks, cutting across old shingle and dunes, with *Calluna*, gorse and self-seeded pine.

Examples:
(date of visit**: 1.6.08)** **Plot 13** **NJ 05173.64066**

Habitat 4
Low, linear flat-topped shingle ridges. There are two main forms of ridges:
4A shallow, linear stony ridges with a sand matrix, variously vegetated, > 50% with *Calluna* and/or *Erica*;
4B shallow, linear stony ridges with a sand matrix, variously vegetated, < 50% with *Calluna* and/or *Erica*;

Habitat 4A
Shallow, linear stony ridges with a sand matrix, variously vegetated, > 50% with *Calluna* and/or *Erica.*

Examples:
(date of visit**: 1.6.08)** **Plot 4** **NJ 05166.64289**

Habitat 4B
Shallow, linear stony ridges with a sand matrix, variously vegetated, < 50% with *Calluna* and/or *Erica.*

Examples:
(date of visit**: 1.6.08)** **Plot 5** **NJ 0532.6432 & NJ 05443.64348**

Habitat 5
Shingle in the lee of partial development of self-seeded pine.

Examples:
(date of visit**: 1.6.08)** **Plot 6** **NJ 05592.64320**

Habitat 6
Exposed, open stone fields, formerly shingle deposits, with scattered dwarf *Calluna* (some moribund) with abundant lichen cover of up to 100% over sand and shingle, including in some places, *Alectoria sarmentosa* subsp. *vexillifera*.

Examples:
(date of visit**: 1.6.08)** **Plot 7** **NJ 05690.64279**
(date of visit**: 4.6.08)** **Plot 20** **(i) NJ 06076.64489**
(ii) NJ 06040.64496

Habitat 7

Very exposed, coastal open stone fields and shallow shingle ridges, with scattered flattened and wind-sculptured *Calluna*. In some places lichen cover is up to 70% over sand and shingle. This habitat encompasses an extensive zone at the northern edge of the central section of the Findhorn Dunes, along the coastal edge of the consolidated shingle beds. This habitat is difficult to clearly categorize and delimitate as shingle ridges grade into stone fields, and prostrate *Calluna* occurs at one area, grading into more dwarf forms where there is slight rise in topography offering a modicum of shelter. Lichen interest here is extraordinary – this is an extreme and hostile habitat, in many way similar to the fell-fields on montane plateaux; how does *Calluna* cling to life? How do the leafy-lobed lichens cling to the shingle beds without being blasted away? How do the lichens on shingle survive being baked by relentless hot sun in high summer, or pounded by rain, hail and sleet in winter, and scoured by sand blowing over the surface in gales?

Examples:

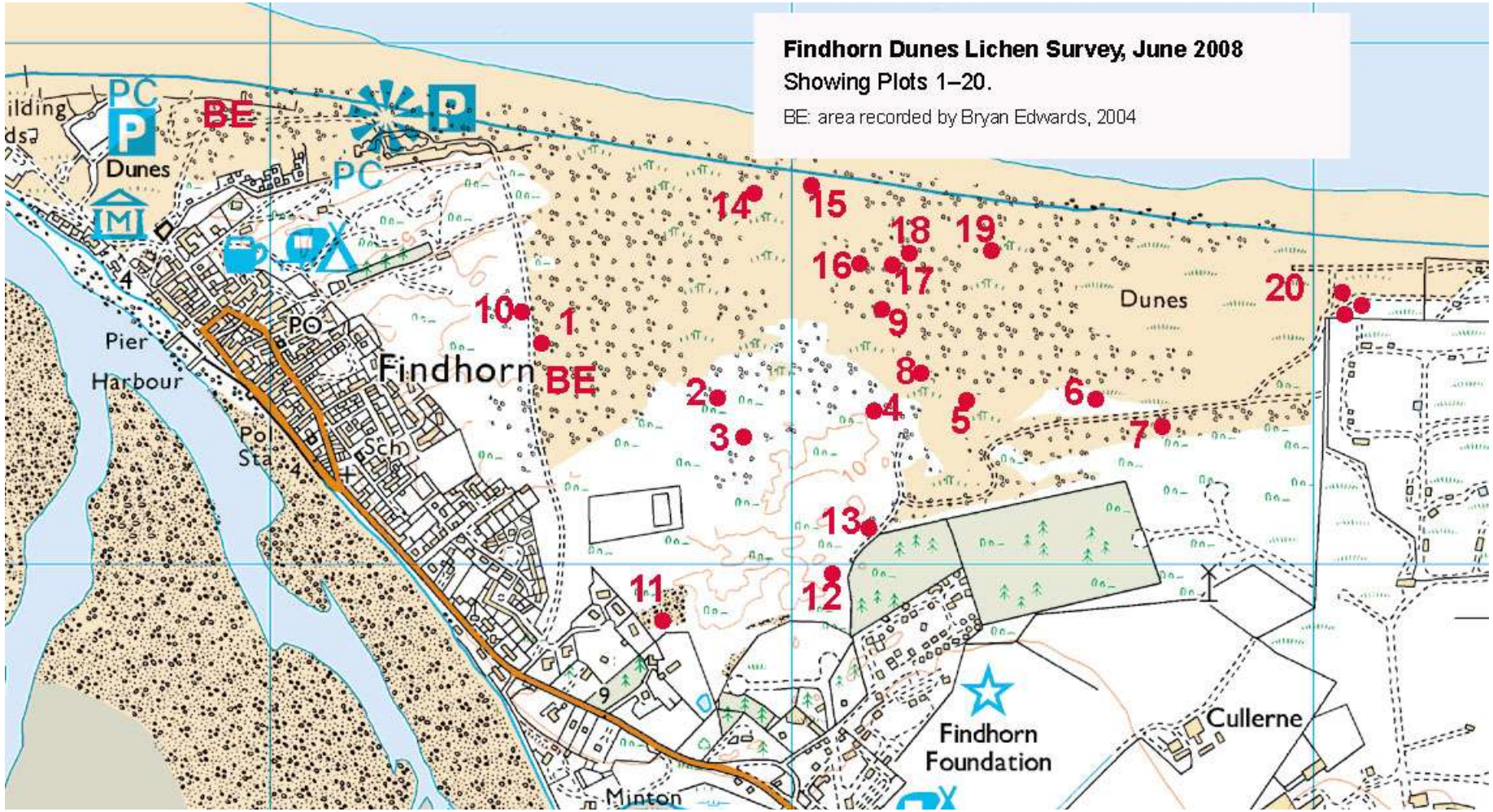
(date of visit**: 4.6.08)**	**Plot 16**	**NJ 05136.64598**
	Plot 18	**NJ 05225.64598**
	Plot 19	**NJ 05356.64600**

Habitat 8

Open, flat stony areas, with scattered, dwarf *Calluna*; lichen cover almost restricted to a single species, *Cladonia zopfii*, which is abundant, creating a pale green haze over the site. This habitat we called "**The Fields of Zopf**". Two examples only are listed here (Plot 8 and Plot 17), but this phenomenon of areas dominated by *Cladonia zopfii* was seen several times during our visit. Fragments of the habitat do occur at the edges of other habitats as well, and sometimes there are mosaics or overlap, where *Cladonia zopfii* is locally frequent or dominant.

Examples:

(date of visit**: 1.6.08)**	**Plot 8**	**NJ 05255.64376**
(date of visit**: 4.6.08)**	**Plot 17**	**NJ 05228.64574**


Findhorn Dunes Lichen Survey, June 2008
Showing Plots 1–20.
BE: area recorded by Bryan Edwards, 2004
Dunes
Pier
Harbour
Findhorn
BE
PO
Sch
Dunes
Findhorn
Foundation
Cullerne
Minton
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

65

64

04 05 06


Findhorn Dunes Lichen Survey, June 2008
Showing Plots 1–20.
Aerial photograph from Google Earth
N
14
15
16
19
18
20
17
10
1
9
8
5
4
6
7
2
3
13
12
11
© 2008 Tele Atlas
Image © 2008 DigitalGlobe
©2008 Google
57°39'31.07" N
3°35'14.30" W
elev 8 m
Feb 26, 2007
Eye alt 1.73 km

HABITAT 1

Habitat description: flat, open areas (at least about the size of a football pitch), with small to medium pebbles in a sandy matrix; low-lying, spreading *Calluna* (very browsed) clumps present, perhaps 50% cover and occasional bird's foot trefoil. Dense hedges of gorse at the periphery; ant activity noted and rabbit droppings present. Lichen cover 70–90%. Comparing Figs. 1.1 (Plot 1) and 1.4 (Plot 10), there is very little overall difference.

Examples:

(1.6.08) Plot 1 NJ 04515.64430

East of tarmac road, close to edge of caravan and campsite and the village, so in a zone of potential heavy visitor pressure, trampling and litter. There are various clear pathways through the vegetation, and most other parts appear untrampled. This could be the result of a dense development of gorse running along the edge of the road, so that people walking from the camp-site, or from houses, will head for gaps in the gorse to reach the road or go further afield. This leaves the middle part of the Plot fairly undisturbed. Rabbit droppings present (despite frequency of dogs being walked close to habitation). This is a fairly species-rich habitat, with lichens recorded growing directly over the sandy soil, on pebbles and on the thin twigs of *Calluna*.

(2.6.08) Plot 10 NJ 04493.64473

West of tarmac road, so a lot closer to the village, caravan and camp site than Site 1. There are some well-defined and well-worn paths, and trampling otherwise seems to be moderate, but spread over a wide area. There are also some areas which appear not to be trampled (or only rarely), and these have the most obvious lichen developments, with eye-catching clumps of the pale, shrubby 'reindeer' lichens such as *Cladonia portentosa* (see Figs. 1.4 & 1.6). *Peltigera malacea* is frequent. The habitat is characterised by a series of low ridges, mostly sand and small shingle with islands of *Calluna*. Rabbits graze the *Calluna*, keeping it short clipped and restricting expansion, so enabling lichens to get well established. In places, the cover abundance between individual clumps of *Calluna* is 100%, especially at the tops of ridges. Percentage lichen cover does grade down, however, in the south part of Plot 10, perhaps due to past disturbance events. Towards the western edge of the site (nearest to habitation), there is a significant cover of closely grazed grass and clumps and hedges of gorse. The grass is grazed by rabbits, making a pleasant 'lawn' for people to walk or even sit and picnic. Lichens found here include scattered incidences of rather battered *Cladonia cervicornis*, *C. cornuta*, *C. diversa*. and *C. foliacea*.

An additional sub-habitat was seen nearer to the edge of the caravan park; some time in the past, ashes and cinders from household fires had been emptied out onto the dune area at NJ 0449.6447. These have now been trampled into the ground, so as to be barely discernable, except as slightly dark or blackened areas in amongst the short mossy turf (Fig. 1.8). A few lichens were found growing on or near the cinders (slightly more acidic conditions than occur locally on the dunes), comprising a lichen

assemblage similar to that found on mine-spoil heaps: *Peltigera didactyla, Scoliciosporum umbrinum, Stereocaulon leucophaeopsis* and *Trapelia obtegens.*

This area acts as a 'zone' of greatest disturbance adjacent to the village, caravan and campsite. Although lichen interest here can be classed as moderate to high, the importance of this 'zone' cannot be over-stressed; if, for example, the caravan park wanted to expand, or applications were made for building houses on the edge of the dunes, this present 'zone' would disappear under building or caravan park, and the existing edge of the dunes be moved inexorably eastwards.

Lichens recorded – growing on the ground (T) or on pebbles (Pe); NR = Nationally Rare; NS = Nationally Scarce; NT = Red Data Book category Near Threatened; EN = Red Data Book category Endangered; VU = Red Data Book category Vulnerable; r = rare (at this Plot); r/o = rare/occasional; o = occasional; f = frequent; a = abundant; d = dominant.

Lichens	**substrate**	**Plot No.**		**additional notes**
		1	**10**	
Acarospora smaragdula	Pe	✔		
Baeomyces rufus	T	✔	✔	
Bryoria fuscescens	T	✔	✔	r/o
Buellia aethalea	Pe	✔		
Catillaria atomarioides	Pe	✔		NS
Cetraria aculeata	T	✔	✔	
Cetraria muricata	T	✔		
Cladonia arbuscula	T	✔	✔	
Cladonia cervicornis	T	✔		
Cladonia chlorophaea agg.	T	✔	✔	
Cladonia ciliata var. ciliata	T	✔	✔	
Cladonia ciliata var. tenuis	T		✔	
Cladonia cornuta	T		✔	
Cladonia diversa	T	✔	✔	
Cladonia foliacea	T	✔	✔	
Cladonia furcata	T	✔	✔	
Cladonia gracilis	T	✔	✔	
Cladonia macrophylla	T	✔		r, NS
Cladonia mitis	T	✔	✔	NT, NR
Cladonia portentosa	T	✔	✔	
Cladonia ramulosa	T		✔	
Cladonia rangiformis	T	✔		
Cladonia uncialis subsp. biuncialis	T		✔	
Evernia prunastri	T	✔		r
Hypogymnia physodes	T	✔	✔	
Hypogymnia tubulosa	T	✔	✔	
Ochrolechia androgyna	T		✔	
Peltigera canina	T		✔	
Peltigera didactyla	T cinders		✔	
Peltigera hymenina	T		✔	
Peltigera malacea	T	✔	✔	EN, NR

Peltigera membranacea	T		✔	
Placynthiella icmalea			✔	
Placynthiella oligotropha	T		✔	
Placynthiella uliginosa	T		✔	
Platismatia glauca	T	✔		
Porpidia tuberculosa	Pe	✔	✔	
Pseudevernia furfuracea var. ceratea	T	✔	✔	
Protothelenella corrosa	Pe	✔		NS
Rhizocarpon reductum	Pe	✔	✔	
Scoliciosporum umbrinum	T cinders		✔	
Stereocaulon condensatum	T	✔	✔	r
Stereocaulon leucophaeopsis	T cinders		✔	NS
Trapeliopsis granulosa	T		✔	
Trapelia obtegens	T cinders		✔	
Usnea subfloridana	small *Calluna* stems	✔	✔	r/o
Xanthoparmelia mougeotii	Pe		✔	
47	7 Pe, 39 T	31	37	

Cetraria aculeata, (× 5) the shiny, spiky brown lichen, perhaps the most common species seen at Findhorn.

Findhorn Dunes, June 2008
Habitat 1, Fig. 1.1: Plot 1, looking SE. (NJ 04515.64430), east of the road. Open area of pebbles in a sand matrix, bounded by dense gorse hedges. Scattered dwarf *Calluna* (rabbit browsed), lichen cover 70–90%.

Findhorn Dunes, June 2008
Habitat 1, Fig. 1.2: Plot 1, looking NE. The area of Plot 1 lies to the left of the path running diagonally across the plot.

Findhorn Dunes, June 2008
Habitat 1, Fig. 1.3: Plot 1, typical community found in this habitat. *Calluna* (heather) and Bird's foot trefoil, with some bare sand and rabbit droppings are here with the lichens including *Cetraria aculeata*, *Cladonia portentosa* and *Hypogymnia physodes*.

Findhorn Dunes, June 2008
Habitat 1, Fig. 1.4: Plot 10.
General view, looking south, typical community, showing the scattered, rabbit-browsed *Calluna*, with the spaces between dominated by lichens, with occasional areas of bare sand. Not much evidence of damage by trampling here.

Findhorn Dunes, June 2008
Habitat 1, Fig. 1.5: Plot 10.
An old, moribund *Calluna* bush falling apart and with lots of bare, woody stems, now abundantly colonized by pale fluffy *Usnea subfloridana*, and silvery-grey patches of *Hypogymnia physodes*.

Findhorn Dunes, June 2008
Habitat 1, Fig. 1.6: Plot 10.
A robust patch of *Cladonia portentosa* nestling in among a dwarf *Calluna* bush. *Cladonia portentosa* is one of the 'reindeer' lichens, and is able to be drawn up and keep its tips at the same level as the expanding *Calluna*.

Findhorn Dunes June 2008, Habitat 1: Fig. 1.7, Plot 10. Looking NW across a main trackway from habitation, to a small area of grass and gorse, with the caravan park in the background. Lichens persist in untrampled areas, especially in the lee of gorse.

Findhorn Dunes June 2008, Habitat 1: Fig. 1.8, Plot 10. area towards the western edge, where cinders are fairly widespread. *Peltigera didactyla*, *Stereocaulon condensatum* and *S. leucophaeopsis* occasional to frequent.

HABITAT 2

Small sand 'cliffs' or banks (sand faces), with vertical or near-vertical sides and often over-topped by vegetation mats (such as *Calluna*, gorse or marram grass). In some instances, *Calluna* roots dangle free where the sand has eroded away beneath the plant. These roots often support quite interesting lichen assemblages, mostly lichens associated with trees and twigs (epiphytes).

Examples:

(1.6.08) Plot 2 NJ 04852.64311; NJ 04854.64309
Plot 9 NJ 05208.64490
(4.6.08) Plot 14 NJ 04934.64710
Plot 15 NJ 05053.64705; NJ 05071.64622 (Fig. 2.12)

Lichens which form soil 'crusts' are important in this habitat niche, as they stabilize the vertical faces of sand banks. Exposed mineral sand that is left undisturbed, will assume a 'biological crust', where sand grains are bound together by microscopic algae, cyanobacteria ('blue-green algae'), bryophyte protonema and fungal mycelia – some of the latter often precursors to lichen thalli developing. *Cetraria aculeata* seems to grow directly on sand. *Stereocaulon condensatum* forms a crust of scattered, whitish crumbs over the sand surface, sometimes with dense black nodules (pycnidia) or shortly stalked black nodules (apothecia, or fruiting bodies) (see Fig. 2.3). The most frequent 'sand-cementing' lichen is *Baeomyces rufus*, seen as a pale green screed over the sand surface, and is actually quite tough to break through. *B. rufus* is sometimes found with scattered pinkish-brown stalked fruits. Occasionally, small holes can be seen over the surface of the lichen crust – these are where mining bees or ants have burrowed into the sand, using the 'cemented' surface to stop the entrance to the hole filling up with loose sand (see Fig. 2.2). *Epilichen scabrosus* is an uncommon species, which begins life semi-parasitizing *Baeomyces rufus*, before seeming to be able to exist happily on its own.

Another notable species occasionally recorded from the sand face at Plots 2 and 15 is *Peltigera malacea* (Red Data Book Endangered and Nationally rare). This species is never so well developed in this particular niche-habitat as elsewhere at Findhorn (e.g. Habitat 3), and is found on the more sheltered sand faces where there is often a sizeable capping of vegetation, providing shelter, shade and drip or seepage of moisture onto the sand face below.

There are gradients in the overall habitat of vertical sand walls, sand faces and small sand cliffs, and these gradients all affect the range of lichen species that can be present at a given section of sand face, e.g. aspect (sunny S-facing slopes contrast with N-facing slopes that are cooler and stay damper than S-facing ones); whether sheltered or exposed (some dune faces are part of a complex of systems (see Fig. 2.12), and can be enclosed and sheltered, or at the edge of an open space, so more exposed); degree of the sloping face; amount of vegetation 'thatch'; amount of disturbance and age of the face. Because of the overall vulnerability of a sand face to erosion, these habitat niches are of fairly short duration, as sand slippage occurs. Then the gradual process of consolidation of the newly exposed sand surface will begin all over again. The list of species recorded from this habitat, represents a range

of typical sand face community lichens; so, not all these species will occur on any given sand face.

An additional feature of sand faces, seen particularly at Plots 14 & 15, are dangling woody *Calluna* roots. Where a *Calluna* clump has got established on a sloping dune, the circumstances that lead up to the roots becoming exposed and dangling are probably the result of exceptional storms**:** fierce winds sweep in, shifting loose sand, except where the deep-rooted *Calluna* holds the sand together, but lower down, beneath the *Calluna*, the sand may be scoured away and eroded, forming under-cut sand faces (see Figs. 2.8 & 2.9). In these circumstances, *Calluna* roots are often exposed, and dangle down, providing opportunity for lichens associated with twigs (epiphytes) to become established. The habitat niche is particularly suitable, as the under-cut sand face provides a sheltered hollow space trapping moisture and humidity, yet as the roots are dangling, air is able to pass freely around the roots, providing ideal conditions (Fig. 2.11). The lichen assemblages present on *Calluna* roots in this niche will vary with the aspect of the face, i.e. N-facing will be cooler and more shaded, less sunlight than S-facing sides.

Lichens Recorded from Habitat 2 (Plots 2, 9, 14 & 15)

Lichens recorded – growing on the ground (T) or on pebbles (Pe); NR = Nationally Rare; NS = Nationally Scarce; NT = Red Data Book category Near Threatened; EN = Red Data Book category Endangered; VU = Red Data Book category Vulnerable; r = rare (at this Plot); r/o = rare/occasional; o = occasional; f = frequent; a = abundant; d = dominant.

Lichens	substrate	Plot No.				additional notes
		2	9	14	15	
Amandinea punctata	*Calluna*			✔		
Baeomyces rufus	T	✔		✔	✔	
Bryoria fuscescens	T		✔			
Buellia griseovirens	*Calluna*				✔	
Caloplaca asserigena	*Calluna*				✔	
Cetraria aculeata	T	✔	✔	✔	✔	
Cladonia chlorophaea agg.	T	✔		✔		
Cladonia ciliata var. tenuis	T	✔				
Cladonia cornuta	T	✔				
Cladonia diversa	T	✔			✔	
Cladonia fimbriata	T				✔	
Cladonia furcata	T	✔		✔	✔	
Cladonia humilis	T			✔	✔	
Cladonia mitis	T		✔		✔	
Cladonia portentosa	T	✔	✔	✔	✔	
Cladonia rangiformis	T	✔			✔	
Cladonia ramulosa	T	✔				
Cladonia subulata	T	✔		✔		
Cladonia zopfii	T	✔				NS
Dibaeis baeomyces	T		✔			

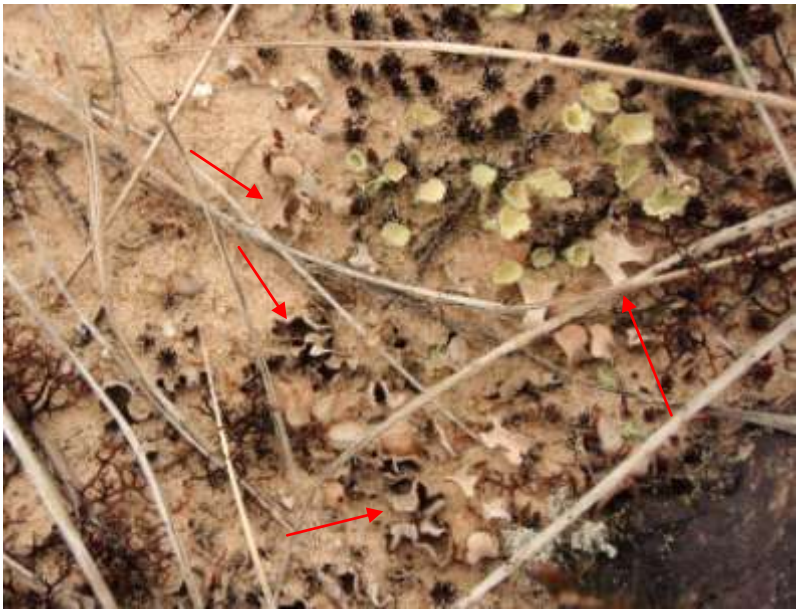
Lichens	**substrate**	**Plot No.**				**additional notes**
		2	**9**	**14**	**15**	
Epilichen scabrosus	*Baeomyces rufus*	✔				NS
Evernia prunastri	*Calluna*			✔	✔	
Hypogymnia physodes	T & *Calluna*	✔	✔	✔	✔	
Hypogymnia tubulosa	*Calluna*				✔	
Lecania naegelii	*Calluna*				✔	
Lecanora confusa	*Calluna*				✔	
Lecanora expallens	*Calluna*				✔	
Lecanora persimilis	*Calluna*				✔	
Lecanora symmicta	*Calluna*				✔	
Lepraria elobata	T		✔			
Melanelia subaurifera	*Calluna*			✔	✔	
Parmelia sulcata	*Calluna*			✔	✔	
Peltigera canina	T				✔	
Peltigera hymenina	T			✔	✔	
Peltigera malacea	T	✔	✔		✔	EN, NR
Physcia tenella	*Calluna*			✔	✔	
Placynthiella uliginosa	T			✔		
Pseudevernia furfuracea	*Calluna*			✔		
Ramalina farinacea	*Calluna*			✔		
Ramalina fastigiata	*Calluna*			✔	✔	
Scoliciosporum chlorococcum	*Calluna*			✔		
Stereocaulon condensatum	T	✔	✔	✔	✔	NS
Usnea hirta	*Calluna*				✔	
Usnea subfloridana	*Calluna*			✔	✔	
Usnea wasmuthii	*Calluna*				✔	
Xanthoria polycarpa	*Calluna*			✔	✔	
46	24 T 22 *Calluna*					

Findhorn Dunes, June 2008
Habitat 2, Fig. 2.1: Plot 2, (NJ 04852.64311), vertical faces of dunes, under gorse and *Calluna*, at the edge of a broad track.

Findhorn Dunes, June 2008, Plot 2.
Habitat 2, Fig. 2.2 (above): a vertical sand face, the pale green surface is the lichen *Baeomyces rufus*, forming a hard surface, binding sand grains. Tiny holes are used by ants.
Fig. 2.3 (left) the lichen *Stereocaulon condensatum* on a vertical sand face.

Findhorn Dunes, June 2008, Plot 2.
Habitat 2, Fig. 2.4: a typical lichen community associated with vertical sand faces, over-topped by *Calluna* or gorse; the pale green cups (some fringed with bright red fruits) are *Cladonia diversa*. The pale yellow shrubby lichen is *Cladonia portentosa*.

Findhorn Dunes, June 2008, Plot 2.
Habitat 2, Fig. 2.5: another example of the lichen assemblages found on sand faces, here the gingery branches are *Cladonia furcata*, with dark spiky *Cetraria aculeata*, and a small, whitish crust of *Stereocaulon condensatum*.



Findhorn Dunes, June 2008, Plot 2.
Habitat 2, Fig. 2.6: more examples of *Cladonia diversa* and the spiky *Cetraria aculeata*, and a tiny dark brown moss (top centre). Scattered lobes of *Peltigera malacea* (some arrowed, dark upper surface, pale lower) gaining a precarious foothold on this vertical sand face.

Findhorn Dunes, June 2008, Plot 2. Habitat 2, Fig. 2.7: clusters of lichens forming exquisite gardens on sand faces. Here, the lichen with tall, powdery grey podetia is *Cladonia subulata*, with *Cladonia portentosa* (pale yellow shrubby), a shade form of *Cetraria aculeata*, looking brown, and (to the right) fertile *Cladonia furcata*.

Findhorn Dunes, June 2008, Plot 14. **Habitat 2, Fig. 2.8:** Extensive dunes close to the coast, with small, localized blow-outs forming under-cut sand faces, topped by *Calluna* or Marram grass.

Findhorn Dunes, June 2008, Plot 14. **Habitat 2, Fig. 2.9:** An example of a typical sand face at Plot 14, showing the under-cut face, probably created by scouring winds from a major storm. The over-topping of vegetation casts shade and allows slow release of moisture.

Findhorn Dunes, June 2008, Plot 14. **Habitat 2, Fig. 2.10.** An example of the lichen cover present on the sand faces at Plot 14, with *Cladonia humilis* (one of the 'cup' lichens, dominant) and a few podetia of *Cladonia subulata*.

Findhorn Dunes, June 2008, Plot 15. Habitat 2, Fig. 2.11. An example of the luxuriant cover of lichens on hanging, exposed *Calluna* roots associated with undercut sand faces. Here, the silvery-grey leafy lobes lichen with black edges to the lobes is *Hypogymnia physodes*. The wiry-looking yellow strands are *Usnea subfloridana*, and the flat, branched yellowish lobes (at the top) are *Evernia prunastri*.

Findhorn Dunes, June 2008, Plot 15. Habitat 2, Fig. 2.12. (NJ 05053.64705) An extensive area of undulating low dunes and deep cut gullies with sand faces, most with over-topping of *Calluna*, and with exposed dangling roots liberally covered by lichens.

HABITAT 3

Habitat 3 broadly encompasses lichen assemblages found in conjunction with stands of gorse, and paths or tracks at the edges of gorse. **3A** considers large or small gaps or mosaics of open ground between Gorse, and **3B** deals with vegetated fringes at the edge of gorse stands, particularly low-growing cover of *Calluna* and *Erica*. (There may be some overlap of habitat and community between Habitat 1 and Habitat 3B). Habitat **3C** is really a catch-all, mopping up a small habitat that doesn't quite fit elsewhere.

HABITAT 3A

Small or large gaps or mosaics of open ground between dense gorse (*Ulex*), Heather (*Calluna*) and Bell heather (*Erica*).

Examples: **(1.6.08) Plot 3 NJ 04915.64243**

These vary from patches of open sand, grading to tiny bryophytes forming thin mats, to thicker bryophyte mats, juvenile plants of Gorse, *Erica* or *Calluna* (sub shrubs), plus scattered patches of lichens (Fig. 3.2). Litter from the adjacent Gorse and sub-shrubs is an important component of this habitat niche, as is the presence of rabbits: rabbits impact directly on this habitat in positive ways by actually browsing young gorse, sub shrubs and other vascular plants (so helping to keep the gaps open, at least slowing down the infill), plus rabbit scrapes and burrows creating localised disturbance, plus scattered or accumulated rabbit droppings.

Important in this habitat is the frequent presence of *Peltigera malacea* (see Fig. 3.1). This is the dominant species of *Peltigera* recorded in this habitat in Plot 3, with *P. hymenina* (rare) and *P. membranacea* (occasional).

Examples: **(2.6.08) Plot 11 NJ 04765.63895** (visited with Heather Paul)

This Plot is in the SW part of the overall dune area. Gorse is abundant over much of this area, forming closed, dense stands. Several main paths have been kept open through the gorse. There is some concern that the proximity of so much gorse close to homes at the edge of the dunes poses a significant fire risk. Open areas within the gorse are few, but there is one fairly large area, probably an old sand blow-out hollow, with a sandy, pebbly floor. Gorse fringes the area, making it very sheltered. Within, it is mainly fairly open, but there are 'islands' of *Calluna*, and some small gorse (Fig. 3.4). In the lee of these shrubs, mosses have developed (benefiting from water-drip from the shrub canopy, and the slight build up of leaf litter holding moisture), and at the edge of the mosses *Peltigera malacea* is abundant (Fig. 3.8). On compacted sandy soil at the edges of the 'islands', *Stereocaulon condensatum* can be seen forming whitish crust-like patches, dotted with black knob-like extensions (pycnidia) (Fig. 3.5). Elsewhere in Plot 11, there are some beautifully developed stands of lichens, benefiting from the shelter afforded to the site overall, but particularly the localized shelter from the vegetated sub-shrub islands.

Although rabbits are present here, and there is some evidence that they nibble away at young gorse, they are not able to stop it gradually increasing, and eventually, it will fill up this space. For management discussion, see Management section.

Examples: **(2.6.08) Plot 12 (Lyell's Grave) NJ 05077.63987** (visited with Heather Paul)

This Plot is also in the southern part of the overall dune area, at the edge of the main gorse block (see Fig. 3.10). This is another shallow, hollow opening similar to Plot 11, but this is more arid in character, and perhaps has received more recent disturbance. There has been quite extensive planting of tubed and staked young trees within the immediate edges of the gorse surrounding this plot (Scot's pine, rowan, hazel, etc.) (Fig. 3.11). Heather Paul believed that this is experimental planting, the idea being that as the trees and shrubs mature, they will shade out the gorse. Below the gorse lie mosaics of low *Calluna* mounds and moss, with carpets of *Cladonia* in between, with occasional *Peltigera malacea* close to the edges of *Calluna*, and *Cladonia* diversa, etc. Lichen cover varies over the plot, being 100% in places, and 0% in others, probably averaging out to 60% overall.

There is a proposal to cut a wide swathe out of the gorse as a fire-break. From the point of the lichen interest, this is absolutely no problem, the wider the swathe the better, with perhaps a bull-dozer to scarify the roots and seed bed? Over time, vegetation will return to the fire-break strips (especially if there is only moderate trampling) and the species diversity seen in Plots 11 & 12 will develop.

Lichens recorded from Plots 3, 11 & 12, Habitat 3A

Lichens recorded – growing on the ground (T) or on pebbles (Pe); NR = Nationally Rare; NS = Nationally Scarce; NT = Red Data Book category Near Threatened; EN = Red Data Book category Endangered; VU = Red Data Book category Vulnerable; r = rare (at this Plot); r/o = rare/occasional; o = occasional; f = frequent; a = abundant; d = dominant.

Lichens	**substrate**	**Plot No.**			**additional notes**
		3	**11**	**12**	
Baeomyces rufus	T		✔	✔	
Cetraria aculeata	T	✔	✔	✔	
Cetraria muricata	T		✔		
Cladonia arbuscula	T		✔	✔	
Cladonia chlorophaea agg.	T		✔	✔	
Cladonia ciliata var. ciliata	T		✔		
Cladonia ciliata var. tenuis	T		✔	✔	
Cladonia diversa	T	✔	✔	✔	
Cladonia foliacea	T		✔		
Cladonia furcata	T		✔	✔	
Cladonia gracilis	T	✔	✔	✔	
Cladonia humilis	T		✔		
Cladonia portentosa	T	✔	✔	✔	
Cladonia rangiformis	T		✔		
Cladonia subulata	T		✔	✔	

Lichens	**substrate**	**Plot No.**			**additional notes**
		3	**11**	**12**	
Cladonia uncialis subsp. biuncialis	T		✔		
Cladonia uncialis subsp. uncialis	T	✔	✔		VU, NS
Cladonia zopfii	T		✔		NS, r
Evernia prunastri	T			✔	
Hypogymnia physodes	T		✔	✔	
Lecidea lithophila	Pe		✔		
Lecidea plana	Pe		✔		
Peltigera hymenina	T	✔	✔		r
Peltigera malacea	T	✔	✔	✔	f, EN, NR
Peltigera membranacea	T	✔	✔		o
Placynthiella uliginosa	T			✔	
Pseudevernia furfuracea	T		✔		
Rhizocarpon reductum	Pe		✔		
Stereocaulon condensatum	T		✔	✔	NS
Trapeliopsis granulosa	T			✔	
30	3 Pe, 27 T	8	27	16	

Findhorn Dunes, June 2008
Habitat 3A, Fig. 3.1: Plot 3,
(NJ 04915.64243), old dunes, becoming totally covered in gorse, *Calluna* and *Erica*, but still with little mosaics of open ground between the bushes.

Findhorn Dunes, June 2008
Habitat 3A, Fig. 3.2: Plot 3,
An example of one of the small open patches between gorse and *Erica*, with rabbits helping to slow down complete closing over. Here, some bare sandy ground, then bryophytes and patches of lichens, plus small, browsed gorse seedlings.

Findhorn Dunes, June 2008
Habitat 3A, Fig. 3.3: Plot 3,
A well-developed patch of *Peltigera malacea* (dry state), showing the smooth brown upper surface, and the paler undersurface of the thick, in-rolled lobes. Also here dense moss carpet and some podetia of the cup lichen *Cladonia diversa*.

Findhorn Dunes, June 2008
Habitat 3A, Fig. 3.4: Plot 11, General view of the Plot, showing small 'islands' of gorse and (in the foreground), *Calluna*. Rabbits make some check on the spread of gorse, but it's a losing battle. Good lichen cover at present.

Findhorn Dunes, June 2008
Habitat 3A, Fig. 3.5: Plot 11,

Detail of a patch of *Stereocaulon condensatum* on consolidated sandy soil at edge of 'islands'. Rabbit dropping for scale.

Findhorn Dunes, June 2008
Habitat 3A, Fig. 3.6: Plot 11,

A well-developed patch of *Cladonia subulata*, pale mouse-brown wonky podetia with a slight powdery dusting (soredia).

Findhorn Dunes, June 2008
Habitat 3A, Fig. 3.7: Plot 11,

A lovely patch of fiery-ginger *Cladonia gracilis* (centre), with *Cladonia furcata* (pale ginger) and *Cladonia portentosa*, blondey branched tufts.

Findhorn Dunes, June 2008
Habitat 3A, Fig. 3.8: Plot 11,

Thick, incurled lobes of *Peltigera malacea*, green above (when damp), and pale beige below.

Findhorn Dunes, June 2008
Habitat 3A, Fig. 3.9: Plot 11,

A patch of *Cladonia foliacea*, nestling among grasses, mosses and tufts of *Cladonia portentosa*.

Findhorn Dunes, June 2008. Habitat 3A, Fig. 3.10: Plot 12 (Lyell's Grave). View from the upper path looking north-east through the sea of gorse towards the conifer plantation, and Lyell's Grave (circled).

Findhorn Dunes, June 2008. Habitat 3A, Fig. 3.11: Plot 12 Lyell's Grave. General view of the plot, showing gorse with a *Calluna* zone below, opening out to open shingle and sand at the centre. Lichen cover abundant in the *Calluna* zone and spreading down to the shingle edges, but virtually absent within the dense gorse. Tubed trees are a recent occurrence.

HABITAT 3B

Vegetated fringes at the edge of Gorse stands, particularly low-growing cover of *Calluna* and *Erica*.

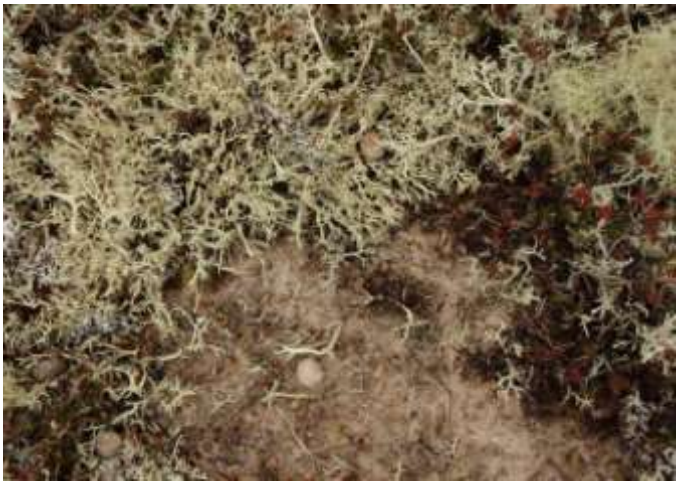
Examples: **(1.6.08) Plot 3 NJ 04915.64243**

Sheltered edges at the bottom of Gorse-dominated dunes can be vegetated by moderately scattered and low-growing *Calluna* and/or *Erica*. This is often rabbit browsed, but not excessively so. In the example at Plot 3, there is a well-defined, narrow path running through the *Calluna*, and zones either side of the path suggest low-levels of trampling (Fig. 3.4). Lichens are able to take advantage of the reduced vigour of the *Calluna*, although the species present have a fairly low tolerance of trampling. Patches of *Cladonia zopfii* are occasional to frequent in open spaces between the *Calluna*, or amongst moribund stands, together with *Cladonia mitis* (rare/occasional) (Fig. 3B.3), *Cetraria aculeata* and *Peltigera membranacea*. On woody stems and exposed *Calluna* roots, *Usnea subfloridana* is fairly frequent (Fig. 3B.4).

Lichens recorded – growing on the ground (T) or on pebbles (Pe); NR = Nationally Rare; NS = Nationally Scarce; NT = Red Data Book category Near Threatened; EN = Red Data Book category Endangered; VU = Red Data Book category Vulnerable; r = rare (at this Plot); r/o = rare/occasional; o = occasional; f = frequent; a = abundant; d = dominant.

Lichens	substrate	additional notes
Cetraria aculeata	T	
Cladonia mitis	T	NT, NR
Cladonia zopfii	T	NS
Peltigera membranacea	T	
Usnea subfloridana	T	

Findhorn Dunes, June 2008
Habitat 3B, Fig. 3B.1: edge of Plot 3, (NJ 04915.64243), edge of gorse on dunes, with rabbit-browsed *Calluna* and *Erica*, with scattered incidences of lichens in this light to moderately trampled area either side of the footpath.



Findhorn Dunes, June 2008
Habitat 3B, Fig. 3B.2: edge of Plot 3,
At the edge of the path, an example of the straggling form of *Cladonia zopfii*, with the brown spiky *Cetraria aculeata*. At the upper right is *Usnea subfloridana*, growing on old exposed *Calluna* roots. Note the presence of rabbit droppings.

Findhorn Dunes, June 2008
Habitat 3B, Fig. 3B.3: edge of Plot 3,
A good example of *Cladonia mitis*, growing here with dove-grey lobes of *Peltigera membranacea*, with an underlying carpet of mosses.

Findhorn Dunes, June 2008
Habitat 3B, Fig. 3B.4: edge of Plot 3,
Further examples of the fluffy *Usnea subfloridana* growing along the edge of the path on old exposed *Calluna* roots or stems. Also here some *Hypogymnia physodes*.

HABITAT 3C

Disturbed and now recovering habitat, associated with edges of dusty tracks, cutting across old shingle and dunes, with *Calluna,* gorse and self-seeded pine.

Examples: **(1.6.08) Plot 13 NJ 05173.64066**

Plot 13 occurs at the corner of the pine plantation, where a wide track runs along the edge of the plantation (see Figs. 3C.1 & 2). There was probably quite heavy disturbance in this area in the past, for example vehicular traffic when the trees were planted. Today, the vegetation has recovered, and a sort of balance between trampling disturbance and vegetation recovery seems to exist. The track diverges here, and seems to be quite heavily used as in places it has cut fairly steep banks through the shingle and dunes. Because of the open, arid nature of the ground, wind-blown dust will be a particular added influence on the vegetation adjacent to the track. There will also be some peripheral trampling over the low vegetation at the sides of the track. Vegetation on the tops of steeper banks will not be trampled.

Lichen interest here is patchy, but still fairly diverse, with a few features not encountered elsewhere, such as some fine colonies of *Leptogium palmatum*, one of the so-called 'jelly' lichens, because the blackish lobes swell slightly when wet, and become slightly jelly-like (see Fig. 3C.1). *Peltigera malacea* is frequent along the turfy edges of the track, usually over mosses under the edges of stunted *Calluna*.

This will always be a disturbed area, and lichen abundance will fluctuate, increasing in periods of low disturbance, and decreasing with increased disturbance.

Lichens recorded from Plot 13, Habitat 3C

Lichens recorded – growing on the ground (T) or on pebbles (Pe); NR = Nationally Rare; NS = Nationally Scarce; NT = Red Data Book category Near Threatened; EN = Red Data Book category Endangered; VU = Red Data Book category Vulnerable; r = rare (at this Plot); r/o = rare/occasional; o = occasional; f = frequent; a = abundant; d = dominant.

Lichens	**substrate**	**additional notes**
Acarospora smaragdula	Pe	
Baeomyces rufus	T	
Cladonia arbuscula	T	
Cladonia gracilis	T	
Cladonia foliacea	T	
Cladonia furcata	T	
Cladonia subulata	T	
Diploschistes muscorum	T	
Hypogymnia physodes	*Calluna* stems	
Hypogymnia tubulosa	*Calluna* stems	
Lecidea auriculata	Pe	
Lecidea plana	Pe	
Leptogium palmatum	T	NS, r
Micarea denigrata	*Calluna* stems	
Parmelia sulcata	*Calluna* stems	

Lichens	substrate	additional notes
Peltigera malacea	T	EN, NR
Platismatia glauca	T	
Porpidia crustulata	Pe	
Porpidia tuberculosa	Pe	
Rhizocarpon reductum	Pe	
Stereocaulon condensatum	T	
Trapelia obtegens	T	
Usnea subfloridana	*Calluna* stems	
23		

Findhorn Dunes, June 2008. Habitat 3C, Fig. 3C.1, Plot 13: Community at the edge of the track, with the thick, in-rolled lobes of *Peltigera malacea* (slightly damp, so the upper surface shows dark green), and *Leptogium palmatum*, seen as the shiny, wrinkled reddish-brown lobes top left, growing directly over sandy soil.

Findhorn Dunes, June 2008
Habitat 3C, Fig. 3C.2: Plot 13,
(NJ 05173.64066), general view of the corner of the conifer plantation, showing the main broad track, with other paths leading off. Banks of *Calluna* and gorse, with occasional self-seeded pine, and intermittent lichen cover.

Findhorn Dunes, June 2008
Habitat 3C, Fig. 3C.3: Plot 13,
An old fence stob at the corner of the plantation by the track (looking NE), with Heather Paul and Brian Coppins examining lichens at the edge of the dusty track.

Findhorn Dunes, June 2008
Habitat 3C, Fig. 3C.4: Plot 13,
Same location as above, but across to the other side of the track, where colonies of *Leptogium palmatum* and *Peltigera malacea* occur below stunted *Calluna* at the edge of the dusty track.

HABITAT 4

Low, linear flat-topped shingle ridges. There are two main forms of ridges:
4A shallow, linear stony ridges with a sand matrix, variously vegetated, > 50% with *Calluna* and/or *Erica*;
4B shallow, linear stony ridges with a sand matrix, variously vegetated, < 50% with *Calluna* and/or *Erica*;

HABITAT 4A

Shallow, linear stony ridges with a sand matrix, variously vegetated, > 50% with *Calluna* and/or *Erica.*

Examples: **4A (1.6.08) Plot 4 NJ 05166.64289**

Plot 4, a typical shallow, linear ridge with > 50% cover of *Calluna* and/or *Erica*, with exposed shingle. There is a broad path-track on the west side of the ridge, which is widely and heavily used (walking and cycling), with a loose gritty, sandy and pebbly surface. There is a Waymark post (Moray Coast Trail, and North Sea Trail Coast Path), indicating a main route or path through the dunes. The ridge itself shows little evidence of disturbance from trampling or cycling. Several pebbles here were seen with *Xanthoparmelia mougeotii* (Fig. 4.2). At the eastern end of the ridge is a large dune extensively blanketed with gorse, *Calluna* and a couple of pines. A cutting through this dune (part of the waymarked path), brings you out onto an open plain, with a series of low shingle ridges comprising Habitat 4B.

Lichens recorded from Habitat 4A (Plot 4)

Lichens recorded – growing on the ground (T) or on pebbles (Pe); NR = Nationally Rare; NS = Nationally Scarce; NT = Red Data Book category Near Threatened; EN = Red Data Book category Endangered; VU = Red Data Book category Vulnerable; r = rare (at this Plot); r/o = rare/occasional; o = occasional; f = frequent; a = abundant; d = dominant.

Lichens	substrate	additional notes
Cetraria aculeata	T	
Cladonia furcata	T	
Cladonia zopfii	T	NS
Xanthoparmelia mougeotii	Pe	

Findhorn Dunes, June 2008
Habitat 4A, Fig. 4.1: Plot 4,
(NJ 05166.64289), Habitat of the low shingle ridge, the pale areas are patches of *Cladonia*. The Moray Coast Trail is the wide track on the left, with the Waymark Post arrowed.

Findhorn Dunes, June 2008
Habitat 4A, Fig. 4.2: Plot 4,
Example of *Xanthoparmelia mougeotii* on a large pebble at Plot 4. Growing over sand is *Cetraria aculeata* and *Cladonia zopfii*.

Findhorn Dunes, June 2008
Habitat 4A, Fig. 4.3: Plot 4,
Looking through a gully where the Moray Coast Trail cuts through dunes at the eastern end of Plot 4, to Plot 5, Habitat 4B spreading extensively on both sides of the Coast Trail.

HABITAT 4B

Shallow, linear stony ridges with a sand matrix, variously vegetated, < 50% with *Calluna* and/or *Erica.*

Examples: **4B (1.6.08) Plot 5 NJ 0532.6432 & NJ 05443.64348**

This habitat appears more arid than 4A, as vascular vegetation is much less frequent, often just scattered individual clumps of rather stunted *Calluna* forming hummocks. These act as 'islands' within an otherwise harsh environment of mostly pebbles, providing low topographical relief (wind resistance), localised shelter zones. The shingle here is very stabilized, small to medium pebbles embedded in sand. The sand has a distinct 'crust', which breaks when you walk over it, and you can break it with your fingers. Although not easily seen with casual looking, these areas are good examples of the formation of 'biological crusts', the binding of the sand grains by micro-organisms. The majority of lichens here are growing on the pebbles, and form coloured patches of mostly black, grey or whitish (species of *Lecidea*), although one crustose lichen is a distinctive yellow-green, the Map lichen, *Rhizocarpon geographicum* (Fig 4.6). It was in this area that *Buellia jugorum* was found on a pebble in 2006. This was not refound in 2008, though there are millions of pebbles, so it is a bit like a needle in a haystack to find a specific species, and one is always aware of trampling over a delicate and fragile habitat. So for the time being, the 2006 remains the single British record for this Arctic-Alpine lichen, although it is very likely to be present on other pebbles here. The delicate foliose lichen *Xanthoparmelia mougeotii* is occasional on pebbles. Apart from occasional to frequent clumps of *Cladonia zopfii*, there are very few lichens growing directly on the sand (Fig. 4.5).

Lichens recorded – growing on the ground (T) or on pebbles (Pe); NR = Nationally Rare; NS = Nationally Scarce; NT = Red Data Book category Near Threatened; EN = Red Data Book category Endangered; VU = Red Data Book category Vulnerable; r = rare (at this Plot); r/o = rare/occasional; o = occasional; f = frequent; a = abundant; d = dominant.

Lichens	**substrate**	**additional notes**
Acarospora smaragdula	Pe	
Cladonia zopfii	T	NS
Hypogymnia physodes	T	
Lecanora polytropa	Pe	
Lecidea brachyspora	Pe	NS
Lecidea diducens	Pe	NS
Lecidea plana	Pe	
Miriquidica pycnocarpa	Pe	
Polysporina simplex	Pe	
Porpidia crustulata	Pe	
Protoparmelia badia	Pe	
Rhizocarpon geographicum	Pe	
Rhizocarpon reductum	Pe	
Xanthoparmelia mougeotii	Pe	

Findhorn Dunes, June 2008
Habitat 4B, Fig. 4.4: Plot 5,
NJ 0532.6432.
Looking SE across the low shingle ridge, with the wind turbines beyond the dense gorse. end of Plot 4, to Plot 5, Habitat 4B spreading extensively on both sides of the Coast Trail.

Findhorn Dunes, June 2008
Habitat 4B, Fig. 4.5: Plot 5,
Typical example of the habitat, with scattered pebbles and sand, with *Cladonia zopfii* growing on sand.

Findhorn Dunes, June 2008
Habitat 4B, Fig. 4.6: Plot 5,
Lichen colonization on pebbles is mostly of small grey crustose species of *Lecidea*, but also occasionally the bright yellow-green of the Map lichen, *Rhizocarpon geographicum*.

HABITAT 5

Shingle in the lee of partial development of self-seeded pine.

Examples: **(1.6.08) Plot 6 NJ 05592.64320**

There are scattered pockets of self-seeded pine throughout the sites, often in conjunction with stands of gorse and/or *Calluna*, but sometimes just as a few pines (Fig. 5.1). Development of individual pine trees on sand or shingle depends on the amount of nutrient available and degree of exposure to wind. Traditionally, pines are planted at the back of dunes in order to curtail spread of wind-blown sand from mobile dunes encroaching onto reclaimed farmland, golf courses, campsites, holiday homes or permanent dwellings. Culbin Forest across the Findhorn River is a classic example of massive planting of dunes and old shingle ridges. At Culbin, development of lichen-rich habitats occurs where pines have failed or remain very stunted and dwarf because of lack of nutrients in the sandy soils. In parts of Culbin where the pines have grown strongly, lichen interest has decreased and often disappeared. Lichens like light, and, in nutrient-poor conditions where other plants cannot exist or are stunted, lichens are able to be present and form robust communities. The self-seeded pines on the dunes at Findhorn are generally regarded as detrimental and needing to be removed, simply because if left unchecked they will spread, and eventually would overwhelm and reduce the unique habitats of the Findhorn dunes.

There is no hard line between one habitat and another, there are only gradients in between. So there exists a gradient between open, exposed shingle ridges, and shingle under pine. At Plot 6, the habitat at the edges of the scattered clump of pines has different characteristics to the shingle under the pine, and different also to the adjacent open shingle beds. The pines here are not dense or fully grown; they provide shelter to the shingle in the immediate vicinity: shelter from wind scouring across the open habitat, plus increase (or extended time-periods) of localized humidity. There is also some needle litter present (Fig. 5.6) and evidence of rabbits. The area we examined (Plot 6) lies south of the track and SE in the lee of the pine (Figs. 5.1–5.3). The lichen assemblages present on shingle and on the sandy matrix were very luxuriantly developed with several species not seen elsewhere (bearing in mind that our visit of three day meant that our cover of the site was not exhaustive).

As for what (if anything) to do about the pines on the dunes, see Management Recommendations.

Notable species present include several pebbles with examples of *Arctoparmelia incurva* (Fig. 5.4), sometimes found overgrowing *Xanthoparmelia mougeotii*. Another interesting species here is *Pycnothelia papillaria*, spreading over pebbles and sand in untidy patches (Fig. 5.5). Also spreading over pebbles and sand, and binding all together, is *Parmelia saxatilis*, together with localized patches of *Ochrolechia frigida* f. *frigida* (Fig. 5.7). *Ochrolechia frigida* f. *lapuensis* was also present; this is the rare form, with discrete powdery patches (soralia). Two leafy lichens often seen growing on trees are also here, *Platismatia glauca* and *Pseudevernia furfuracea*, growing amongst pebbles and sand. Scattered incidences of *Peltigera malacea* were

also noted, and localized clumps of *Cladonia portentosa*, some of the latter scuffed up by rabbits.

Lichens recorded – growing on the ground (T) or on pebbles (Pe); NR = Nationally Rare; NS = Nationally Scarce; NT = Red Data Book category Near Threatened; EN = Red Data Book category Endangered; VU = Red Data Book category Vulnerable; r = rare (at this Plot); r/o = rare/occasional; o = occasional; f = frequent; a = abundant; d = dominant.

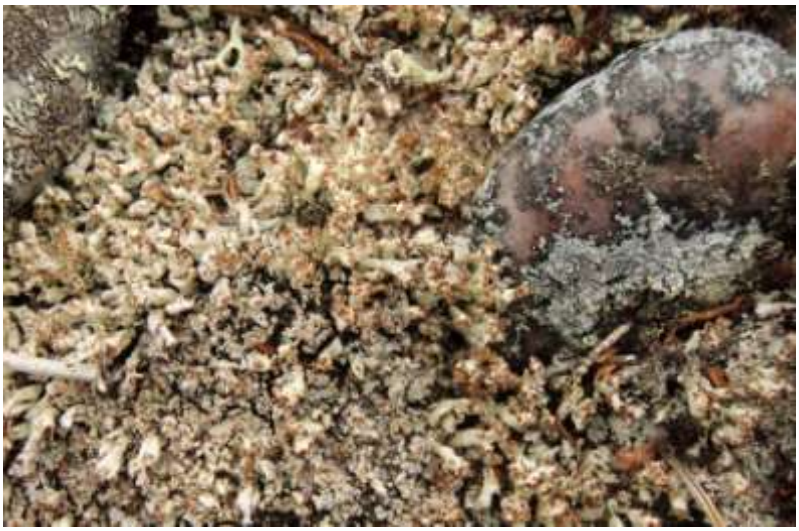
Lichens	**substrate**	**additional notes**
Arctoparmelia incurva	Pe	
Bacidia caligans	T	
Cetraria aculeata	T	
Cladonia cervicornis	T	
Cladonia gracilis	T	
Cladonia portentosa	T	
Cladonia subcervicornis	T	
Dibaeis baeomyces	T	
Ochrolechia frigida f. lapuensis	T-Pe	NR
Parmelia saxatilis	T-Pe	
Peltigera malacea	T	EN, NR
Platismatia glauca	T-Pe	
Pseudevernia furfuracea var. ceratea	T	
Pycnothelia papillaria	T-Pe	
Rhizocarpon geographicum	Pe	
Rimularia furvella	Pe	with *X. mougeotii*
Stereocaulon condensatum	T	NS
Trapelia placodioides	Pe	
Usnea subfloridana	**Calluna**	
Xanthoparmelia mougeotii	Pe	frequent

Findhorn Dunes, June 2008
Habitat 5, Fig. 5.1: Plot 6,
NJ 05592.64320.
Standing on the Moray Coastal Trail, looking eastwards from the edge of Plot 5 towards the small group of pines.

Findhorn Dunes, June 2008
Habitat 5, Fig. 5.2: Plot 6,
Plot 6 lies just to the right of the photograph here. This shot is taken looking towards the Fingerpost at the junction of the trails. Habitat 6 (Plot 7) lies ahead, between the Trail and the gorse.

Findhorn Dunes, June 2008
Habitat 5, Fig. 5.3: Plot 6,
Looking back to Plot 6 (circled) in the lee of the pines. Note the position of the Fingerpost at the junction of the trails.

Findhorn Dunes, June 2008
Habitat 5, Fig. 5.4: Plot 6,
Examples of *Arctoparmelia incurva* on a big pebble.



Findhorn Dunes, June 2008
Habitat 5, Fig. 5.5: Plot 6,
This "messy-looking" lichen is *Pycnothelia papillaria*, growing on sandy spaces between pebbles.

Findhorn Dunes, June 2008
Habitat 5, Fig. 5.6: Plot 6,
General view of the habitat of pebbles in this habitat, where pine needles form a litter, together with bits of dead heather. The green Map lichen is frequent here, and bits of *Cetraria aculeata* (top left).

Findhorn Dunes, June 2008, Habitat 5, Fig. 5.7: Plot 6,: **an example of *Ochrolechia frigida* form *frigida*, showing the wonderfully creamy colour and well developed spines, so typical of this lichen. In upland montane areas where it occurs most usually, it is often poorly developed and eroded, but at Findhorn it is beautiful.**

HABITAT 6

Exposed, open stone fields, formerly shingle deposits, with scattered dwarf *Calluna* (some moribund) with abundant lichen cover of up to 100% over sand and shingle.

Examples: **(1.6.08) Plot 7 NJ 05690.64279**

This is perhaps the most exciting habitat, and to stumble upon this is a real experience. Initially, it seems so arid, so grey and depressing; on a sun-less day, it seems bleak and stark; on a sunny day it seems like the desert, glaring and reflective, heat bouncing off the sand and the stones – what a desperate place, an "extreme" habitat where life must struggle to survive.

Yet there is abundant life here, mostly lichens, with cover values ranging from 70–100%. The habitat is quite distinctive, a stone field of small pebbles in a sandy matrix, that must be derived from an extensive shingle ridge that is flattened. It is a quite open rectangular space, with part of the Moray Coast Trail forming a wide shallow trackway along the northern edge of the habitat, and the southern and western edges fringed with long hedges of gorse. The eastern end abuts onto the barrier fence of RAF Kinloss.

Calluna shrubs are present, forming small hummocks and ranging in density from close together, almost touching, to widely scattered and moribund. The spaces between the *Calluna* are dominated by 'carpets' of the grey, foliose lichen *Parmelia saxatilis* (occasionally also with the very similar-looking *P. omphalodes*) (Figs. 6.4 & 6.5). Other leafy lichens in this community are the pale, silvery-grey patches of *Hypogymnia physodes*, and occasional spreading clumps of pale grey branches of *Pseudevernia furfuracea* (Fig. 6.6). So abundant is the cover of lichens in some parts, that the ground looks grey, with occasional small white quartz pebbles dotted about (Fig. 6.3).

In between the dominant grey lichen cover are the dark brown areas of the ubiquitous *Cetraria aculeata*, nestling between a few exposed pebbles (Fig. 6.5). In some parts of Plot 7, are patches of *Ochrolechia frigida* – where this is really well developed, it looks the colour of Ambrosia rice pudding (Fig. 6.7). Forming crusts over sand and pebbles are *Ochrolechia androgyna*, *Pycnothelia papillaria*, *Stereocaulon condensatum*, *Trapeliopsis granulosa* and *Baeomyces rufus*. Scattered clumps of *Cladonia portentosa* are found colonising at the edges of *Calluna* clumps, and in more open spaces *Cladonia strepsilis* (Fig. 6.1) and *Cladonia uncialis* subsp. *uncialis* (Fig. 6.10). An unusual fine on a pebble was *Pseudephebe pubescens* (Fig. 6.8 & 6.9). This Arctic-Alpine lichen is characteristic of windswept montane sites; it is dark brown-black, and forms tight mats of interwoven wiry strands over siliceous rocks. Small bryophytes are also present growing through the sand, but are almost squeezed out by the vigour of the lichens.

Several lichens were recorded growing on *Calluna* stems: *Buellia griseovirens*, *Evernia prunastri*, *Imshaugia aleurites*, *Ochrolechia androgyna*, *O. microstictoides*, *Parmelia saxatilis* and *Usnea subfloridana*.

Towards the eastern end of Plot 7, scattered incidences of *Alectoria sarmentosa* subsp. *vexillifera* occurs in three sub-habitats:

(a) it is found as individual, sometimes tiny isolated strands, seemingly growing directly on sand in areas best described as 'bare' where there is very little vegetation, just scattered pebbles partly buried in a sandy matrix (Figs. 6.11–6.13). However, it seems to be associated with *Cetraria aculeata*, which does grow directly (and fairly firmly) on sand, and the strands of *Alectoria* wind round and get attached to the *Cetraria*. This sub-habitat for *Alectoria* was seen along the northern edge of the eastern part of Plot 7, where it abuts not the track.

(b) associated with moribund, partly buried *Calluna*, the sub-shrub appearing as an open arc, with short twigs and often exposed roots. *Alectoria* is seen as winding around exposed roots (Figs. 6.14–6.19) or in some instances, winding around *Calluna* shoots, but almost always *Cetraria aculeata* is also present. Associated species growing on the ground include *Cladonia subcervicornis*, *Pycnothelia papillaria* and *Stereocaulon condensatum*.

(c) amongst dwarf but fairly robust *Calluna* (Figs. 6.20–6.25); *Alectoria* in this situation is often quite thickly developed, and is entwined around *Calluna* stems and in close association with several other lichens, including *Cetraria aculeata*. At least six large patches and several smaller occur here. The GPS for this little 'hot-spot' of *Alectoria* is NJ 05915.64266.

Examples: **(4.6.08)** **Plot 20** **(i) NJ 06076.64489**
(ii) NJ 06040.64496
(iii) NJ 06039.64492

Plot 20 is really a little outlier of Plot 7, an area of dune at the NW corner of the RAF perimeter fence. It was recorded on 4 June, after we had worked along the north edge of the dunes, and reached the far eastern edge of the site, on the Way-marked Moray Coastal Trail (see Fig. 6.25 & 26).

Colonies of *Alectoria sarmentosa* subsp. *vexillifera* were found at three sub-sites, with 3 patches at the first, 2 patches at the second, and 3 at the third. All patches were very well developed and looking healthy. Most of the examples in Plot 20 would fall into the third sub-habitat described above, i.e. associated with several other lichens, often with plants of Calluna present, but here also some small grasses were also noted as being in the overall assemblage.

Lichens recorded from Habitat 6 (Plots 7 & 20)

Lichens recorded – growing on the ground (T) or on pebbles (Pe); NR = Nationally Rare; NS = Nationally Scarce; NT = Red Data Book category Near Threatened; EN = Red Data Book category Endangered; VU = Red Data Book category Vulnerable; r = rare (at this Plot); r/o = rare/occasional; o = occasional; f = frequent; a = abundant; d = dominant.

Lichens	substrate	Plot No.		additional notes
		7	20	
Alectoria sarmentosa subsp. vexillifera	T, *Calluna* twigs	✔	✔	NS
Aspicilia grisea	Pe	✔	✔	(fertile)
Baeomyces rufus	T	✔		
Buellia aethalea	Pe	✔	✔	
Buellia griseovirens	*Calluna* twigs	✔		
Cetraria aculeata	T	✔	✔	
Cladonia arbuscula	T		✔	
Cladonia ciliata var. tenuis	T		✔	
Cladonia diversa	T	✔		
Cladonia furcata	T		✔	
Cladonia mitis	T		✔	NT, NR
Cladonia portentosa	T	✔		
Cladonia subcervicornis	T	✔		
Cladonia strepsilis	T	✔	✔	
Cladonia uncialis subsp. uncialis	T	✔		VU, NS
Cladonia zopfii	T		✔	NS
Evernia prunastri	T, *Calluna* twigs	✔		
Fuscidea cyathoides	Pe	✔	✔	
Fuscidea lygaea	Pe		✔	
Hypogymnia physodes	T, Pe	✔	✔	
Imshaugia aleurites	*Calluna* twigs	✔		
Lecanora polytropa	Pe	✔	✔	
Lecidea brachyspora	Pe	✔		NS
Lecidea plana	Pe	✔		
Ochrolechia androgyna	T, *Calluna* twigs	✔		
Ochrolechia frigida f. frigida	T	✔		
Ochrolechia frigida f. lapuensis	T	✔		NR
Ochrolechia microstictoides	*Calluna* twigs	✔		
Parmelia omphalodes	T, Pe	✔		
Parmelia saxatilis	T, Pe, *Calluna* twigs	✔	✔	
Porpidia tuberculosa	Pe	✔	✔	
Pseudephebe pubescens	Pe	✔	✔	
Pseudevernia furfuracea	T, Pe	✔		
Pycnothelia papillaria	T	✔		
Rhizocarpon lecanorinum	Pe	✔		
Rhizocarpon reductum	Pe	✔	✔	
Rimularia furvella	Pe	✔		X mou

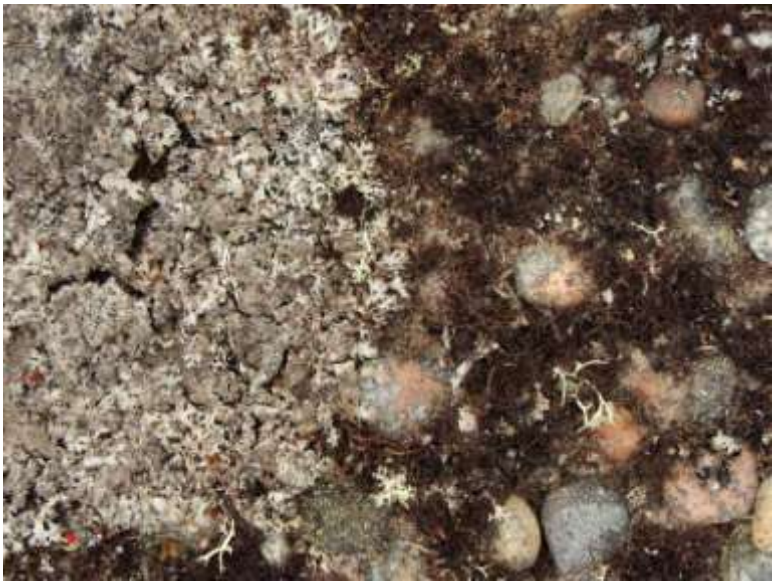
Lichens	substrate	Plot No.		additional notes
		7	20	
Scoliciosporum umbrinum	Pe	✔		
Stereocaulon condensatum	T	✔	✔	NS
Trapeliopsis granulosa	T	✔		
Usnea subfloridana	*Calluna* twigs	✔	✔	
Xanthoparmelia mougeotii	Pe	✔	✔	
42	24 T, 18 Pe, 8 *Calluna* twigs			

Findhorn Dunes, June 2008: Habitat 6, Fig. 6.1 (Plot 7), detail of *Cladonia strepsilis*, the greenish-beige squamules (tiny lobes) nestling over pebbles and sand, with other lichens including the brown spiky branches of *Cetraria aculeata*.

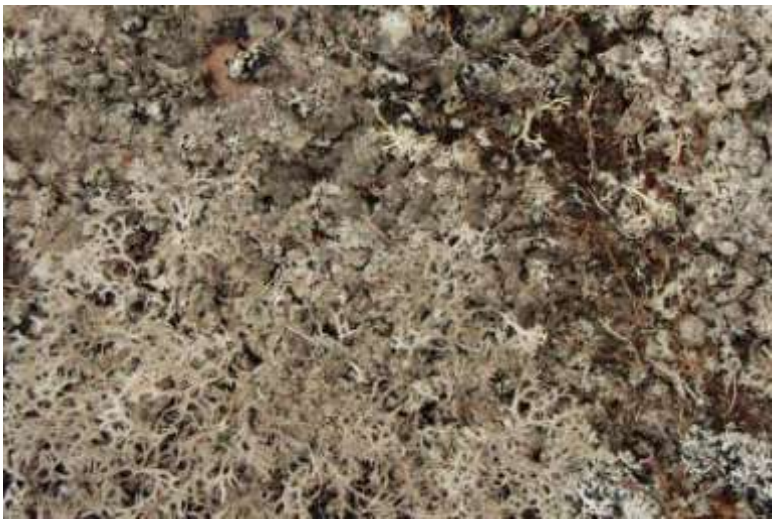
Findhorn Dunes, June 2008
Habitat 6, Fig. 6.2: Plot 7,
NJ 05690.64279
Looking east towards the perimeter fence to RAF Kinloss at the far end of this plot. This shows the typical habitat, with scattered *Calluna* and 'carpets' of lichens everywhere.

Findhorn Dunes, June 2008
Habitat 6, Fig. 6.3: Plot 7,
A closer view, showing a few areas where the underlying shingle is exposed, but elsewhere apart from *Calluna* and bryophytes, lichens are dominant in this landscape.

Findhorn Dunes, June 2008
Habitat 6, Fig. 6.4: Plot 7,
Detail of the typical lichen community, the dominant grey is a mantle of *Parmelia saxatilis*, with the brown (top left) of *Cetraria aculeata*.



Findhorn Dunes, June 2008
Habitat 6, Fig. 6.5: Plot 7,
Close up, showing the leafy lobes of *Parmelia saxatilis* covering both shingle and sand, whereas the spiky *Cetraria aculeata* grows nearly always directly on sand. A few podetia of *Cladonia diversa* with red fruits also present.



Findhorn Dunes, June 2008
Habitat 6, Fig. 6.6: Plot 7,
A silvery-grey shrubby lichen here, *Pseudevernia furfuracea* with delicate upraised branches, growing with *Parmelia saxatilis*, *Cetraria aculeata* and *Hypogymnia physodes*.

Findhorn Dunes, June 2008
Habitat 6, Fig. 6.7: Plot 7,
Dense ground cover here, with ericoid sub-shrubs almost overwhelmed by lichens, including the rich creamy coloured *Ochrolechia frigida*.

Findhorn Dunes, June 2008
Habitat 6, Fig. 6.8: Plot 7,
A large pebble amongst the more usual small sized shingle, near the northern edge of Plot 7. The dark lichen here is *Pseudephebe pubescens*, and Arctic-Alpine lichen found more often in the mountains.

Findhorn Dunes, June 2008
Habitat 6, Fig. 6.9: Plot 7,
Detail of *Pseudephebe pubescens*, showing the finely divided, interlaced branching pattern of the lobe ends.

Findhorn Dunes, June 2008: Habitat 6, Fig. 6.10 (Plot 7): *Cladonia uncialis* subsp. *uncialis*, with (left) showing the general habit, and (right) close-up detail of the way the tips of the podetia flare out like brown-tipped stars around a central hole.

Findhorn Dunes, June 2008
Habitat 6, Fig. 6.11: Plot 7,
Looking east (towards the fence of RAF Kinloss), the walking stick marks a spot where *Alectoria sarmentosa* subsp. *vexillifera* occurs (about 20 incidences along this edge. The Waymark post is where the track diverges.

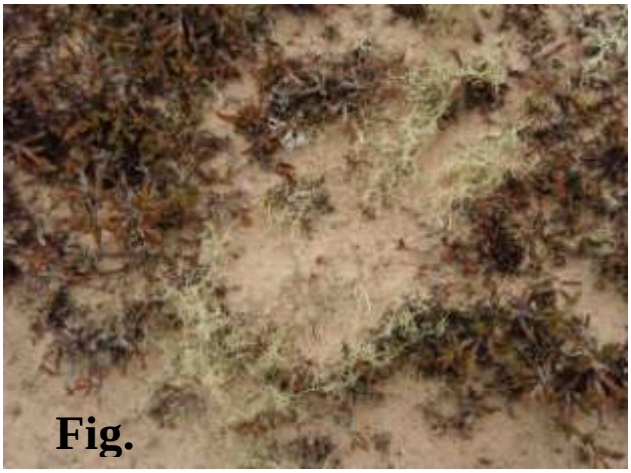
Findhorn Dunes, June 2008
Habitat 6, Fig. 6.12: Plot 7,
Showing the habitat of small, loose shingle over a sandy matrix. Despite appearances, there is a slight biological 'crust' present, which looks grey when viewed from a distance. Circled areas are *Alectoria sarmentosa*.

Findhorn Dunes, June 2008
Habitat 6, Fig. 6.13: Plot 7,
Detail of *Alectoria sarmentosa* subsp. *vexillifera* (Mountain witches' hair), the yellow strands caught up with the stiff spiky dark brown branches of *Cetraria aculeata*.

Findhorn Dunes, June 2008
Habitat 6, Fig. 6.14: Plot 7,
Examples of *Alectoria sarmentosa* subsp. *vexillifera* associated with exposed roots of old, moribund *Calluna* on the shingle and sand habitat. Note the slight grey cover over the sand on the left; this is the delicate biological crust.

Findhorn Dunes, June 2008
Habitat 6, Fig. 6.15: Plot 7,
Another example (circled). Here, the *Calluna* bush is reduced to a narrow arc of young, living twigs. The pale grey lichen on *Calluna* stems is *Hypogymnia physodes*.

Findhorn Dunes, June 2008
Habitat 6, Fig. 6.16: Plot 7,
A partially buried *Calluna* bush, supporting several strands of *Alectoria sarmentosa*. The pale green area (bottom right) is a partly submerged mat of moss, binding the sand grains together. A lot going on here.



Findhorn Dunes, June 2008
Habitat 6, Fig. 6.17: Plot 7, (above, left) close-up of the strands of *Alectoria sarmentosa* subsp. *vexillifera* seen in Fig. 6.16.

Findhorn Dunes, June 2008
Habitat 6, Fig. 6.18: Plot 7, (above, right) another example of *Alectoria sarmentosa* on old *Calluna* roots, here with *Cetraria aculeata*. A small whitish patch of *Stereocaulon condensatum* can be seen at the bottom of the picture.

Findhorn Dunes, June 2008
Habitat 6, Fig. 6.19: Plot 7, (left) Close-up of *Alectoria sarmentosa* subsp. *vexillifera*, twined around an exposed root of *Calluna*, and with a small tuft of *Cetraria aculeata* also present.

Findhorn Dunes, June 2008
Habitat 6, Fig. 6.20: Plot 7,
Looking south, a 'hot-spot' for *Alectoria sarmentosa* subsp. *vexillifera* (to left of bag). The bare sand area is due to rabbit disturbance, creating localized areas for early colonising species to establish.

Findhorn Dunes, June 2008
Habitat 6, Fig. 6.21: Plot 7,
Large, tangled strands of *Alectoria sarmentosa* wound round old *Calluna* and some of the *Cladonia* species here. Elsewhere, *Parmelia saxatilis* over pebbles, and clumps of *Hypogymnia physodes*.

Findhorn Dunes, June 2008
Habitat 6, Fig. 6.22: Plot 7,
Two large clumps of *Alectoria sarmentosa* entangled with *Cetraria aculeata*, *Cladonia portentosa*, *Cladonia furcata* and *Calluna* stems. This habitat is rich with lichens.

Findhorn Dunes, June 2008: Habitat 6, Fig. 6.23: Plot 7. A really well-grown mass of *Alectoria sarmentosa* (Mountain witches' hair, even has a slight 'blue rinse'), with *Cetraria aculeata*, *Cladonia furcata*, *Ochrolechia androgyna*, and a bit of *Xanthoparmelia mougeotii* on a pebble (upper right).

Findhorn Dunes, June 2008: Habitat 6, Fig. 6.24: Plot 7. Another superb example of *Alectoria sarmentosa*, with *Hypogymnia physodes* and *Cladonia* spp.

Findhorn Dunes, June 2008: Habitat 6

Fig. 6.25: Plot 20

Standing near the Waymark post for the Moray Coastal Trail, looking east (the main trail follows round to the left). The figures are standing at the site of the first *Alectoria sarmentosa* find of Plot 20.

Findhorn Dunes, June 2008: Habitat 6

Fig. 6.26: Plot 20

The Moray Coastal Trail, looking north. The third site for *Alectoria sarmentosa* find of Plot 20 (circled).

Findhorn Dunes, June 2008: Habitat 6

Fig. 6.27: Plot 20

Two well-formed examples of *Alectoria sarmentosa* (circled) at the first site of Plot 20, NJ 06076.64489.

Associated species are *Cetraria aculeata*, *Cladonia arbuscula* and *Cladonia furcata*.

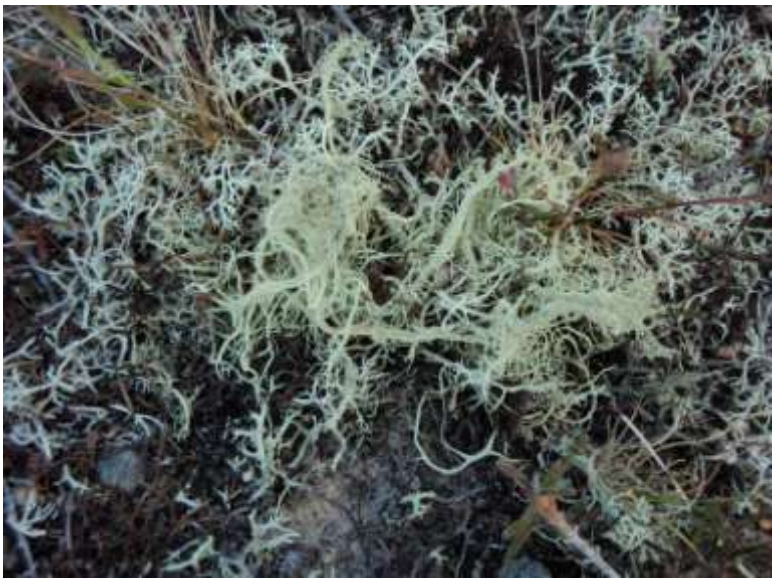
Picture taken in bright sunshine.

Findhorn Dunes, June 2008: Habitat 6

Fig. 6.28: Plot 20

One of the two examples of *Alectoria sarmentosa* at the second site of Plot 20, NJ 06040.64496.

Associated species include mostly *Cetraria aculeata*, and there is quite a bit of bare sand present. (Shade, using umbrella).



Findhorn Dunes, June 2008: Habitat 6

Fig. 6.29: Plot 20

Another example of *Alectoria sarmentosa* at the second site of Plot 20. Associated species here include some grasses, *Cetraria aculeata*, *Cladonia furcata* and *Cladonia portentosa*.

Findhorn Dunes, June 2008: Habitat 6

Fig. 6.30: Plot 20

Alectoria sarmentosa at the third site of Plot 20, NJ 06039.64492.

A long straggling example, entwined around small *Calluna* plants, *Cetraria aculeata* and *Cladonia portentosa*.

HABITAT 7

Very exposed, coastal open stone fields and shallow shingle ridges, with scattered flattened and wind-sculptured *Calluna*. In some places lichen cover is up to 70% over sand and shingle. This habitat encompasses an extensive zone at the northern edge of the central section of the Findhorn Dunes, along the coastal edge of the consolidated shingle beds. This habitat is difficult to clearly categorize and delimitate as shingle ridges grade into stone fields, and prostrate *Calluna* occurs at one area, grading into more dwarf forms where there is slight rise in topography offering a modicum of shelter. Lichen interest here is extraordinary – this is an extreme and hostile habitat, in many ways similar to the fell-fields on montane plateaux; how does *Calluna* cling to life? How do the leafy-lobed lichens cling to the shingle beds without being blasted away? How do the lichens on shingle survive being baked by relentless hot sun in high summer, or pounded by rain, hail and sleet in winter, and scoured by sand blowing over the surface in gales?

Description of this habitat follows our route across it, in good weather on 4th June, with Dr Chris Ellis and Dr Rebecca Yahr. We moved from west (Plots 14 & 15) to east (Plots 16, 17, 18, & 19). (N.B. Plot 17 is included in Habitat 8).

Examples: **(4.6.08)** **Plot 16** **NJ 05136.64598**

A series of low shingle ridges; at the western ends looking yellow with bird's foot trefoil (see Fig. 7.1) amongst dwarf *Calluna*, and clumps of *Cladonia arbuscula*, *C. ciliata* var. *tenuis* and *C. portentosa*. In little local niches amongst the *Calluna* there are patches of *Cladonia gracilis*. *Hypogymnia physodes* occurs on the ground as well as on *Calluna* twigs. Towards the central section, exposed pebbles on the ridges support several curled up foliose lichens, such as *Parmelia omphalodes* and *P. saxatilis*. On sand between the shingle are scattered clumps of the straggly *Cladonia zopfii*.

At the eastern ends of these ridges, the topography flattens out, and greater exposure to severe winds has resulted in prostrate, wind-sculptured *Calluna*, hugging the ground. *Cladonia zopfii* is occasional. On the pebbles, foliose lichens such as *Parmelia saxatilis* seem to occur more frequently on the ridges rather than on the slopes of shingle ridges. The reason for this is unclear, but may be related to sea mists condensing or dew forming slightly more abundantly on stones on the tops of ridges. Other lichens include *Xanthoparmelia mougeotii* (occasional), *X. pulla* (rare to occasional, also spreading directly on to sand), *Rhizocarpon geographicum* (occasional)

Findhorn Dunes, June 2008: Habitat 7, Fig. 7.1 (Plot 16), (left) approach to Plot 16 from a trampled track. The western section is yellow with bird's foot trefoil. Note the prominent dune in the background (circled).

Fig. 7.2 (right) the middle section of the shingle ridges, showing typical habitat. Same dune in the background (circled).

Fig. 7.3 (left), looking east towards the same prominent dune, the eastern section of the shingle ridges, showing greater exposure to on-shore winds. Plot 17 (Fields of Zopf) and Plot 18 (*Calluna* ridges) occur towards the background right of the picture.

Fig. 7.4 (right) close-up of the shingle habitat with prostrate, wind-sculptured *Calluna*.

Findhorn Dunes, June 2008: Habitat 7, Fig. 7.5 (Plot 16), Examples of the unusual lichen cover seen amongst shingle in Plot 16. The curled-up fragments that look like dead leaves are *Parmelia saxatilis*, growing on the biological crust on sand. The grey patches on the pebbles are crustose lichens.

Findhorn Dunes, June 2008: Habitat 7, Fig. 7.6 (Plot 16), Here, foliose lichens (*Parmelia saxatilis* and *Xanthoparmelia mougeotii*) are growing directly on pebbles. When the lichen gets old, it fragments and blows away, leaving the stone temporarily bare of lichen cover.

Findhorn Dunes, June 2008: Habitat 7, Fig. 7.6 (Plot 16), An example of *Xanthoparmelia mougeotii* spreading over a pebble. Probably, lichen cover on pebbles here is cyclical, with periods when the stone is covered, followed by a bare period, then colonisation re-starts.

Examples: **(4.6.08)** **Plot 18** **NJ 05225.64598**

Slightly more inland than Plot 16, this is a series of low shingle ridges, the shallow sloping side (facing the sea) is covered with fairly robust dwarf *Calluna*. The shingle and sand gaps in between the *Calluna* provide a sheltered habitat niche for a range of lichens, including *Cladonia zopfii* (in large gaps) and *Peltigera malacea* (in small gaps, or in the lee of *Calluna*. On the landward edges of the ridges where the shingle and sand is exposed and forming a slight bank, *Diploschistes muscorum* is locally frequent.

Findhorn Dunes, June 2008: Habitat 7, Fig. 7.7 (Plot 18), Looking west along the two shingle ridges (the sea is away to the right out of shot). The fairly dense cover of robust, dwarf *Calluna* is clearly seen, together with the mosaics of gaps

Examples: **(4.6.08)** **Plot 19** **NJ 05356.64600**

The small shingle forming stony fields and low, undulating ridges represents an extreme habitat, where the effect of exposure to severe on-shore winds can be clearly seen by the prostrate form of the *Calluna* (see Figs. 7.11–13). *Parmelia saxatilis* encrusts small shingle, binding it together; *Xanthoparmelia mougeotii* is occasional to frequent on pebbles (Fig. 7.14 & 15), whereas *Xanthoparmelia pulla* is more localized, but can be abundant where it does occur, encrusting pebbles and growing directly over sand (Fig. 7.16). Other species are rare or infrequent, such as *Cetraria aculeata*, *Cladonia diversa*, *C. foliacea* and *C. zopfii*.

Findhorn Dunes, June 2008: Habitat 7.

Fig. 7.8 (Plot 19)

Looking north to the sea of the Moray Firth from a raised dune, across open stone fields with scattered *Calluna*.

Findhorn Dunes, June 2008: Habitat 7.

Fig. 7.9 (Plot 19)

Small shingle in slightly raised and undulating ridges above the shore. This is a very exposed and hostile environment, with small, scattered clumps of *Calluna* and patches of lichens.

Findhorn Dunes, June 2008: Habitat 7.

Fig. 7.10 (Plot 19)

View of the edge of the shingle ridge at the coast (looking east). The beach has mobile shingle, immersed twice a day at high tide. Above the shore, the eroding dune edge clearly shows successive layers of shingle embedded in the profile.

Findhorn Dunes, June 2008: Habitat 7.

Fig. 7.11–13 (Plot 19)

Examples of the amazing prostrate and wind-sculptured *Calluna* on the exposed stone fields of Plot 19. They look almost like prehistoric fossils. It is difficult to know how old these sub-shrubs could be, but they have an amazing tenacity to survive.

Blown sand collects amongst the prostrate canopy. Some lichens become established in local niches between the stones, and then are able to spread out from a firm base. Some stones are coloured with grey and blackish crustose lichens.

Findhorn Dunes, June 2008: Habitat 7.

Fig. 7.14–16 (Plot 19)

Community life on pebbles at Plot 19. In **Fig. 7.14** the main lichen colonizing pebbles is *Xanthoparmelia mougeotii* (seen as greenish 'fingers'). The little grey and blackish crusts are species of *Lecidea*. There is a patch of *Parmelia saxatilis* on the sand at bottom left.

Fig. 7.15 shows *Parmelia omphalodes* and *Parmelia saxatilis* encrusting pebbles.

Fig. 7.16 *Xanthoparmelia pulla* (brown lobes) growing over a large pebble, the lobes spreading out over sand to include other pebbles and a *Calluna* stem. The grey lichen is *Hypogymnia physodes*.

Lichens recorded from Habitat 7 (Plots 16, 18 & 19).

Lichens recorded – growing on the ground (T) or on pebbles (Pe); NR = Nationally Rare; NS = Nationally Scarce; NT = Red Data Book category Near Threatened; EN = Red Data Book category Endangered; VU = Red Data Book category Vulnerable; r = rare (at this Plot); r/o = rare/occasional; o = occasional; f = frequent; a = abundant; d = dominant.

Lichens	substrate	Plot No.			additional notes
		16	18	19	
Acarospora smaragdula	Pe	✔			
Aspicilia grisea	Pe	✔		✔	
Buellia aethalea	Pe			✔	
Catillaria atomarioides	Pe	✔			NS
Cetraria aculeata	T	✔	✔	✔	
Cladonia arbuscula	T	✔			
Cladonia cervicornis subsp. verticillata	T		✔		
Cladonia chlorophaea agg.	T		✔		
Cladonia ciliata var. tenuis	T	✔			
Cladonia diversa	T			✔	
Cladonia foliacea	T		✔	✔	
Cladonia furcata	T		✔		
Cladonia gracilis	T	✔	✔		
Cladonia mitis	T		✔		NT, NR
Cladonia portentosa	T	✔			
Cladonia rangiformis	T		✔		
Cladonia subulata	T		✔		
Cladonia zopfii	T	✔	✔	✔	NS
Diploschistes muscorum	T		✔		
Fuscidea cyathoides	Pe		✔	✔	
Hypogymnia physodes	T, *Calluna*	✔	✔		
Hypogymnia tubulosa	T, *Calluna*	✔	✔		
Lecanora polytropa	Pe	✔	✔		
Lecidea fuscoatra	Pe	✔			
Lecidea lithophila	Pe	✔			
Lecidea plana	Pe	✔			
Miriquidica pycnocarpa	Pe	✔			
Parmelia omphalodes	Pe	✔		✔	
Parmelia saxatilis	Pe	✔	✔	✔	
Peltigera malacea	T		✔		EN, NR
Peltigera membranacea	T		✔		
Pertusaria corallina	Pe			✔	r
Platismatia glauca	T		✔	✔	
Polysporina simplex	Pe	✔			
Porpidia tuberculosa	Pe	✔			
Protoparmelia badia	Pe	✔		✔	
Protothelenella corrosa	Pe	✔			NS
Rhizocarpon geographicum	Pe	✔	✔	✔	
Rhizocarpon reductum	Pe	✔	✔	✔	

Lichens	substrate	Plot No.			additional notes
		16	18	19	
Scoliciosporum umbrinum	Pe	✔		✔	
Tremolecia atrata	Pe			✔	
Xanthoparmelia mougeotii	Pe	✔	✔	✔	
Xanthoparmelia pulla	Pe	✔		✔	

HABITAT 8

Open, flat stony areas, with scattered, dwarf *Calluna*; lichen cover almost restricted to a single species, *Cladonia zopfii*, which is abundant, creating a pale green haze over the site. This habitat we called "**The Fields of Zopf**". Two examples only are listed here (Plot 8 and Plot 17), but this phenomenon of areas dominated by *Cladonia zopfii* was seen several times during our visit. Fragments of the habitat do occur at the edges of other habitats as well, and sometimes there are mosaics or overlap, where *Cladonia zopfii* is locally frequent or dominant.

Examples: **(1.6.08)** **Plot 8** **NJ 05255.64376**

Plot 8 is fairly extensive, a slightly sloping flat area of small shingle with dwarf, scattered *Calluna*, and a pale green haze over the surface. *Cladonia zopfii* is abundant to dominant, with few other lichens present, some *Hypogymnia physodes* on *Calluna* stems, plus of course the ubiquitous *Cetraria aculeata*. Most of the stones here are small with low lichen colonization, although on one of the larger pebbles, *Arctoparmelia incurva* was seen.

Examples: **(4.6.08)** **Plot 17** **NJ 05228.64574**

Lichens recorded from Habitat 8 (Plot 8)

Lichens recorded – growing on the ground (T) or on pebbles (Pe); NR = Nationally Rare; NS = Nationally Scarce; NT = Red Data Book category Near Threatened; EN = Red Data Book category Endangered; VU = Red Data Book category Vulnerable; r = rare (at this Plot); r/o = rare/occasional; o = occasional; f = frequent; a = abundant; d = dominant.

Lichens	substrate	additional notes
Arctoparmelia incurva	Pe	
Cetraria aculeata	T	
Cladonia zopfii	T	NS, a/d
Hypogymnia physodes	T	

Findhorn Dunes, June 2008
Habitat 8, Fig. 8.1: Plot 8,
NJ 05255.64376
A shingle field with very shallow topography, small stones in a sandy matrix and low, scattered *Calluna*. Note the pathway across the site as a light area through the green 'haze' of *Cladonia zopfii*.

Findhorn Dunes, June 2008
Habitat 8, Fig. 8.2: Plot 8,
Detail showing the typical straggling habit of *Cladonia zopfii*, here with small pebbles and rabbit droppings, the rabbits browsing the *Calluna* and making small, localized scuffing among the lichen cover.

Findhorn Dunes, June 2008
Habitat 8, Fig. 8.3: Plot 8,
A view of Habitat 7, dominated by extensive cover of a single species, *Cladonia zopfii*, leading to this habitat being termed "The fields of Zopf". Brian Coppins examining some pebbles.

Findhorn Additional site records

On 7th May 2004. Bryan Edwards and Joe Hope stayed at Findhorn whilst carrying out Site Condition Monitoring for Lichens for SNH. The wandered out onto the dunes to the north of the village, and recorded lichens. Amongst the species they found were four populations of *Peltigera malacea*, at the following Grid Refs.:

Population 1, NJ03876 64789
Population 2, NJ03880 64778
Population 3, NJ03876 64773
Population 4, NJ03860 64765

They also found one population of *Psoroma hypnorum*. This Nationally scarce lichen was seen by us in 2008 only once, in short turf by the gate at the east end of the caravan site, at GR: NJ 0444.6465.

Bryan Edwards and Joe Hope recorded lichens from the area north of Findhorn village (GR: NJ 036.648 and 038.647) and also east of the village (GR: 047.643).

Pe = pebbles; T = terricolous (on sandy soils); NS = Nationally scarce; EN = Red Data Book category Endangered.

Bryoria fuscescens	T		Lecidea lithophila	Pe	
Cetraria aculeata	T		Ochrolechia frigida	T	
Cladonia arbuscula	T		Peltigera hymenina	T	
Cladonia cervicornis	T		Peltigera malacea	T	EN
Cladonia chlorophaea	T		Peltigera membranacea	T	
Cladonia ciliata var. ciliata	T		Peltigera rufescens	T	
Cladonia diversa	T		Placynthiella icmalea	T	
Cladonia fimbriata	T		Porpidia crustulata	Pe	
Cladonia foliacea	T		Porpidia tuberculosa	Pe	
Cladonia furcata	T		Pseudevernia furfuracea	T	
Cladonia portentosa	T		Psoroma hypnorum	T	NS
Cladonia pyxidata	T		Rhizocarpon geographicum	Pe	
Cladonia rangiformis	T		Rhizocarpon reductum	Pe	
Cladonia uncialis subsp. biuncialis	T		Stereocaulon condensatum	T	
Cladonia zopfii	T	NS	Thelenella muscorum	T	
Diploschistes muscorum	T		Trapeliopsis granulosa	T	
Hypogymnia physodes	T		Usnea subfloridana	T	
Lecanora dispersa	Pe		Xanthoparmelia mougeotii	Pe	
Lecanora polytropa	Pe		Xanthoria parietina	Pe	

Findhorn Dunes
Car Park site, Bryan Edwards & Joe Hope, **May 2004.**
Fig. 9.1:

NJ 038.647

The Car Park seen top right; in the foreground a partly vegetated shingle ridge, slightly base-rich habitat, moderately trampled with short, rabbit-grazed turf.

Findhorn Dunes
Car Park site, Bryan Edwards & Joe Hope, **May 2004.**
Fig. 9.2:

The same area, with yellow pointers marking patches of *Psoroma hypnorum*. The prostrate figure in the background is Joe Hope, looking for more colonies. *Peltigera malacea* was also found in this area.

Findhorn Dunes
Car Park site, Bryan Edwards & Joe Hope, **May 2004.**
Fig. 9.3:

Detail of *Psoroma hypnorum*, a cluster of small apothecia (looking like jam tarts) growing very close to the ground, so able to withstand moderate trampling.

Findhorn Dunes
Bryan Edwards & Joe Hope, May 2004.
Fig. 9.4:
NJ 047. 643
East of Findhorn village, looking west. A fairly disturbed habitat with *Calluna*, the yellow pointers (enhanced) showing instances of *Peltigera malacea*.

Findhorn Dunes
Bryan Edwards & Joe Hope, May 2004.
Fig. 9.5:
NJ 047. 643
Detail of a patch of *Peltigera malacea*.

Findhorn Dunes
Bryan Edwards & Joe Hope, May 2004.
Fig. 9.4:
NJ 047. 643
Another interesting lichen recorded in 2004 is *Diploschistes muscorum*, looking like a large bird dropping, but with little grey jam tarts (apothecia).

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Species name	Substr	Scale habitat	Record notes	W	E	SW	SE	NE	Cons Eval
Acarospora smaragdula	S	Pe		1	2				LC
Alectoria sarmentosa subsp. vexillifera	T				2			5	LC NS
Amandinea punctata	C	Cl		1					LC
Arctoparmelia incurva	S	Pe	NJ0559 6432		2				LC
Aspicilia grisea	S	Pe	c.ap.		2			5	LC
Bacidia caligans	T		on side of hummock		2				LC
Baeomyces rufus	T			1	2	3	4		LC
Bryoria fuscescens	C+T	P		1	2				LC
Buellia aethalea	S	Pe		1	2			5	LC
Buellia griseovirens	C	Cl,P			2				LC
Buellia jugorum	S	Pe	2006		2				DD NR
Caloplaca asserigena	C	Cl,P	on thin twigs		2				LC NS
Catillaria atomarioides	S	Pe		1	2			5	LC NS
Cetraria aculeata	T		c.ap.	1	2	3	4		LC
Cetraria muricata	C+T	Cl		1		3			LC
Cladonia arbuscula subsp. squarrosa	T			1	2	3	4	5	LC
Cladonia cervicornis subsp. cervicornis	T			1	2				LC
Cladonia cervicornis subsp. verticillata	T				2				LC
Cladonia chlorophaea s.lat.	T			1	2	3	4		LC
Cladonia ciliata var. ciliata	T			1	2	3	4		LC
Cladonia ciliata var. tenuis	T			1	2	3	4	5	LC
Cladonia cornuta	T			1					LC

Cladonia diversa	T			1	2	3	4		LC
Cladonia fimbriata	T				2				LC
Cladonia foliacea	T			1	2	3			LC
Cladonia furcata	T			1	2	3	4	5	LC
Cladonia gracilis	T			1	2	3	4		LC
Cladonia humilis	T			1		3			LC
Cladonia macilenta	T						4		LC
Cladonia macrophylla	T		NJ0487 6429	1					LC NS
Cladonia mitis	T			1	2			5	NT NR
Cladonia portentosa	C+T	Ux		1	2		4		LC
Cladonia portentosa	T		2004	1	2		4		LC
Cladonia ramulosa	T			1		3			LC
Cladonia rangiformis	T			1	2	3			LC
Cladonia squamosa var. squamosa	T			1		3			LC
Cladonia strepsilis	T				2			5	LC
Cladonia subcervicornis	T				2				LC
Cladonia subulata	T			1	2	3	4		LC
Cladonia uncialis subsp. biuncialis	T			1		3			LC

Cladonia uncialis subsp. uncialis	T			1	2	3			VU
									NS
Cladonia zopfii	T		esp. abundant at NJ0525 6437	1	2	3		5	LC
									NS
Cliostomum griffithii	C	P			2				LC
Dibaeis baeomyces	T				2				LC
Diploschistes muscorum	T		on Cladonia sp.		2				LC
Epilichen scabrosus #	T		on Baeomyces rufus	1					LC
									NS
Evernia prunastri	C + T	Cl,P		1	2	3	4		LC
Fuscidea cyathoides var. cyathoides	S	Pe			2			5	LC
Fuscidea lightfootii	C	Cl			2				LC
Fuscidea lygaea	S	Pe						5	LC
Hypogymnia physodes	C+T	Cl,P		1	2	3	4	5	LC
Hypogymnia tubulosa	C	Cl,P		1	2				LC
Imshaugia aleurites	C	Cl			2				LC
Lecania naegelii	C	Cl			2				LC
Lecanora confusa	C	Cl,P			2				LC
Lecanora dispersa	S	Pe		1	2				LC
Lecanora expallens	C	Cl,P			2				LC
Lecanora farinaria	C	P			2				LC
									NS
Lecanora persimilis	C	Cl		1					LC
Lecanora polytropa	S	Pe		1	2			5	LC
Lecanora pulicaris	C	Cl,P			2				LC
Lecanora symmicta	C	Cl,P,Ux		1	2				LC
Lecidea auriculata	S	Pe			2				LC
									NS
Lecidea brachyspora	S	Pe	NJ058 642		2				LC
									NS
Lecidea diducens	S	Pe			2				LC

							NS
Lecidea fuscoatra	S	Pe	aff. L. fuscoatra, C-; NJ0513 6459		2		LC
Lecidea lithophila	S	Pe			2	3	LC
Lecidea plana	S	Pe			2	3	LC
							NS
Lepraria elobata	T		E-facing sand bank		2		LC
							NS
Leptogium palmatum	T		on edge of gravelly track & old bank cuttingNJ0517 6406		2		LC
							NS
Melanelia subaurifera	C	Cl,P		1	2		LC
Micarea denigrata	T+Lig	LgCl	Terr - on moribund Cladina		2		LC
Micarea erratica	S	Pe		1			LC
Miriquidica pycnocarpa f. pycnocarpa	S	Pe			2		LC
Mycoblastus fucatus	C	Cl			2		LC
Ochrolechia androgyna	C+T	Cl		1	2		LC
Ochrolechia frigida f. frigida	T				2		LC
Ochrolechia frigida f. lapuensis	T				2		LC
							NR

Ochrolechia microstictoides	C	Cl			2				LC
Parmelia omphalodes	T				2				LC
Parmelia saxatilis	C+T+S	Cl,P,Pe			2			5	LC
Parmelia sulcata	C	Cl,P			2				LC
Peltigera canina	T			1	2				LC
Peltigera didactyla	T		mossy turf with cinders	1					LC
Peltigera hymenina	T			1	2	3			LC
Peltigera malacea	T		c.ap. @ NJ0500 6388	1	2		4		EN NR
Peltigera membranacea	T			1	2	3	4		LC
Peltigera rufescens	T		2004						
Physcia tenella subsp. tenella	C	Cl		1	2				LC
Placynthiella icmalea	T			1					LC
Placynthiella oligotropha	T			1			4		LC
Placynthiella uliginosa	T			1			4		LC
Platismatia glauca	T			1	2				LC
Polysporina simplex	S	Pe		1	2				LC
Porpidia cinereoatra	S	Pe			2				LC
Porpidia crustulata	S	Pe			2				LC
Porpidia tuberculosa	S	Pe		1	2			5	LC
Protoparmelia badia	S	Pe		1	2				LC
Protothelenella corrosa	S	Pe		1	2				LC NS
Pseudephebe pubescens	S	Pe	NJ058 642		2			5	LC
Pseudevernia furfuracea var. ceratea	C+T	Cl		1	2	3			LC
Psoroma hypnorum	T		in short turf by gate @ NJ0444 6465	1					LC NS
Pycnothelia papillaria	T				2				LC
Ramalina farinacea	C	Cl,P		1	2				LC

Ramalina fastigiata	C	Cl,P		1	2				LC
Rhizocarpon cinereovirens	S	Pe	2006		2				DD NR
Rhizocarpon geographicum	S	Pe		1	2				LC
Rhizocarpon lecanorinum	S	Pe			2				LC
Rhizocarpon reductum	S	Pe		1	2	3	4	5	LC
Rimularia furvella	S	Pe	mostly assoc. with Xanthoparmelia mougeotii		2				LC
Scoliciosporum chlorococcum	C	Cl			2				LC
Scoliciosporum umbrinum	S	Pe	& on cinders	1	2				LC
Stereocaulon condensatum	T			1	2	3	4	5	LC NS
Stereocaulon leucophaeopsis	S		on cinders @ NJ0449 6447	1					LC NS
Trapelia coarctata	S	Pe			2				LC
Trapelia obtegens	S		on cinders		4				LC
Trapelia placodioides	S	Pe			2				LC
Trapeliopsis flexuosa	C	Ux		1					LC
Trapeliopsis granulosa	T			1	2		4		LC
Thelenella muscorum	T		2004						
Tremolecia atrata	S	Pe	NJ0535 6460		2				LC
Tuckermanopsis chlorophylla	C	P			2				LC

Usnea hirta	C	Cl,P			2			LC
Usnea subfloridana	C	Cl,P		1	2		5	LC
Usnea wasmuthii	C	Cl	NJ0505 6470		2			LC
Xanthoparmelia mougeotii	S	Pe		1	2		5	LC
Xanthoparmelia pulla	S	Pe			2			LC
Xanthoparmelia verruculifera	S	Pe			2			LC
Xanthoria parietina	C	Cl			2			LC
Xanthoria polycarpa	C	Cl		1	2			LC
Lichenicolous Fungi								
Abrothallus cladoniae	Lic	Z0360	on Cladonia arbuscula		2			
Abrothallus prodiens	Lic	Z0582	on Hypogymnia physodes		2			
Cercidospora epipolytropa	Lic	Z0667	on Lecanora polytropa		2			
Corticifraga fuckelii	Lic	Z1043	on Peltigera hymenina			3		
Corticifraga peltigerae	Lic	Z1047	on Peltigera membranacea	1				
Lettauia cladoniicola	Lic	Z0360	on Cladonia arbuscula		2			
Lichenodiplis lecanorae	Lic	Z1836	in apothecia of Lecanora persimilis		2			
Muellerella pygmaea var. pygmaea	Lic	Z1266	on Rhizocarpon reductum		2			
Nesolechia oxyspora	Lic	Z1005	on Xanthoparmelia mougeotii		2			
Polycoccum trypethelioides	Lic	Z1351	on Stereocaulon condensatum		2			

Rhymbocarpus neglectus	Lic	Z0833	on Lepraria elobata @ NJ0520 6449		2
Skyttea gregaria	Lic	Z0908	on Mycoblastus fucatus		2
Stigmidium peltideae	Lic	Z1047	on moribund Peltigera membranacea	1	
Syzygospora bachmannii	Lic	Z0389	on Cladonia furcata		2
Taeniolella cladoniicola	Lic	Z0360	on Cladonia arbuscula		2

Totals
Total taxa = 145 (130 lichens & 15 lichenicolous fungi

Terricolous = 62
Saxicolous = 40 (38 on pebbles & 2 on cinders)
Corticolous = 37
Lignicolous = 1

Nationally Rare = 5

Nationally Scarce = 18

Endangered = 1
Vulnerable = 1
Data Deficient = 2
Near Threatened = 1

Record Notes
2004 = records by Bryan Edwards and Joe Hope; precise area not known
2006 = records by Brian & Sandy Coppins